Transactions of ISATE

The 13th International Symposium on Advances in Technology Education

Engineering Education for Sustainable Development in the 21st Century

17-20 September 2019

National Institute of Technology (KOSEN), Tokuyama College

ISATE 2019 Technical Program Committee

ISBN: 978-4-9911159-0-5

Published in 2019 by National Institute of Technology (KOSEN), Tokuyama College

Gakuendai, Shunan, Yamaguchi, 745-8585, Japan

Printed in Japan

Contents

About ISATE 1

ISATE 2019 Committees 2

Welcome Messages 6

Plenary Sessions 14

Institutional Presentations 22

Invited Lectures and Workshops 30

Transactions Index 38

- EdTech for the Future 54
- Pedagogy for the Contemporary Learner 212
- Learning Outcomes for Sustainable Development 363
- Partnership and Collaboration in Engineering Education 508

Presenters Index 638

About ISATE

The 13th International Symposium on Advances in Technology Education (ISATE) provides a platform for educators from institutions of higher education to share their knowledge and experiences in practice-based engineering and technology education. Through the Symposium, stakeholders can benefit from sharing innovative teaching methodologies and practices used in colleges from various countries.

Organizers

National Institute of Technology (KOSEN), Japan

Nanyang Polytechnic, Singapore

Ngee Ann polytechnic, Singapore

Republic Polytechnic, Singapore

Singapore Polytechnic, Singapore

Temasek Polytechnic, Singapore

IVE Engineering Discipline, Vocational Training Council, Hong Kong

Co-Organizers

Nagaoka University of Technology, Japan

Toyohashi University of Technology, Japan

ISATE 2019 Committees

Honorary Chair

Name	Institution
Dr. Isao Taniguchi	National Institute of Technology, KOSEN, Japan

General Chair

Name	Institution
Dr. Hidenori Isami	National Institute of Technology (KOSEN), Tokuyama College, Japan

Organizing Committee

Name	Institution
Dr. Kazuhito Amanai (Chair)	National Institute of Technology (KOSEN), Tokuyama College, Japan
Dr. Kentarou Kitamura (Deputy chair)	National Institute of Technology (KOSEN), Tokuyama College, Japan
Dr. Yorinobu Toya	National Institute of Technology, KOSEN, Japan
Dr. Tsutomu Matsumoto	National Institute of Technology, KOSEN, Japan
Dr. Kazutaka Baba	National Institute of Technology (KOSEN), Sendai College, Japan
Dr. Naritoshi Aoyagi	National Institute of Technology (KOSEN), Nagaoka College, Japan
Dr. Masatoshi Takeda	Nagaoka University of Technology, Japan

Dr. Akihiro Wakahara	Toyohashi University of Technology, Japan
Dr. Kong Wai Ming	Nanyang Polytechnic, Singapore
Mr. Andy Lee	Ngee Ann Polytechnic, Singapore
Mr. Long Tien Kian	Republic Polytechnic, Singapore
Mr. Danny Lee	Singapore Polytechnic, Singapore
Mr. Teo Sze Cheng	Temasek Polytechnic, Singapore
Ms. Katherina Tan	Temasek Polytechnic, Singapore
Dr. Frankie Leung	Hong Kong Institute of Vocational Education (Haking Wong), Hong Kong
Mr. Arthur Yu	Hong Kong Institute of Vocational Education (Haking Wong), Hong Kong
Dr. Juha Kontio	Turku University of Applied Sciences, Finland
Dr. Sutheera Puntheeranurak	King Mongkut's Institute of Technology Ladkrabang, Thailand

Technical Program Committee

Name	Institution
Dr. Norihiko Harada (Chair)	National Institute of Technology (KOSEN), Tokuyama College, Japan
Mr. Yasuhiro Kuramashi (Deputy chair)	National Institute of Technology (KOSEN), Tokuyama College, Japan
Dr. Akemi Emoto	National Institute of Technology (KOSEN), Tokuyama College, Japan
Dr. Hideaki Aburatani	National Institute of Technology, KOSEN, Japan
Dr. Seiji Fujiwara	National Institute of Technology, KOSEN, Japan
Dr. Katsumi Katakura	National Institute of Technology (KOSEN), Nara College, Japan
Dr. Yuko Uesugi	National Institute of Technology (KOSEN), Kure College, Japan
Dr. Yasuyuki Shimada	National Institute of Technology (KOSEN), Kumamoto College, Japan
Dr. Ching Wee Soon	Nanyang Polytechnic, Singapore
Dr. Kannathal Natarajan	Ngee Ann Polytechnic, Singapore
Mr. Andrew V	Republic Polytechnic, Singapore
Mr. Leo Chin Khim	Republic Polytechnic, Singapore
Dr. Daniel Lim	Singapore Polytechnic, Singapore

Dr. Tony Halim	Temasek Polytechnic, Singapore
Dr. Foo Chek Yang	Temasek Polytechnic, Singapore
Dr. Lau Wai Hoi Clement	Hong Kong Institute of Vocational Education (Tsing Yi), Hong Kong
Dr. Janne Roslöf	Turku University of Applied Sciences, Finland
Dr. Narisara Thongboonchoo	King Mongkut's Institute of Technology Ladkrabang, Thailand

Welcome Message

As the President of National Institute of Technology, Japan (NIT, KOSEN), it is my great pleasure and honor to welcome you to ISATE 2019 held in Shunan, Japan, on September 17-20, 2019, hosted by NIT, Tokuyama College.

ISATE provides a unique platform for educators and experts from institutions of higher education in engineering and technology around the world to share their knowledge and experiences in practical-based engineering and technology, and to foster young people with relevant knowledge and skills required for a better future of society. The symposium started in 2007 as an academic exchange program between 10 colleges under NIT in Kyushu and Okinawa areas of Japan and 3 polytechnics in Singapore. At present, ISATE is a regular annual event organized by 5 polytechnics (Nanyang Polytechnic, Ngee Ann Polytechnic, Republic Polytechnic, Singapore Polytechnic, Temasek Polytechnic) in Singapore, Hong Kong Institute of Vocational Education (IVE), and NIT (with its 51 Colleges, in Japan) together with, Nagaoka University of Technology and Toyohashi University of Technology in Japan. This year, I am pleased to have approximately 120 fruitful presentations. I would like to welcome a lot of members from overseas countries. Participants will provide new insights into engineering and technology education on the symposium theme of this year, “Engineering Education for Sustainable Development in the 21st Century” as the Main Theme with 4 Sub Themes, which are EdTech for the Future, Pedagogy for the Contemporary Learner, Learning Outcomes for Sustainable Development, and Partnership and Collaboration in Engineering Education. I hope through discussion in this symposium we can obtain more information to foster young people to be world-class engineers, as I recommend to call, “Social Doctors”, who work hard to keep the society healthy in hard and soft aspects, as “Creators” of new concepts and new values, and as “Innovators” for the future wealthy and affluent society.

I would like to sincerely thank the members of Organizing (Chair: Dr. Kazuhito Amanai) and Technical Program (Chair: Dr. Norihiko Harada) Committees for their great efforts to prepare this symposium, and Dr. Hidenori Isami, General Chair of this symposium and President of NIT, Tokuyama College, Japan, for hosting this symposium. Also, I would like to thank all the speakers who give the papers in this symposium.

I believe that ISATE 2019 is interesting, stimulating and rewarding for all participants. You will be able to share your knowledge and experiences in practice-based engineering and technology education. You also share innovative teaching methodologies and practices used in colleges from various countries. I hope you all enjoy this fruitful symposium and you will see many new friends and colleagues for further academic exchange and collaborations with a lot of new ideas. Once again, please enjoy the symposium and your stay in Shunan, the city of industry in harmony with history and nature, Japan.

Dr. Isao Taniguchi

President

National Institute of Technology, KOSEN

Japan

Welcome Message

First, I would like to express my sincere appreciation to the National Institute of Technology, Japan, for this opportunity to deliver the welcome message on behalf of the Singapore polytechnics.

The main theme for ISATE 2019, Engineering Education for Sustainable Development in the 21st Century, is aptly titled to reflect the present global sustainability-related issues and challenges facing us, and how Engineering Education can play a crucial role in helping our students appreciate these challenges, and co-create solutions to transform these challenges into opportunities to build a better world for today and beyond.

One major challenge facing countries worldwide is global warming which will pose serious threats to sustainability. As the average global temperature continues to rise, ice sheets in Greenland and Antarctica are melting and raising sea levels around the world. Low lying countries including Singapore are especially vulnerable to this threat. Singapore Prime Minister Mr Lee Hsien Loong mentioned in his recent National Day Rally speech that combating climate change in the forthcoming years will be crucial. On this front, there is much scope for Engineering Education to play a vital role in empowering our students with the relevant knowledge to implement good engineering solutions to protect Singapore against the impact of climate change and rising sea levels in the next 50 to 100 years. Mr Lee, in his speech, said, “In Singapore, for long-term problems, we can make long-term solutions.”

In the same vein, the Polytechnics in Singapore are collaborating with government agencies and industry partners on a new initiative called the Future City Programme. The central idea is to curate interesting and often back-of-house learning journeys, identify internship opportunities, and gather industry mentors who will share with students how their companies are reshaping the city we live in. We are seeking to collaborate with 10 to 20 companies who are shaping solutions for the city in areas such as transportation, health, energy, urban spaces, with a view for our students to meet with them, learn their plans and be inspired to build careers in them.

Concurrently, it is imperative that we innovate our teaching and learning practices, harness emerging technologies and adopt student-centric learning pedagogies such as experiential learning, immersive learning using AR/VR, flipped learning, design thinking, problem-based learning, service learning as part of the overall transformation in engineering education. Furthermore, Polytechnics continue to review and map our diploma course curricula to the national skills framework covering diverse industry sectors so that our graduates will be equipped with the key competencies to meet the future workplace challenges and for sustainable development in the 21st century.

ISATE 2019 is an excellent platform for us to share our vision, experiences and practices and I do hope that at the end of the Symposium, all of us will gain insights into new possibilities that we can implement, share or build on what we take away from here. I also hope that the networks established over these few days will endure for the benefit of our students in forging sustainable solutions for the betterment of our societies and future generation.

It leaves me to express my appreciation, on behalf of the five polytechnics in Singapore, to the ISATE 2019 Committees, and the staff and students of our host National Institute of Technology, Tokuyama College for their hard work in making this event possible.

I wish you all a pleasant stay and fruitful time at ISATE 2019.

Mr. Clarence Ti
Principal and CEO
Ngee Ann Polytechnic
Singapore

Welcome Message

On behalf of the Vocational Training Council (VTC), I would like to extend a very warm welcome to all delegates coming from different places to here, Tokuyama. I believe all of you, including me, are excited to attending this symposium in such a charming city, Shunan City.

IVE Engineering of VTC has been very honoured to become one of the organizers of ISATE since 2017. My colleagues are always keen to share their knowledge and experience in practice-based engineering and technology education with educators from different institutions of higher education. Last year, we were very delighted to hold the first ISATE in Hong Kong and it was also well received by the participants. I must take this opportunity to thank National Institute of Technology (KOSEN) and the five polytechnics from Singapore for including us in such a wonderful and meaningful platform for exchanges.

The development of Smart City is high on the agenda in many world cities, while the development and adoption of technology are the greatest and fundamental driving force. Hong Kong strives to be a world-class smart city where people are empowered by new technologies to boost connectivity and operation efficiency. Rising to this challenge, VTC advocates an approach “Technology Enhanced Learning (TEL)” by deploying emerging techniques and technologies, such as Virtual Reality (VR), Augmented Reality (AR), Mobile Learning and Gamification, etc., to enhance the students’ learning experience with innovative teaching methods. Various innovative technologies blended in learning and teaching activities could mimic different real-life scenarios and allow co-creation between industry and academia, help students comprehend the complex structure, operational principles and realistic situation, providing flexibility in learning. TEL is also important to prepare students to successfully engage in this new technological world and guarantee their bright future ahead. New facilities such as Building Information Modelling Innovation Hub, Robotics and Artificial Intelligence Laboratory, Big Data Studio, and IoT

Innovation and Technology Centre are established against this backdrop. Through these facilities, students could interact with experts from industries and enterprises in Hong Kong.

Underlying the theme "Engineering Education for Sustainable Development in the 21st Century", ISATE 2019 provides an excellent platform for us, as educators, to share insights on embracing technologies in engineering education and learning for grooming skilled engineering and technology professionals for future. The four sub-themes: EdTech for the Future, Pedagogy for the Contemporary Learner, Learning Outcomes for Sustainable Development, and Partnership and Collaboration in Engineering Education, will open more discussion opportunities for participants to exchange their thoughts on issues of common interests.

Last but not least, I would like to express my heartfelt gratitude to all members of the Organising Committee and Technical Programme Committee for their tremendous effort and contribution to the success of the symposium. I sincerely hope that all participants will have fruitful exchanges of ideas and experience on engineering education for sustainability. Once again, welcome participants and thank you very much for attending ISATE 2019!

Dr. Eric Liu

Deputy Executive Director

Vocational Training Council

Hong Kong

Welcome Message

This 13th International Symposium on Advanced in Technology Education (ISATE) is focused on 'Engineering Education for Sustainable Development in the 21st Century'. This event is hosted by National Institute of Technology, five polytechnics (Nanyang Polytechnic, Ngee Ann Polytechnic, Republic Polytechnic, Singapore Polytechnic and Temasek Polytechnic) in Singapore, IVE Engineering in Hong Kong, along with Nagaoka University of Technology and Toyohashi University of Technology.

As educators, we do our best to support our students. We are expected to foresee the future, to look ahead to the next 10 to 30 years and anticipate future trends. We are also expected to enhance the teaching environment so that our students can overcome challenges to realize their dreams. These are no borders in our efforts to improve the quality of education to cultivate creative and practical engineers. ISATE 2019 is a good platform towards these aims.

ISATE 2019 consists of 4 plenary sessions, 4 institutional presentations, 2 invited lectures, 4 workshops, and 114 research presentations from participants of various countries. These professionals are dedicated to engineering education. I look forward to the sharing of practical techniques to cultivate good engineering education for positive impact.

Dr. Nobuhiko Azuma

President

Nagaoka University of Technology

Japan

Welcome Message

It is my great honor as a co-organizer to welcome all of you to the International Symposium on Advances in Technology Education 2019 (ISATE 2019).

Globalized engineers have to have a comprehensive and integrated perspective about the future of the world, and the ability to bring together knowledge and technology at every level, because globalization is accelerating due to the spread of research networks and the increasing pace of technological innovation. In addition, recent very rapid growth of internet-based connected society and deep learning technology opened the door toward the Fourth Industrial Revolution. In order to foster global engineers who will play important roles in the new era, it is important not only to provide opportunities for acquiring fundamental knowledge and experience for latest technology, but also to train necessary skills for collaborating with other researchers beyond specialized fields, and also the philosophy of "Sustainable Development Goals".

The main theme of ISATE 2019, “Engineering Education for Sustainable Development in the 21st Century " is timely and very important subjects for considering new education system that is capable of coping with rapidly transforming technology. All of participants will share their experiences and knowledge by attending round table sessions and will find a solution for education of practical engineers. We will have 124 presentations and 4 workshops from 4 countries, i.e., Finland, Hong Kong, Singapore, and Japan. I hope that the symposium will contribute to furthering education for practical engineers in acquiring a comprehensive and multilateral perspective.

Dr. Takashi Onishi

President

Toyohashi University of Technology

Japan

Plenary Session 1

Challenge of “Social Implementation Education” in Tokyo KOSEN in order to Create Future Engineers

Mr. Koichi SHINPO
President,
National Institute of Technology (KOSEN),
Tokyo College,
Japan

Profile

Mr. Shinpo joined Tokyo KOSEN (National Institute of Technology, Tokyo College) as the President in 2016.

He was born in 1956 and graduated the faculty of engineering, Hokkaido National University. After graduation he entered the Ministry of Education, Science, Sports and Culture in 1983.

He has held various positions in this Ministry : Director of Technical Affairs Division, Director of Planning Division, Director of Educational Facilities Research Center of National Institute of Educational Policy Research, Deputy Director General in Department of Facilities and Administration, and so on.

His specialties are planning of educational facilities, facility management and financial affairs of educational facilities.

Abstract

We are developing a new higher education approach for KOSEN students to become engineers who can bring innovation and improve our society. This project is named “Social Implementation Education” and started in 2012.

We have suggested “Social Implementation Education” to provide students with opportunities of interacting with actual social issues and creating value in cooperation with people through dialogue and engineering solutions. We think, these are necessary experiences to develop for future engineers. In the process of this project, KOSEN students experience these 4 main steps.

Step1“Recognition of the issue” Step2“Design of the value to offer”

Step3“Introduction to society” Step4“Evaluation (Feedback)”

Students can take the initiative to discover social needs, interact with society, and create value with external cooperators. The comprehensive learning experience encourages the development of their practical technology, creative thinking, and communication skills. While addressing the needs of society, students extract their own themes and work on the social implementation of science and technology, taking advantage of the futures of their colleges, as well as regional characteristics.

“The Social Implementation Education Contest” is where such achievements are recognized. The contest enables students to both compete for their achievements and to obtain accurate evaluation from experts. It is also a great opportunity for teachers to explore ideal engineering design education. In 2018, 126 students (71 teams) from 19 KOSEN and a total of 529 audience participated in the contest.

We have been practicing for this education with dedicated curricula, which start from lower grades and are aimed at project-based graduation research work.

Plenary Session 2

Developing Next-Generation Engineers

Mr. Loh Yew Chiong
Senior Director,
Engineering, Singapore Polytechnic,
Singapore

Profile

Mr Loh Yew Chiong joined Singapore Polytechnic in 1996 as a lecturer in the School of Electrical & Electronic Engineering, after working as a software engineer for 3 years. He was appointed as Director of the School in 2014, and to his current position as Senior Director of the Engineering Cluster in 2017. As Senior Director, Mr Loh has oversight of the Polytechnic's School of Electrical & Electronic Engineering, School of Mechanical & Aeronautical Engineering and the Singapore Maritime Academy.

Mr Loh had taught various courses like Network Security, Broadband Communications, Digital Communications, Networks and Protocols, Programming and other professional industry certification courses. He was also involved in various staff and student R&D projects related to Next Generation Networks and Services.

Mr Loh holds a Bachelor of Engineering (1st Class Hons) from the University of Singapore and a Master of Science with Distinction (Communications and Signal Processing) from the Imperial College of Science, Technology and Medicine, UK. He was awarded the R&D Commendation Award in 2004 and 2009, and the Excellence in R&D Award in 2013 by Singapore Polytechnic. He was conferred the National Day Award - Public Administration Medal (Silver) in 2018.

Abstract

Singapore Polytechnic (SP) is the first polytechnic in Singapore, established in 1954 to address the manpower needs in the various stages of the nation's development. It has since developed into a comprehensive institution with pre-employment and continuing education courses in Architecture, Business, Computing, Design, Engineering, Sciences, Maritime and Media, and has graduated more than 200,000 alumni for the diverse industries within Singapore.

SP's Engineering education, since its establishment, has been a major pillar in the nation building, supporting the manpower needs in manufacturing, infrastructure development and industrialization. As Singapore is evolving towards an innovation-driven economy, the next-generation of engineers need to be equipped with multidisciplinary skillset and competencies, and imbued with a mindset of exploring new possibilities.

The Engineering schools have been adopting new pedagogical approaches such as Conceive, Design, Implement, Operation (CDIO), Design Thinking (DT) and FabLab since 2004 so that the next generation of engineers can graduate with technical, communication, teamwork, empathy, problem solving and lifelong learning skills and competencies.

The Engineering curriculum is also mindful of the need to apply the integrated set of skills and competencies to the workplace so that transformation can be introduced into the workplace by its new graduates. With this objective in mind, SP introduced a framework on Solution-Minded Internship in 2017 so that our graduating students will have opportunities during their internship, with deeper partnership with the industry, to transform and innovate processes and improve productivity.

This presentation will share how CDIO, DT and FabLab permeate the Engineering courses to achieve the intended graduate attributes and preliminary outcomes of the Solution-Minded Internship initiative.

Plenary Session 3

Extreme Human Centered Engineering

Dr. Ken Endo
CEO / Associate researcher,
Xiborg Co., Ltd. / Sony Computer Science Laboratories Inc.,
Japan

Profile

Ken Endo is an associate researcher at Sony Computer Science Laboratories Inc., and CEO of Xiborg Co., Ltd. Endo received his PhD as a member of the Media Lab's Biomechatronics group. At Sony CSL, he works on the technology that rehabilitates and augments human physical capability, such as prostheses and orthoses. His team is now developing an athletic prosthesis with a goal of a gold medal in the 100m/200m sprint at the Tokyo Paralympic games in 2020. He has been named to MIT Technology Review's list of top innovators under 35 (TR35). He has also been chosen as a Young Global Leader 2014 by the World Economic Forum.

Abstract

Recently, a number of inventions have been developed and deployed by lead users as Eric Von Hippel, Professor at Massachusetts Institute of Technology reported. This indicates a person or organization who has an actual problem has more opportunity to find a solution as he knows what problem is. Furthermore, cutting technology is more likely be applied in the situation where market exists like Formula One. We propose extreme human centered design beyond human center design by developing two kinds of prostheses, one is a robotic prosthesis and the other is a running-specific prosthesis. In the both cases, we focus on specific persons and develop a solution based on knowledge of our team including mechanical engineering, biomechanics, robotics, rehabilitation, prosthetics and so forth. In this talk, I will talk about a process of designing prostheses from a view point as an engineer.

Plenary Session 4

Skilling Talent for Sustainable Developmnet through Workplace Learning and Assessment

Mr. Jonathan Kam-fat LEE
Assistant Executive Director cum Deputy Academic Director (Engineering),
Vocational Training Council,
Hong Kong

Profile

Mr. Jonathan LEE is the Assistant Executive Director of Vocational Training Council (VTC) cum Deputy Academic Director of the Engineering Discipline and concurrently acts as the Vice Principal of the Hong Kong Institute of Vocational Education (Tsing Yi) and the Strategic Leader of the VTC STEM Education Centres. Prior to his current positions, he served as the Head of the Department of Engineering in the Hong Kong Institute of Vocational Education (Chai Wan & Sha Tin) and the Senior Project Manager in the Engineering Discipline Planning Office.

Mr. Lee is a seasoned educator and has extensive knowledge and experiences in leading strategic initiatives such as promoting internationalization, STEM (Science, Technology, Engineering and Mathematics) education, and workplace learning and assessment for the VTC. Mr. Lee also served as Education Advisor and Expert of the Automation and Robotics in the VTC. His research interests include the development of elderly care robot to improve the quality of life for the seniors, smart manufacturing applications to suit the latest Industry 4.0 development and nurturing young talents through STEM education and training, and the development of STEM experts for supporting the continuous development of Hong Kong.

Before joining the VTC, Mr. Lee started his teaching career at the University of Hong Kong and the Hong Kong Polytechnic University. Mr Lee is a professional engineer with expertise in robotics and automation. Apart from teaching, he actively participated in the engineering-related consultancy projects in Hong Kong and China. He had developed and delivered professional training programmes for various government departments in

Hong Kong and served as a moderator at the Hong Kong Examination and Assessment Authority. Mr. Lee currently serves as an advisor of the Institute of Measurement and Control and a senior advisor of the Shenzhen Automation Association.

Abstract

With an increasing emphasis on Vocational and Professional Education and Training (VPET) in Hong Kong, the Vocational Training Council (VTC), in support of the HKSAR Government's commitment to promote VPET programmes, is launching a strategic initiative – **Workplace Learning and Assessment** (WLA) which aims to integrate workplace training into the VTC's programme curricula so as to enhance trainees' capabilities and enable them to become more work-ready with the professional knowledge and industry-relevant skills required by the employers.

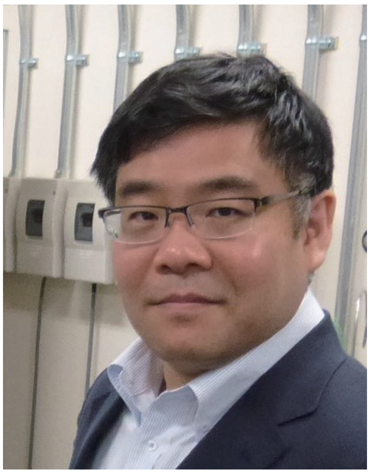
Referencing the best practice of the internationally recognized German and Swiss dual-track vocational and education systems, and the well-established WLA model adopted in New Zealand, the VTC has developed its own WLA system. A competency-based approach is adopted in implementing workplace assessment, which focuses on collecting and judging evidence of a trainee's competence against specified unit standards. Trainees' competencies are assessed in an authentic workplace to ensure that their performance could meet the employers' needs. In this regard, the employers' inputs are indispensable to the design of the WLA activites which have subsequently been incorporated into the programme curricula. It is undoubtedly a significant breakthrough in fostering a dual-track culture and a more structured duck-track model in VPET development of Hong Kong. To facilitate the implementation of WLA in a more interactively and efficiently way among the VTC, employers and trainees, a web-based assessment system will be rolled out in 2019.

The Government is also strongly supporting the launch of WLA by introducing the Pilot Incentive Scheme to Employers in 2019 to encourage employers to join hands with the VTC to develop and implement structured WLA activities, through which, workplace training could further be standardised and formalised, that contributes to sustain a well-trained and qualified workforce in the industry.

In this presentation, the development of Workplace Learning and Assessment in VTC programmes, its good practices and challenges will be addressed.

Institutional Presentation 1

Development of Evaluation Indicators of Achievement in Engineering Experiments in KOSEN



Dr. Koji Takamura
Professor
National Institue of Technology (KOSEN),
Asahikawa College,
Japan

Profile

Dr. Takamura is currently the Assistant President and the chief of the Department of Electrical and Computer Engineering, at National Institute of Technology(KOSEN),Asahikawa College, Japan. He receieved his Ph.D. in Physics at Hokkaido University, Japan, in 1999. He joined Asahikawa KOSEN in 2003 and was promoted to a full professor in 2016.Before joining KOSEN, he studied spintronics in Tohoku University in Japan from 1999 to 2003.His major field of study is semiconductor physics and engineering education.

His current work focuses on guaranteeing the quality of education and the development of the method to do assesment/evaluation of students'skills in engineering experiments.

He served as a leader in the project of "the development of evaluation indicators of achievement in engineering experiments in KOSEN" from 2015 to 2018.

Abstract

In Japanese higher education, there has been a great emphasis on guaranteeing the quality of education. Each school of the National Institute of Technology (KOSEN), Japan had individually been making an effort to enhance students'experimental skills. KOSEN recently established the Model Core Curriculum (MCC), which clarifies the abilities and skills each student should acquire while at college whichever college they belong to. Moreover, in order to carry out the experimental section of the MCC properly, we developed a set of new indicators to evaluate the KOSEN students' achievement in engineering experiments.

The system of our evaluation consists of three parts. In the project, we first made a common guideline to make textbooks on experiments in all the fields of engineering; i.e., Mechanical, Material, Electrical and Electronics, Information, Chemistry and Biochemistry, Civil, and Architecture engineering. The guideline proposes three levels of achievement (Level 1: knowledge and memory; Level 2: comprehension; and Level 3: application, which was determined based on the Revision of Bloom's Taxonomy). Second, we made a total of more than 200 model textbooks on experiments based on the guideline. Third, we made evaluation sheets for each model textbook.

In our new approach to promote the use of the evaluation indicators, we made instruction books which show how to use the model textbooks and evaluation sheets we developed. In addition, we showed how to make new evaluation sheets for the experiment textbooks each KOSEN had individually made before. We also propose the way to modify each KOSEN's original textbooks on experiment so that they can easily make evaluation sheets for the textbooks.

Institutional Presentation 2

Key to Developing Professionals of the Future – OJT

Ms. Loh Chuu Yi
Director, Centre for Industry & Lifelong Learning,
Nanyang Polytechnic,
Singapore

Profile

Chuu Yi is the Director of the Centre for Industry & Lifelong Learning at Nanyang Polytechnic (NYP). She oversees strategies, policies and processes for industry collaboration, continuing education and training at the polytechnic. The centre coordinates across 10 schools and CET institutes to drive these areas.

Prior to this role, she was leading and managing the School of Business Management for 3 years. Her responsibilities span across areas including Staff and Student matters, Academic Programmes, Professional Training and Industry Collaborations.

A computer engineer in training, she had also been with the School of IT for 15 years and had worked closely with industry leaders such as Microsoft, IBM, SAP and many others to bring industry best practices and technology into NYP's pedagogy and curriculum. In particular, she championed the setup of the Big Data & Analytics Innovation Centre, Cloud Enablement Centre and Enterprise Mobility Innovation Centre at the school.

Her other experiences include project development and management for the Ministry of Defence during her stint with the Defence Science and Technology Agency.

Abstract

The world is changing and at a speed that is unprecedented; changes driven by the rise of disruptive technologies, pervasive connectivity, new media ecology and increasingly VUCA (volatile, uncertain, complex, ambiguous) environment. This presentation aims to address how On-the-Job (OJT) training at the workplace is a key approach to better prepare our learners for the future. The 70:20:10 learning model proposed by Michael M. Lombardo and Robert W. Eichinger opined that the workplace itself is a significant source of learning. The presentation will discuss why workplace learning is a key mode of learning and how instituitions can work closely with employers in developing professionals of the future. It will also share how Singapore help enterprises develop and implement workplace learning with the setup of the National Centre of Excellence for Workplace Learning (NACE) by Nanyang Polytechnic and SkillsFuture Singapore. The centre collaborates with the Swiss Federal Institute for Vocational, Education and Training and the German Chamber of Industry & Commerce drawing on their expertise to adapt the Best-In-Class (BIC) model for Singapore enterprises. The presentation will conclude with some examples of companies NACE has engaged and how the 5 polytechnics came together to harmonise OJT for Earn-and-Learn programmes across 25 sectors.

Institutional Presentation 3

Integrating Lifelong Learning into Vocational and Professional Education and Training (VPET)

Ir. Peter Si Kit

Project Manager

Engineering Discipline In-service Training Office

Vocational Training Council

Hong Kong

Profile

Ir Peter Si Kit is currently Project Manager of Engineering Discipline In-service Training Office (EDITO) under the umbrella of Vocational Training Council (VTC). He received his Associateship in Production and Industrial Engineering at the Hong Kong Polytechnic University, his Master's Degree in Industrial Engineering at the University of Hong Kong and a Master's Degree in Information Technology Management at the Staffordshire University of United Kingdom. He joined VTC since 1993 and has over 26 years' of experience in the Vocational and Professional Education and Training (VPET) in Hong Kong.

Ir Si's professional engineering qualifications/memberships include: Chartered Engineer (UK), Member of Hong Kong Institution of Engineers (MHKIE) and Member of The Institution of Engineering and Technology (MIET). Ir Si is also serving in various professional bodies. He is currently Deputy Chairman of Manufacturing and Industrial Division Committee of Hong Kong Institution of Engineers, Executive Committee Member of Hong Kong ACM SIGGRAPH and the Former Chairman of Manufacturing and Industrial Engineering Section of the Institution of Engineering & Technology Hong Kong.

Abstract

Vocational Training Council (VTC) was established in 1982, is the largest Vocational and Professional Education and Training (VPET) provider in Hong Kong. VTC provides valuable credentials for some 200,000 students each year through a full range of pre-employment and in-service programmes with internationally recognized qualifications.

VPET is an integral part of our education system, which is provided at different levels of the education system, offering diploma to post-graduate qualifications. It is the Hong Kong Special Administration Region (HKSAR) Government's policy to provide multiple and flexible pathways for young people with diverse aspirations and abilities through VPET. This is achieved by providing subventions and support measures to the University Grants Committee-funded universities, VTC and other post-secondary education and training institutions, and financial subsidy to students to enable them to acquire skills and knowledge that prepare them for employment and at the same time equip them with the foundation for lifelong learning. Furthermore, the Government also invests heavily in strengthening our qualifications system through development of the Hong Kong Qualifications Framework to facilitate recognition of vocational and professional qualifications with a view to promoting the status and value of VPET and supporting lifelong learning.

Lifelong learning is the "ongoing, voluntary, and self-motivated" pursuit of knowledge for either personal or professional reasons. Therefore, it not only enhances social inclusion, active citizenship, and personal development, but also self-sustainability, as well as competitiveness and employability. Evolved from the term "life-long learners", the term recognizes that learning is not confined to childhood or the classroom but takes place throughout life and in a range of situations. During the last fifty years, constant scientific and technological innovation and change has had profound effects on how learning is understood. Learning can no longer be divided into a place and time to acquire knowledge (school) and a place and time to apply the knowledge acquired (the workplace). Instead, learning can be seen as something that takes place on an ongoing basis from our daily interactions with others and with the world around us.

In the presentation, it is going to share the experiences how to integrate lifelong learning into the Vocational and Professional Education and Training (VPET) in Hong Kong with case studies.

Institutional Presentation 4

Building a Technical Innovation University @TUAS

Dr. Juha Kontio
Dean,
Faculty of Engineering and Business,
Turku University of Applied Sciences,
Finland

Profile

Juha Kontio is a Doctor of Sciences in Economics and Business Administration. He received the M.Sc. degree in Computer Science from the University of Jyväskylä in 1991 and the D.Sc. degree in Information Systems from Turku School of Economics in 2004. Currently he is Dean at the Faculty of Engineering and Business in Turku University of Applied Sciences. Previously he worked as Principal Lecturer and Degree Program Manager in Business Information Systems. His research interest is in higher education related topics such as quality enhancement and teaching and learning. He has presented and published over 100 papers. He is one of the co-leaders in the European CDIO region and a CDIO Council member.

Abstract

The engines of growth in Southwest Finland are export companies competing in the international operating environment and new startups. Turku University of Applied Sciences produces the expertise in engineering and business needed by these companies for global success. In cooperation with our trade and industry partners as well as partner universities, we are building a technical innovation university of working life in Southwest Finland by establishing new faculty covering all engineering and business activities. This new faculty of Engineering and Business answers the future requirements of the working life such as strong professionalism, responsiveness, active participation, multiprofessional collaboration and continuous learning from professionals. Turku University of Applied Sciences supports the build-up of these skills through the Innovation pedagogy operational model. It emphasizes the learner's own responsibility and the significance of continuous collaboration with working life as a foundation of learning. In addition to Innovation Pedagogy we utilize ideas of the CDIO approach. Innovation pedagogy combines learning and applied research, development and innovation activities with the development needs of the working life in our region. The CDIO approach aligns with the Innovation Pedagogy and brings several important elements to higher education such as active learning, design-build experiences, engineering workspaces and faculty development. Our learning environments consist of our working life partners as well as the state-of-the-art laboratories and training facilities which act as our students' workplaces and are used and developed in cooperation with working life. Currently we are investing heavily to our laboratories in Digital factory, New Energy and Cybersecurity for example. We build flexible and multidisciplinary competence tracks that support the continuous evolution of working life and continuous development of personal learning. Our graduates are prepared for the changing needs of working life with elements such as the Project Hatchery and the Innovation Project. This presentation describes how technical innovation university @TUAS is built and what are the key elements of it.

Invited Lecture 1

Necessity of Education on System Safety in KOSEN in Asian Countries

Dr. Takabumi Fukuda
Prof. Dr.,
Department of System Safety,
Nagaoka University of Technology,
Japan

Profile

Takabumi Fukuda was born in 1956. He graduated Yokohama national University in 1979, and worked for Toyo Denki Seizo K.K. (Toyo Electric Mfg. Co., Ltd.) until 1983 as a mechanical engineer. After the job, he studied in Master and Doctoral course and got his position in Yokohama National University, Department of Safety Engineering. In 1995, he got his Dr. degree in Safety Engineering. He got his position in Nagaoka University of Technology, Department of System Safety in 2006, and since 2010 he is a professor.

His recent study field is safety measures based on International Standards and risk assessment.

He is also the chief of Japanese national committee for IEC/TC44, “safety of machinery - electrotechnical aspects” and chief of Japanese national committee and member of international committee (expert) for ISO/TC313, “safety of packaging machinery.”

Abstract

KOSEN graduates are involved in product development and design as practical engineers. In product design, it is naturally necessary to realize the specification concerning required performance. Adding to this, at the same time the implementation of risk assessment and safety design based on the risk assessment is essential. Globally, taking safety measures is a basic requirement for launch. In other words, products can not be put on the market without risk assessment and safety measures. The safety design includes techniques based on unique one, but the basics are common with various products and is not difficult. Rather, it is important to know the basics. Safety design is performed in the following steps. (a) carring out risk assessment to find potential hazards and hazards in the product. (b) reduction of risk identified in risk asessment by changing the product design. (c) reducing risk using guards and safety devices. (d) transfer of the remaining risk to the user. (e) implemention of appropriate measures based on information of (d). Performing safety design in the order of (b), (c) and (d) is called a “three-step method.” In addition to the safety of the product, the safety of work to make the product is also important. In other words, also in the design of manufacturing lines, risk assessment and implementation of safety measures by the three-step method are necessary. Therefore, by learning the basics of safety design, it is possible to ensure product safety and work safety. To learn the basics of safety while in KOSEN, the engineers who have graduated KOSEN can considere safety from the early stages of product or production line design, and as a result, it can be put on the world-wide market inexpensively and smoothly. From the above merits, the importance of teaching the fundamentals of safety in KOSEN are clear. Its curriculum examples are shown in this report.

Invited Lecture 2

Developing Future Ready Talents through Curriculum Redesign - Temasek Student Profile

Dr. Tony Halim
Assistant Director,
Temasek Polytechnic,
Singapore

Profile

Dr Halim is the Assistant Director with the School of Engineering, Temasek Polytechnic. He oversees the student development and career guidance for the School of Engineering students. He started his career as an Engineer with STMicroelectronics before joining National University of Singapore (NUS) in Singapore where he joined as Research Engineer and he was re-appointed as Research Fellow subsequently. Besides teaching, he also does research focusing on industrial engineering, sustainable supply chain management and business analytics. Having many years of experience as an Engineer, Dr Halim has also published widely on industrial and systems engineering matters in several leading Engineering journals. He holds a PhD in Industrial Engineering and also sits on the Training Advisory Committee for Singapore Logistics Association's training arm, The Logistics Academy. Dr Halim is a regular presenter and panel moderator at international conferences and career fairs.

Abstract

In 1993, TP first came up with a target graduate profile to describe the kinds of attributes that TP wants to develop in its students. Over the years, this graduate profile has been continually updated and fine-tuned to keep TP up-to-date with the world that we are preparing students for.

In 2017, and in the context of a VUCA world and the nation's SkillsFuture initiative, we believed that it was time once again to review and update the set of attributes we want in our students, to better prepare them for the future economy not only by equipping them with industry-relevant skills, but life skills as well – such as a passion for lifelong learning, entrepreneurship, and good citizenship.

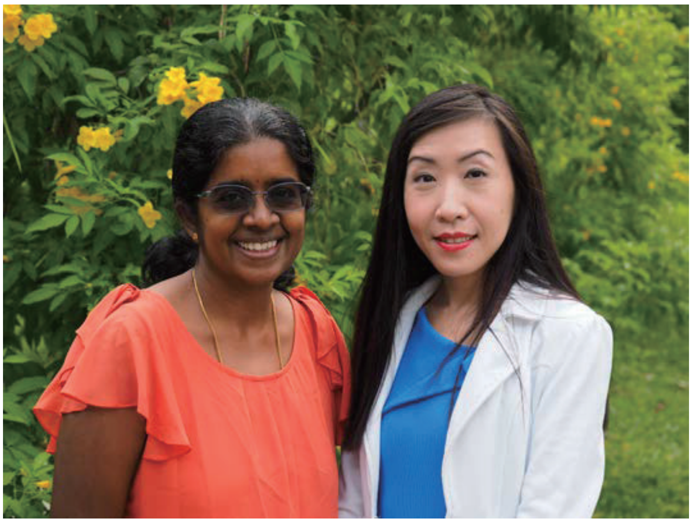
The intent of our curriculum redesign was to enable us to develop a strong foundation in our students, while at the same time having a stronger focus on developing life skills, which will help see our graduates through he world of work, and life as well.

Workshop Sub-theme 1

EdTech for the Future

Ms. Erika Foo
Assistant Director,
Centre for Educational Development,
Republic Polytechnic,
Singapore

Dr. Kannathal Natarajan
Senior Manager and Senior Educational Specialist,
School of Engineering,
Ngee Ann Polytechnic,
Singapore



Workshop Summary

With the advent of Education Technology (EdTech), curriculum developers are faced with a demand to marry technological affordances with pedagogical considerations. This workshop aims to guide participants in the use of EdTech for curriculum design and delivery, with a focus on key pedagogical considerations and guidelines, as well as emerging trends and associated affordances.

Participants in this workshop will be introduced to use cases involving EdTech tools to drive specific outcomes such as learners' engagement, communications and collaboration, and immersive learning. Through team-based breakout discussions, participants will ideate and propose ways to leverage EdTech meaningfully in their curriculum now, and more critically, in the future. The workshop presenters will guide the participants in their curriculum design through use of driving questions and though-provoking interactive activities.

At the end of the workshop, the workshop facilitators will invite participants to share their proposals, and to conduct peer review of these proposals in order to strengthen and build on the ideas shared.

Workshop Sub-theme 2

Pedagogy for the Contemporary Learner

Making the change in education through Innovation pedagogy

Dr. (cand.) Meiju Keinänen

M.A. (Educ.), Senior lecturer,
Turku University of Applied Sciences,
Finland

Dr. Janne Roslöf

D.Sc., Head of Education and Research,

Turku University of Applied Sciences,
Finalnd

Workshop Summary

Since the first machines were invented we have experienced several industrial revolutions which have profoundly changed the way how work is done. It is now possible to build a smart factory using digitally connected network of different machines. The current revolution is called Industry 4.0. Using all these opportunities of digitalization requires new knowledge and skills and challenges the ways how we educate the future professionals. Industry 4.0 requires a change in education which can be called Education 4.0.

One way to approach the revolution in education is Innovation pedagogy. It is a learning approach which aims at producing graduates who have the ability of participating in the innovation processes required in Industry 4.0. To reach this aim innovation pedagogy concentrates on making sure that both study field specific competences as well as innovation competences are set as an aim for the students' learning. In innovation pedagogy, the students must adapt the attitude of life-long learning and take ownership of their learning. Moreover, developing their personal character qualities in authentic project-based practical applications becomes crucial.

This workshop focuses on discussing how to make change to meet the challenges of Education 4.0. We start the workshop by presenting the cornerstones of Innovation pedagogy and sharing some examples of how to make the change. After that, the theme will be discussed together with the participants by aiming at co-creating ways of implementing the change with activating methods and sharing best practices.

Workshop Sub-theme 3

Learning Outcomes for Sustainable Development

Mr. Curtis Revis
Global Coordinator and Curriculum Designer,
National Institute of Technology (KOSEN),
Tokuyama College,
Japan

Mr. Yasuhiro Kuramashi
Associate Professor,
National Institute of Technology (KOSEN),
Tokuyama College,
Japan

Workshop Summary

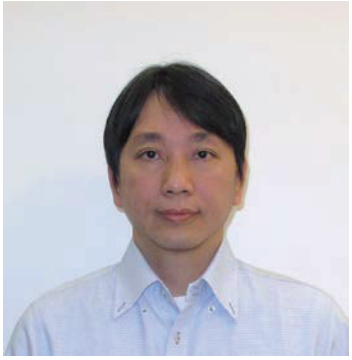
The principle aims of this workshop is to foster discussion which can help participants identify desirable learning outcomes for sustainable development, note barriers to implementing those learning outcomes at their schools, and outline methods for overcoming those barriers. More specifically, participants will:

1. Review the 17 Sustainable Development Goals (SDGs) as outlined by the World Health Organization.
2. Examine a list of common learning outcomes (LOs) specifically tailored to reach these SDGs.
3. Select which LOs the participants would like to see implemented at their own schools.
4. Identify the nature of barriers that stand in the way of implementing these learning outcomes, whether they be institutional, cultural, or other.
5. Discuss with other workshop members in their groups whether they have identified similar barriers and how they have already overcome those barriers or ways in which these barriers could be overcome.

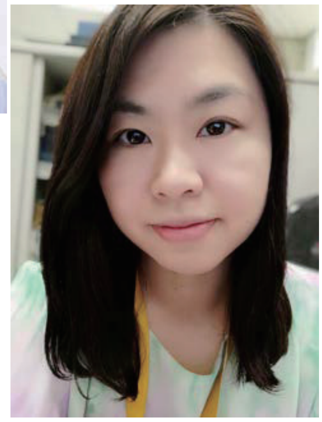
As a group, present their conclusions to the workshop.

Workshop Sub-theme 4

Partnership and Collaboration in Engineering Education



Mr. Winston Yeung
Senior Lecturer,
Department of Engineering,
Institute of Vocational Education,
Vocational Training Council,
Hong Kong



Ms. Mavis Lam
Senior Project Officer,
Engineering Discipline Planning Office,
Vocational Training Council,
Hong Kong

Workshop Summary

Terms like “smart cities”, “AI” and “Industry 4.0” definitely involve manpower in engineering related fields. The needs for engineering and technology talents are therefore anticipated. However, a common phenomenon is that young people do not treat engineering career as their top priority. How to arouse young people’s interest in engineering and technology education is always a hot topic in the global engineering education agenda. Education sectors cannot work alone, instead academia-industry partnership and collaboration would be a solution. But what should be done? To whom should be partnering and collaborating? To what extent are such partnership and collaboration go? Who else should be involved?

In this workshop, individuals will be participated to think of what could be done to enhance engineering education through partnership and collaboration, and their pros and cons of doing so based on everyone’s experience and linkages. VTC’s cases and experiences in associating industries to students through competition and projects would be shared with participants. Through real-world projects with industrial partners, would students appreciate the insight of engineering and the power of engineering to leverage the world we live in? Would collaboration to stakeholders assist in nurturing future engineering talents? Summing the wisdom of participants, hope we can see some light.

Transactions Index
Sub theme 1: EdTech for the Future

No.	Paper ID	Title & Authors	Institution	Page
1	3040614	**GROUP LEARNING WITH THE ELEMENTS OF THE GAME** Nobuyuki Sochi, Yasuyuki Kubo, Sae Ishida and Takahiro Makiyama	National Institute of Technology (KOSEN), Yuge College, Japan	55
2	3056237	**ENHANCING PHYSICS EDUCATION USING INTERACTIVE ELECTRONIC BOOKS FOR DIFFERENTIAL AND INTEGRAL CALCULUS, MECHANICS AND AN LMS** S. Fujiwara and M. Takiguchi	National Institute of Technology (KOSEN), Hiroshima College, Japan	61
3	3020676	**VIRTUAL AND AUGMENTED REALITY LEARNING FOR LIFT MAINTENANCE - SUBSTANTIAL ADVANCEMENT IN LIFT MAINTENANCE TRAINING** Hoi Kok Calvin CHEUNG, Kin Sang Timothy LEE and Sai Lok Eric LIU	Hong Kong Institute of Vocational Education, Hong Kong	66
4	3034335	**PILOT STUDY: THE EFFECTIVENESS OF SMARTBOOK FOR FLIPPED CLASSROOM LEARNING IN SCIENCE** Tiong Wei TAN, Edmund LUI and Adrian YEO	Singapore Polytechnic, Singapore	70
5	3031618	**ENCOURAGING MULTIMEDIA AND DIGITAL LITERACY FOR COLLEGE STUDENTS IN RURAL JAPAN WITH PRESENTATIONS AND VIDEO EDITING** Tomek ZIEMBA and Yoshiko ASAMI	National Institute of Technology (KOSEN), Oita College, Japan	76
6	3037749	**EFFECTS OF STEP-BY-STEP ACTIVATION LEARNING IN A PRIMARY COMPUTER PROGRAMMING CLASS** N. Fujishima	National Institute of Technology (KOSEN), Matsue College, Japan	79
7	3031898	**AN ONLINE-BASED EDUCATIONAL FRAMEWORK FOR KOSEN SPACE ACADEMY: THE FIRST YEAR'S RESULTS (2018)** T. Takada, K. Kitamura, J. Nakaya, Y. Kajimura, M. Tokumitsu, M. Wakabayashi, Y. Murakami, N. Hirakoso, K. Imai, A. Kudo, and M. Shinohara	National Institute of Technology (KOSEN), Kochi College, Japan	85

No.	Paper ID	Title & Authors	Institution	Page
8	3060557	**EMPOWERING WOMEN IN STEM: COLLEGE STUDENTS AND SCHOOL PUPILS** Kaori Tsukazaki and Tamiko Ohshima	National Institute of Technology (KOSEN), Kagoshima College, Japan	91
9	3063270	**USING EYE-TRACKING EQUIPMENT TO IMPROVE READING STRATEGIES ON STANDARDIZED TESTS** M.K. Higa and J.C. Herbert	National Institute of Technology (KOSEN), Matsue College, Japan	95
10	3222595	**ANALYSIS OF CORRELATION BETWEEN CLASS ACTIVITY AND STUDENTS' ATTENTION IN ACTIVE LEARNING CLASS FROM BIOLOGICAL VIEWPOINT** Y. Ichikawa, K. Moriya, R. Komura, M. Morimoto, K. Yajima and M. Nakagawa	National Institute of Technology (KOSEN), Tokyo College, Japan	99
11	3095905	**ICT IN TECHNICAL TEACHING TO ENGLISH AS FOREIGN LANGUAGE LEARNERS** Huiyu Zhang, Linda Fang and Hidetoshi Nakashima	Temasek Polytechnic, Singapore	103
12	3052836	**ONLINE COLLABORATIVE LEARNING: STUDENTS' PERCEPTION AND LEARNING EXPERIENCE - A MIXED METHODS STUDY** L. Cai, C.H. Chye and Y.A. Fattah	Nanyang Polytechnic, Singapore	109
13	3063028	**A BLENDED REMOTE LEARNING APPROACH IN ELECTRONICS TECHNOLOGY MODULE** Andy Lee Chung Hong	Ngee Ann Polytechnic, Singapore	116
14	3056359	**COMPARISON OF HANGEUL LEARNING METHODS FOR JAPANESE LEARNERS FOCUSING ON VOWELS AND CONSONANTS** Hiroaki Kosaka, Rika Akiyama and Keunyoung Pak	National Institute of Technology (KOSEN), Nara College, Japan	122
15	3063208	**MATCHING EDUCATIONAL PROGRAMS WITH SKILL OF STUDENTS IN INFORMATION SECURITY EDUCATION** R. Komura	National Institute of Technology (KOSEN), Ishikawa College, Japan	126

No.	Paper ID	Title & Authors	Institution	Page
16	3033737	**TEACHING TRADITIONAL JAPANESE ARCHITECTURE: HOW THE CONSTRUCTION OF AN OKOSHIE CAN LEAD THE STUDENTS TO A BETTER SPATIAL UNDERSTANDING** A.P. Higashino	National Institute of Technology (KOSEN), Akashi College, Japan	129
17	3035555	**EFFECTIVENESS OF THE PBL APPROACH IN CIVIL ENGINEERING TO DEEPEN STUDENTS' UNDERSTANDING** Naho TAKEDA, Vic Marie I. Camacho, Melody M. Clerigo and Crist John M. Pastor	National Institute of Technology (KOSEN), Akashi College, Japan	134
18	3017243	**ANALYSIS OF THE STUDENT PERFORMANCE IN ENGINEERING MODULES BY APPLYING FLIPPED CLASSROOM CONCEPT** K.C. Ying and Benson K.H. Hung	Hong Kong Institute of Vocational Education (IVE), Vocational Training Council (VTC), Hong Kong	139
19	3062551	**DESIGN OF THE CONSTRUCTION ENGINEER EDUCATION FOR i-CONSTRUCTION AND ITS APPLICATION FOR THE RECURRENT EDUCATION PROGRAM** M. Ohya, J. Asada, N. Hirose, Y. Okazaki, S. Arao, S. Kawahara, M. Takebe, M. Suto, T.Yamaguchi, Y. Matsuzaki, S. Omote and S. Ajiki	National Institute of Technology (KOSEN), Matsue College, Japan	145
20	3062364	**INTRODUCTION OF TRINITY OF SCINCE: PHYSICS, EXPERIMENT AND MATHEMATICS FOR INTERNATIONAL STUDENTS** S.Fujii and H. Ohno	National Institute of Technology (KOSEN), Tokyo College, Japan	149
21	3038003	**ON THE SUPPORT SYSTEM KETCINDY FOR CREATING MATHEMATICS TEACHING MATERIALS USING TEX** S. Yamashita	National Institute of Technology (KOSEN), Kisarazu College, Japan	155
22	3049890	**AUGMENTED REALITY IN CHEMISTRY: EFFECT ON LEARNERS' ACADEMIC ACHIEVEMENT AND LEARNING EXPERIENCE** Jayden W. J. Ang, S. Shi and W. M. Kong	Nanyang Polytechnic, Singapore	159

No.	Paper ID	Title & Authors	Institution	Page
23	3039962	**PRACTICAL COMMUNICATION CLASS WITH A "USA" THAT IS LOCATED TEN MINUTES FROM KOSEN** H. Nishiguchi, Y. Yagyu, T. Fukuda, K. Haraguchi, H. Matsuo, K. Morishita, H. Osato, M. Ueda and K. Higashida	National Institute of Technology (KOSEN), Sasebo College, Japan	163
24	3047837	**THE EFFECTIVENESS OF BITE-SIZED TEACHING APPROACH FOR ADULT LEARNERS** Noi Sian KOH	Nanyang Polytechnic, Singapore	169
25	3056899	**EVALUATING A LABORATORY LESSON CONDUCTED FOR SUPPLY CHAIN STUDENTS USING KOLB'S EXPERIENTIAL LEARNING CYCLE** Jing Jin, Liping Wu and Nicholas Chiang	Republic Polytechnic, Singapore	174
26	3063142	**DEVELOPMENT OF COMMUNITY BASED LEARNING PROGRAM AS AN ENGINEERING EDUCATION FOR REGIONAL REVITALIZATION** S. Takehara, S. Ueshima, Y. Taniguchi, C. Araya and N. Fujita	National Institute of Technology (KOSEN), Nara College, Japan	180
27	3038616	**VERIFICATION OF THE APPLICATION OF A PARTICIPATORY AND DELIBERATIVE ENERGY EDUCATION POGRAM IN TECHNICAL COLLEGE** T. Kobayashi, M. Kato. A. Minoda, M. Yagishita and H. Kimura	National Institute of Technology (KOSEN), Tsuyama College, Japan	184
28	3056398	**A STUDY OF THE CHANGES IN DELIVERY METHODS OF A STATISTICS MODULE** S. Chua	Republic Polytechnic, Singapore	190
29	3050953	**TYPING DURING LECTURES AS AN ALTERNATIVE FOR BLACKBOARD WRITING** S.Nishimura	National Institute of Technology (KOSEN), Oita College, Japan	196
30	3064676	**LIBERAL ARTS AS A LEARNING MOTIVATOR FOR NIT STUDENTS** Osamu HARAGUCHI, Takuro FUJITA, Yasunobu TESHIMA, Yuki MIYAMOTO and Takaaki NAKATSUKA	National Institute of Technology (KOSEN), Fukui College, Japan	200
31	3034599	**DEVELOPMENT OF IOT CAR EXPERIMENT TEACHING MATERIALS IN THE K-SEC PROJECT** Shigeo DOI and Takuya MUKOHIRA	National Institute of Technology (KOSEN), Tomakomai College, Japan	206

Transactions Index
Sub theme 2: Pedagogy for the Contemporary Learner

No.	Paper ID	Title & Authors	Institution	Page
32	3061557	**NURTURING SMART CITY PROFESSIONALS THROUGH STEM PROJECT OF UNMANNED ELECTRIC ROVER** Kelvin K. T. To, Dr Joe K.W. Lo, K. C. Ng and Jonathan K.F. Lee	Hong Kong Institute of Vocational Education, Hong Kong	213
33	3041707	**A CLASSROOM STUDY OF TOEIC E-LEARNING INVOLVING FOURTH-YEAR KOSEN STUDENTS AT NIT, HAKODATE COLLEGE** Mariko Okuzaki, Takuya Hirano and Hayato Maruyama	National Institute of Technology (KOSEN), Hakodate College, Japan	216
34	3060229	**BENEFITS OF MENTORING RELATIONSHIPS FROM THE PERSPECTIVE OF THE MENTOR IN ENGINEERING EDUCATION** Tommy H. Y. Cheung, W. K. Lee, Billy M. H. Chow and Frankie Y. C. Leung	Hong Kong Institute of Vocational Education (Haking Wong), Hong Kong	220
35	3057884	**INTRODUCTION OF “LIBERAL ARTS DISCOURSE MEETING”AT NATIONAL INSTITUTE OF TECHNOLOGY, YONAGO COLLEGE** M.Aoto, A.Takeuchi, K.Fuse, H.Kato,Y.Horihata, M.Harada, K.Ohba, M.Nakashima, M.Ohno, O.Tsujimoto	National Institute of Technology (KOSEN), Yonago College, Japan	224
36	3063367	**INNOVATIVE STEM WORKSHOPS FOR ENGINEERING EDUCATION** C. H. Siu, K. W. Lam, Y. K. Miu, Y. L. Tse and Jonathan K. F. Lee	Vocational Training Council, Hong Kong	230
37	3048155	**LEARNER-CENTRIC BLENDED LEARNING PLAN FOR AN ENGINEERING MODULE** F.T.L. Teoh	Nanyang Polytechnic, Singapore	235
38	3062780	**CREATIVITY EXPERIMENT INCORPORATING ORGANIC LIGHT EMITTING DIODE FABRICATION** T Morimune, K. Fukuda and H. Murakami	National Institute of Technology (KOSEN), Kagawa College, Japan	243

No.	Paper ID	Title & Authors	Institution	Page
39	3097881	**AN INNOVATIVE MICRO-LEARNING APPROACH THAT ADDRESSES INDUSTRY KNOWLEDGE AND WORKPLACE RELEVANCY FOR INDIVIDUALS AND CORPORATES** Noor Faridah A R, Zahiruddin A K M and Phua Kuan Hwee Paul	Temasek Polytechnic, Singapore	248
40	3048537	**INVESTINGATING NUDGE EFFECTS WITH SPACED REPETITION ON CONTEMPORARY LEARNER'S MOTIVATION AND PERFORMANCE IN LEARNING DATA COMMUNICATION AND NETWORKING** Y.F. Tang, Z.H. Huan, S.B. Nai, E. Sim and S.K. Koh	Nanyang Polytechnic, Singapore	257
41	3041223	**THE IMPORTANCE OF FACE-TO-FACE DISCUSSION – AN ATTEMPT TO USE "CONCEPTUAL THINKING ENCOURAGING MATERIALS" IN ELEMENTARY PHYSICS EDUCATION** Takahiro NIWA and Akio KIKUCHI	National Institute of Technology (KOSEN), Hachinohe College, Japan	263
42	3063383	**ACTIVE LEARNING BASED ON TOURISM AND CULTURE –CONTENTS TOURISM AS TEACHING MATERIAL** Akio Kikuchi	National Institute of Technology (KOSEN), Hachinohe College, Japan	268
43	3034901	**INTRODUCTION OF THE "INTEGRAL ENGINEERING CLASS" AT TSURUOKA KOSEN: BACKGROUND, DESIGN, AND FUTURE DIRECTION** R. Shomura, M. Tanaka, K. Watanabe, S. Takahashi, H. Arafune, S. Hoshina and T. Morinaga	National Institute of Technology (KOSEN), Tsuruoka College, Japan	271
44	3055137	**INTEGRATING PYTHON PROGRAMMING INTO CURRICULUM FOR SPECIALIST DIPLOMA COURSES IN DATA SCIENCE** U-L. Tang	Singapore Polytechnic, Singapore	274
45	3035405	**CURRICULUM DESIGN BASED ON UNIVERSAL MARITIME EDUCATION** A. Futamura, S. Kubota, A. Yabugami, K. Yamada, H. Murata, N. Yuda and T. Murakami	National Institute of Technology (KOSEN), Yuge College, Japan	278

No.	Paper ID	Title & Authors	Institution	Page
46	3063339	**DEVELOPMENT OF A TASK-BASED ONLINE SELF-LEARNING SYSTEM USING LMS** Y. Usuda	National Institute of Technology (KOSEN), Hakodate College, Japan	283
47	3069963	**TEACHING AI TO ADVANCE SUSTAINABLE DEVELOPMENT GOALS** Peter Leong and Danny Lee	Singapore Polytechnic, Singapore	287
48	3200769	**THE BIG PICTURE OF QUALITY ENHANCEMENT @TUAS** J. Kontio	Turku University of Applied Sciences, Finland	293
49	3039938	**IMPLEMENTATION OF THE REMOTE CLASSES BETWEEN MARITIME COLLEGES (TAKING THE SHIP HEALTH SUPERVISOR "SPECIAL LECTURE" AS AN EXAMPLE)** Teruo HOSHUYAMA, Mitsuo TADA, Norio YUDA, Keiji SASAYA, Tomohito ITO, Yoshiaki KAWAMURA and Tetsuya SUMIDA	National Institute of Technology (KOSEN), Yuge College, Japan	299
50	3039548	**FEASIBILITY STUDY OF ENGLISH PROGRAM BASED ON COMMUNICATION USING STANDARD MARINE COMMUNICATION PHRASES (SMCP)** I. Sakuma and T. Murakami	National Institute of Technology (KOSEN), Yuge College	303
51	3224574	**BUILDING LIFE CYCLE BASED MODEL IN CIVIL ENGINEERING EDUCATION – BETTER CO-OPERATION WITH WORKING LIFE** E. Leinonen	Turku University of Applied Sciences, Finland	309
52	3021347	**DEVELOPMENTAL TRANSFER OF JAPANESE LANGUAGE TO ENGLISH SKILL FOR JAPANESE ADULT LEARNERS OF ENGLISH** M. Ikematsu and T. Izumi	Toyohashi University of Technology, Japan	316
53	3020310	**STUDENT PERCEPTIONS AND EXPERIENCES OF CO-TEACHING IN A PROJECT-BASED SUBJECT** Benson K.H. Hung and K.C. Ying	Hong Kong Institute of Vocational Education (Tsing Yi), Vocational Training Council, Hong Kong	322

No.	Paper ID	Title & Authors	Institution	Page
54	3060424	**ENGINEERING EDUCATION AS CITIZENSHIP EDUCATION BY P4C** T. Ogawa, T. Murase and K. Nishiyama	National Institute of Technology (KOSEN), Ube College, Japan	326
55	3062303	**ACTIVE LECTURE: "COMMUNITY AND ENGINEERING"** Kazumi Furukawa, Shinji Ushimaru, Kazutomo Naganawa, Wataru Yamanouchi, Madoka Kita, Masayuki Takeguchi and Takashi Kobayashi	National Institute of Technology (KOSEN), Numazu College, Japan	332
56	3168323	**MAKING THE CHANGE – APPLYING FIVE MODELS OF ACADEMIC DEVELOPER PRACTICE** L.E. Kairisto-Mertanen and M.Keinänen	Turku University of Applied Sciences, Finland	338
57	3198995	**EDUCATIONAL PROGRAM FOR FUTURE GLOBAL ENGINEERS IN NIT, SUZUKA COLLEGE** N. Hirai, Y. Ohnuki, T. Kusaka, S. Yoshida, K. Kondo, H. Shimofuruya and J. Yoshida	National Institute of Technology (KOSEN), Suzuka College, Japan	343
58	3062548	**SELF-DIRECTED RESEARCH UNDER A QUARTER SYSTEM: HOW THE UNIQUE RESEARCH CURRICULUM IMPLEMENTED, IMPROVED?** Y. Nakamura [Yoshimichi], Y. Nakamura [Yasuo], A. Sai, M. Yoshida, Y. Nakamura [Yoshitaka], K. Wada and T. Niwa	National Institute of Technology (KOSEN), Hachinohe College, Japan	348
59	3037670	**EXAMINATION OF THE EFFECT OF INDIVIDUALIZED MASTERLY LEARNING BASED ON EXTERNAL ASSESSMENT** H. Yagyu, S. Yairi, K. Suzuki, Y. Miyazaki and K. Wako	National Institute of Technology, Sendai College (KOSEN), Japan	352
60	3045312	**COMPETITION-DRIVEN LEARNING FOR IOT TALENTS** Arthur T. T. Yu and Frankie Y. C. Leung	Hong Kong Institute of Vocational Education (Haking Wong), Hong Kong	355
61	3179935	**DEVELOPMENT OF AN EDUCATIONAL SYSTEM TO PROVIDE FOR VIRTUAL LABYRINTHINE STREETS BASED ON LINES DRAWN ON A PAPER** S. Tokutake, T. Ando, Y. Shimazaki, I. Takemoto, H. Tenzou, K. Yokoyama, Y. Kunimi and C. Mouri	National Institute of Technology (KOSEN), Kagawa College, Japan	360

Transactions Index
Sub theme 3: Learning Outcomes for Sustainable Development

No.	Paper ID	Title & Authors	Institution	Page
62	3215410	**A PROPOSAL OF A STUDENTS' VOLUNTARY IMPROVEMENT CYCLE METHOD BY VISUALIZATION OF GENERIC SKILLS** K. Kawasaki, H. Kobayashi, Y. Kubota and K. Yajima	National Institute of Technology (KOSEN), Sendai College, Japan	364
63	3055978	**USING THE EVIDENCE-BASED REFLECTIVE PRACTICE TOOL TO ENHANCE PROFESSIONAL PRACTICE** Mark Wan and Chong Siew Kee	Singapore Polytechnic, Singapore	369
64	3040700	**DEVELOPMENT OF A NEW EDUCATIONAL PROGRAM BASED ON LOCAL ISSUES IN THE MAIZURU KOSEN** Y. Kobayashi, T. Ishii and Y. Utsumi	National Institute of Technology (KOSEN), Maizuru College, Japan	376
65	3032117	**TEACHING STUDENTS SELF-DIRECTED LEARNING TO SUPPORT EDUCATION FOR SUSTAINABLE DEVELOPMENT** Sin-Moh CHEAH	Singapore Polytechnic, Singapore	379
66	3222850	**ESTABLISHMENT OF GLOCAL EDUCATION AND RESEARCH CENTER FOR AGRICULTURAL ENGINEERING IN NIT (KOSEN), MIYAKONOJO COLLEGE - EDUCATIONAL TRIALS FOR LOCAL CONTRIBUTION AND INTERNATIONAL ACTIVITY -** N. Takagi, H. Shiraiwa, Y. Ueno, A. Takahashi, M. Iwakuma and K. Matsukawa, D. Kaewdook, P. Sudwilai, N. Kamata and K. Jitjumnong	National Institute of Technology (KOSEN), Miyakonojo College, Japan	385
67	3063098	**PRELIMINARY DEVELOPMENT OF A SELF-DIRECTED LEARNING INDEX FOR POLYTECHNIC STUDENTS** A. Vedamuthu and J. Periasamy	Republic Polytechnic, Singapre	392
68	3063506	**DEVELOPMENT OF AN AUTHENTIC ASSESSMENT FOR AN ELECTIVE MODULE IN DIPLOMA IN CIVIL ENGINEERING COURSE** T. Law and QS. Liu	Singapore Polytechnic, Singapore	397

No.	Paper ID	Title & Authors	Institution	Page
69	3061705	**STUDENTS` EMOTIONS ANALYSIS USING A REFLECTION SHEET DEVELOPED FOR A PBL TYPE COURSE AND COMPARED WITH A PROG TEST ANALYSIS** Y. Kajimura, S. Tanaka, T. Hiraishi and J. C. Herbert	National Institute of Technology (KOSEN), Akashi College, Japan	402
70	3196376	**THE EFFECTIVENESS OF A LANGUAGE PROGRAM FOR KOSEN STUDENTS IN THE PHILIPPINES** Y. Kuramashi	National Institute of Technology (KOSEN), Tokuyama College, Japan	408
71	3095894	**MINING MAJOR PROJECT REPORTS FOR INSIGHTS** Kai Song, Goh and Li Chin, Ho	Temasek Polytechnic, Singapore	412
72	3096094	**EXPLORATORY LEARNING ANALYTICS: TRANSLATING SHAPES OF EDUCATIONAL DATA INTO EARLY INTERVENTION WARNING SIGNALS IN YEAR ONE COURSE** Jin Sze Samantha, Sow	Temasek Polytechnic, Singapore	418
73	3055262	**THE IMPORTANCE OF BUILDING COLLABORATIVE PARTNERSHIPS WITH INBOUND AND OUTBOUND PARTNERS** Akira OKADA	National Institute of Technology (KOSEN), Oyama College, Japan	425
74	3054570	**A PROJECT-BASED LEARNING APPROACH IN DEVELOPING STUDENTS' CROSS-DISCIPLINE ENGINEERING SKILLS** T.W. NG, K.P. WONG, S.Y. CHAN, T.H. MAK, W.H. WONG and Y. GUAN	Hong Kong Institute of Vocational Education (Chai Wan), Hong Kong	429
75	3031512	**FOSTERING GLOBAL LEADERS THROUGH THE "INTERNATIONAL SEMINAR ON TECHNOLOGY FOR SUSTAINABILITY"** C. Okuma, M. Shimakawa and Y. Shimada	National Institute of Technology (KOSEN), Kumamoto College, Japan	434
76	3225234	**HIGH STAKE E-ASSESSMENT IN ENGINEERING** Tay Jin Wei	Ngee Ann Polytechnic, Singapore	440

No.	Paper ID	Title & Authors	Institution	Page
77	3016723	**THE APPLICATION OF PRACTICAL ACTIVITIES IN SCIENCE AND ENGINEERING TO KOSEN ENGLISH CURRICULUM** Yokota Miyo and William Tharion	National Institute of Technology (KOSEN), Hachinohe College, Japan	446
78	3056913	**SCENARIO-BASED LEARNING IN BIOINFORMATICS: THE USE OF INFECTIOUS DISEASE OUTBREAK** K.S. Lee	Ngee Ann Polytechnic, Singapore	450
79	3062406	**EFFECT OF CAREER EDUCATION USING THE TRAINING SHIP AND CONSIDERATION OF TEACHING TECHNOLOGY** S. Akiba, M.Tada, N.Yuda, T. Murakami, T. Housyuyama, A. Futamura, T. Miyamoto, N. Matunaga, E. Mori, S. Yamashita and K. Nonoyama	National Institute of Technology (KOSEN), Yuge College, Japan	455
80	3057452	**THE IMPACT OF DISTRIBUTED PRACTICE ON STUDENTS' ACADEMIC ACHIEVEMENTS IN DATABASE SYSTEMS MODULE** Irene Tan WC, Diana Wang and Ng Tek Ming	Republic Polytechnic, Singapre	461
81	3036484	**INVESTIGATING THE EFFICIENCY OF FOSTERING BASIC SOCIAL SKILLS BY ACTIVE LEARNING USING AN OBJECTIVE ASSESSMENT** Hideyuki Kobayashi, Koji Kawasaki and Kuniaki Yajima	National Institute of Technology (KOSEN), Sendai College, Japan	466
82	3062254	**ETC LAB. – AN INTERDISCIPLINARY CENTRE FOR COLLABORATIVE DESIGN AND RESEARCH TO CREATE SOCIAL IMPACT AND CHANGE** Khiang Jian Hao Jason	Ngee Ann Polytechnic, Singapore	470
83	3039457	**EFFECT OF PBL ON REMOTE CONTROLLED ROBOT COMPETITION FOR PRACTICAL ENGINEERING EDUCATION** T. Kato	National Institute of Technology (KOSEN) Kumamoto College, Japan	476

No.	Paper ID	Title & Authors	Institution	Page
84	3052916	**USING LEARNING ANALYTICS TO ACHIEVE BETTER STUDENT LEARNING OUTCOMES IN BUSINESS STATISTICS** Eddie YEOU and Ginno YONG	Nanyang Polytechnic, Singapore	479
85	3037652	**DEVELOPMENT OF ESD STUDENT-CENTERED DELIVERY CLASS** Y. Nishii and S. Kuwata	National Institute of Technology (KOSEN), Niihama College, Japan	483
86	3101228	**COLLABORATIVE PARTNERSHIP WITH STUDENTS FOR EFFECTIVE ENGINEERING SERVICE LEARNING PROJECTS** Andrew Kor Seng Giap	Temasek Polytechnic, Singapore	489
87	3056317	**GENESIS@BME: AN INTEGRATED APPROACH TO TECHNOLOGY EDUCATION IN BIOMEDICAL ENGINEERING** Wai Sing ONG, Hock Wei SOON, Tji Leng CHUA, Kannathal NATARAJAN, Peck Ha KHOO-TAN, Shirley WILLIAMS and Hui Leng TAN	Ngee Ann Polytechnic, Singapore	495
88	3042511	**A CLASS FOR HUMAN RESOURCE DEVELOPMENT CAPABLE OF CORRESPONDING TO DIVERSIFICATION OF ENERGY** K. Yamada	National Institute of Technology (KOSEN), Toyama College, Japan	500
89	3173652	**DEVELOPMENT AND PRACTICE OF ULTRAVIOLET SENSOR TEACHING MATERIAL FOR IMPROVING ANALYSIS SKILLS FOR SELF-STUDY** N. Kakuda	National Institute of Technology (KOSEN), Yonago College, Japan	504

Transactions Index
Sub theme 4: Partnership and Collaboration in Engineering Education

No.	Paper ID	Title & Authors	Institution	Page
90	3032187	**INTERNATIONAL EXCHANGE PROGRAM FOR DEVELOPMENT OF GLOBAL HUMAN RESOURCES AND JOINT RESEARCH** O. Yanagisawa, G. Davaa, K. Kuzume, T. Tsutsui, T. Ito, O. Jambal, S. Khayankhyarvaa, Ts. Byambadorj, O. Dashdondog	National Institute of Technology (KOSEN), Yuge College, Japan	509
91	3061003	**A TRIAL OF COOPERATIVE EDUCATION PROGRAM BASED ON PBL WITH LOCAL COMMUNITIES AT NATIONAL INSTITUTE OF TECHNOLOGY (KOSEN), TOMAKOMAI COLLEGE** S. Nihashi, M. Muramoto, T. Suda and A. Watanabe	National Institute of Technology (KOSEN), Tomakomai College, Japan	515
92	3206043	**DEVELOPING CROSS-CULTURAL AWARENESS IN PROVINCIAL HOKKAIDO BY CONNECTING EXCHANGE STUDENTS AND KOSEN JAPANESE STUDENTS** D.Taquet, M. Ono, M. Krause-Ono and M. Kuriyama	National Institute of Technology (KOSEN), Hakodate College, Japan	519
93	3020397	**DEVELOPMENT OF THE CAPSTONE INNOVATION PROJECT COURSE - ANALYSIS OF PROJECT ASSIGNMENTS AND STAKEHOLDERS** J. Roslöf	Turku University of Applied Sciences, Finland	523
94	3062999	**PARTNERSHIP BETWEEN VOCATIONAL TRAINING COUNCIL AND OVERSEAS UNIVERSITIES IN OFFERING TOP-UP ENGINEERING DEGREES IN HONG KONG** K. M. WONG	Vocational Training Council, Hong Kong	529
95	3222627	**A RECURRENT EDUCATION FOR A GRADUATE FROM THE TECHNICAL COLLEGE THROUGH A COLLABORATIVE RESEARCH** Ritsuo SAKIMURA and Issei HAN-YA	National Institute of Technology (KOSEN), Gunma College, Japan	534

No.	Paper ID	Title & Authors	Institution	Page
96	3062938	**NURTURING 'GLOBAL ENGINEERS' THROUGH INTERNATIONAL EXCHANGE ACTIVITIES: AN ATTEMPT BY NIT NARA COLLEGE WITH THE GECEP PROGRAM** Kazuhiro Itakura, Naoshi Kanazawa and Shinji Uchida	National Institute of Technology (KOSEN), Nara College, Japan	540
97	3050418	**JOINT ENGLISH TRAINING PROGRAM IN THE PHILIPPINES** Kangbin Lei, Osami Yanagisawa, Jongdoc Park, Kenichi Fukudome, Katsuhiro Narikiyo and Hiroshi Ohyama	National Institute of Technology (KOSEN), Hiroshima College, Japan	544
98	3039941	**INTERACTIVE EDUCATIONAL EXCHANGES BETWEEN NAGAOKA KOSEN AND ADTEC MELAKA BASED ON PROJECT-BASED LEARNING** Susumu Nakamura, Takahiro Yamamoto, Hisako Okumura, Mohd Fadzly bin Othman, Rezawati binti Ismail, Normazlinda binti Che Mahmood and Mohd Zabidin bin Abd Samad	National Institute of Technology (KOSEN), Nagaoka College, Japan	550
99	3060727	**EXPLORING THE RELATIONS BETWEEN THE INTERNATIONAL EXCHANGE EVENTS AND THE ENHANCEMENT OF STUDENTS' MOTIVATION** Yuko UESUGI	National Institute of Technology (KOSEN), Kure College, Japan	555
100	3014642	**DEVELOPING RESILIENT MINDSETS IN STUDENTS FOR NATURAL DISASTERS BY ENGAGING THEM IN THE DEVELOPMENT OF POCKET MAPS AND GUIDES** Yoshiko ASAMI and Tomek ZIEMBA	National Institute of Technology (KOSEN), Oita College, Japan	559
101	3039276	**ACTIVITY OF SCIENTIFIC EXPERIMENT CLUB BASED ON REMOTE ISLAND ENGINEERING** T. Ito and S. Ishida	National Institute of Technology (KOSEN), Yuge College, Japan	564

No.	Paper ID	Title & Authors	Institution	Page
102	3206695	**PEDAGOGICAL SUGGESTION FOR THE CREATION OF STUDENT'S/TEACHER'S BELIEFS AND JAPANESE LANGUAGE CURRICULUM AIMED AT INTERNATIONAL STUDENTS AT KOSEN** N. Fukuda, M. Hyodo, N. Maharajan, K. Ichimura and S. Akazawa	National Institute of Technology (KOSEN), Nagaoka College, Japan	569
103	3198917	**DISASTER PREVENTION EDUCATION PROGRAM IN COOPERATION WITH PREFECTURAL AREA IN JAPAN** Yasuyuki Hirose	National Institute of Technology (KOSEN), Gifu College, Japan	574
104	3035015	**AN INTER-DEPARTMENTAL COLLABORATIVE PROGRAM TO MOTIVATE FIRST-YEAR KOSEN STUDENTS TO LEARN ENGLISH** M. Hirano, M. Nishi, Y. Matsutani, K. Goto, H. Irie and F. Seki	National Institute of Technology (KOSEN), Kumamoto College, Japan	579
105	3060734	**THE EXPOSURE IS THE KEY: SIMILARITIES AND DIFFERENCES BETWEEN THE MALAYSIAN AND THE JAPANESE ENGLISH EDUCATION SYSTEMS** Yuko UESUGI	National Institute of Technology (KOSEN), Kure College, Japan	585
106	3036082	**HOW TO FOSTER GLOBAL MINDSETS AMONG FIRST YEAR KOSEN STUDENTS -FROM A SEVEN-YEAR SURVEY OF THE “KOREA JOINT STUDY TOUR” PROGRAM** Hironori ARAKAWA and Tomoyuki OHKUMA	National Institute of Technology (KOSEN), Akashi College, Japan	589
107	3170585	**PROGRAMMING COURSE FOR ELEMENTARY AND JUNIOR HIGH SCHOOL STUDENTS** Toshie Matsumura, Shinji Uchida, Takayuki Nishino, Yoshimichi Honma and Tomohiro Yamaguchi	National Institute of Technology (KOSEN), Nara College, Japan	594
108	3041209	**IMPLEMENTATION OF ENGINEERING CLASSES IN KOSEN AND POLYTECHNICS IN MALAYSIA** Fumitake KATO	National Institute of Technology (KOSEN), Ibaraki College, Japan	599

No.	Paper ID	Title & Authors	Institution	Page
109	3062632	**AN INTERNATIONAL HACKATHON WITH THE THEME OF DISASTER PREVENTION COLLABORATING WITH INDUSTRY** N. Shirahama and T. Fukuda	National Institute of Technology (KOSEN), Kitakyushu College, Japan	605
110	3059694	**EVALUATION OF STUDENT FEEDBACK ON EXCHANGE PROGRAMMES FOR CONTINUOUS IMPROVEMENT** SH Lee, WY Leung, CK Chan and YN Chan	Hong Kong Institute of Vocational Education (Tuen Mun), Hong Kong	612
111	3039386	**SURVEYS ON CAREER AND GLOBAL EDUCATION FOR PROGRAM TO DEVELOP LEGAL MIND** Kanaho MATSUDA, Yuko MATSUO and Sai SASAKI	National Institute of Technology (KOSEN), Tomakomai College, Japan	618
112	3040173	**IMPLEMENTATION OF GLOBAL MIND TRAINING CAMP FOR KOSEN STUDENTS IN JAPAN** M. Kobayashi, Y. Ichikawa, J. Park, M. Sekiguchi, Y. Matsumoto and T. Okawara	National Institute of Technology (KOSEN), Anan College, Japan	623
113	3012464	**ENHANCED ENGLISH COMPETENCY OF TEACHERS USING GLOBAL APPROACH FOR MARITIME COLLEGES IN JAPAN** Jongdoc Park and Osami Yanagisawa	National Institute of Technology (KOSEN), Oshima College, Japan	627
114	3053970	**AUTHENTIC LEARNING FOR CYBER SECURITY: AN INDUSTRY PRACTICE PARTNERSHIP** James Tham and Mapel Yap	Republic Polytechnic, Singapore	632

EdTech for the Future

GROUP LEARNING WITH THE ELEMENTS OF THE GAME

Nobuyuki Sochi*, Yasuyuki Kubo*, Sae Ishida*, Takahiro Makiyama*

*National Institute of Technology (KOSEN), Yuge College, Department of General Education, Ochi-gun, Japan

* sochi@yuge.ac.jp

Abstract

In mathematics, group learning was conducted at the time of first year education. The class was divided into five groups of nine people two years ago, and six groups of seven people last year. Each group includes one leader who is good at math and a few students who are not good at math. We give questions to students. First of all, they must think about the problems by themselves, and if they can not understand them, they can use their textbooks and their notes. Next, they have to ask questions to students in the same group or teacher actively. When everyone can explain the problems to others, we give the group the answers. After they correct mistakes, we choose one person arbitrarily from the group. If the student can get the correct answer for one specified question, the group can conclude the exercise. If the student can not do it, one person must resolve one question again after teaching each other in the group. By setting the rule in this way and giving it the elements of gamification, for example, "one person is chosen arbitrarily" and "the group passes if one person in the group can solve the specified question", tension is risen and the student's willingness to learn is activated. By forming teams, they can also be aware of cohesion within the team and competition with other teams. Here, the selection of the group members was carefully decided in consultation with the homeroom teacher so that the students were not overly stressed. The purpose of this group learning is to understand by being taught, and to understand more by teaching. In other words, the goal is to make it possible for everyone in the group to talk to each other actively in order to understand more deeply, and to connect the learning attitude to the self-studying learning style. The results of regular examinations and the proficiency tests are good. The questionnaire showed that about 80 % of the students answered that they were able to teach each other and that this method had a positive effect on their grades.

Keywords: *first year education, active learning, group learning, game, gamification, motivate, homeroom teacher, self-studying learning*

Introduction

In the first year education of mathematics in 2017 and 2018, we introduced group learning. We conducted a math test in April immediately after admission, and based on the results, we divided the classes into five groups of nine in 2017 and six groups of seven in 2018. The average score of each group was adjusted to be the same. In addition, one leader was decided in each group. The leader was selected from among the top graders. We consulted with the class teacher, and social and kind student was chosen as a leader. Each group also included students in the lower grades. The purpose of this group learning is to understand by being taught, and to understand more by teaching to others. Namely, our destination is to make it possible for every member in the group to ask each other actively in order to deepen understanding, and to change the learning attitude to the self-studying learning style.

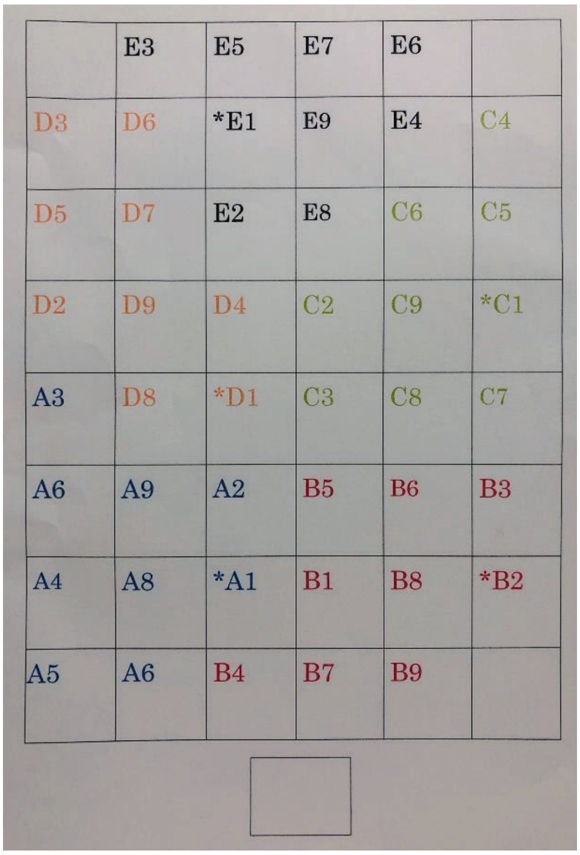
Materials and Methods

The first year education was conducted once a week for 90 minutes in the following procedure.
1. We give problems to students.
2. If everyone is clear (if they can explain to other), they come to teachers and receive answers.
3. After they make corrections, we will appoint one person and ask him or her to answer the question.
4. If the designated student can solve it, the group ends its exercise.
5. The person who solves the problem changes every time, but the same person may be appointed again.
6. If they cannot solve it, they must rethink and teach each other in the group and solve it again.

By setting the rule in this way and giving it the elements of the game, such as "one person is chosen arbitrarily" and "the group passes if this one person in the group can solve the specified question", their tensions increase, and the motivation to learn is activated. By forming teams, they can also be aware of cohesion within the group and competition with other groups. Here, the selection of the group member was carefully decided in consultation with the homeroom teacher so that the shy students were not overly stressed.

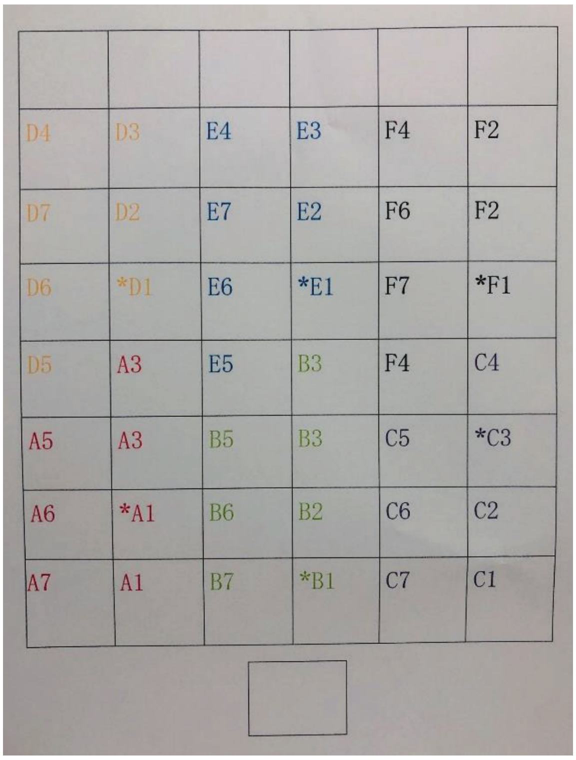
We assigned the seating chart as follows. In Figure 1, the blue, red, green, orange, and black group are named

A, B, C, D and E respectively, and the numbers indicate the ranks in first-year April-math-test in that group. In Figure 2, the red, green, violet, orange, blue, and black group are named A, B, C, D, E and F respectively, and the numbers indicate the ranks in first-year April-math-test in that group. In Figure1 and Figure 2, the leaders are marked *. The classes were divided so that the math averages were almost the same. We consulted with the homeroom teachers and checked the leaders and shy students before grouping in advance. For example, in group B in 2017, the student B2 was designated as a leader instead of B1. Although B1 was the top grade, he was very quiet, so we consulted his homeroom teacher and made B2 the leader. In 2018, C3 was recommended as a leader by the homeroom teacher. In addition, we designed the layout so that the students with the lowest grades are surrounded by the superiors as much as possible. We chose the students who can act kindly and positively as leaders. We left the leaders to decide whether every members could solve the problem and whether mistakes were fixed properly. In the immediate vicinity of the shy students and ones who are not good at math, leaders or students with good math results were placed to make good atmosphere so that the students can ask questions. There was no group change or seat change throughout the year.



	E3	E5	E7	E6	
D3	D6	*E1	E9	E4	C4
D5	D7	E2	E8	C6	C5
D2	D9	D4	C2	C9	*C1
A3	D8	*D1	C3	C8	C7
A6	A9	A2	B5	B6	B3
A4	A8	*A1	B1	B8	*B2
A5	A6	B4	B7	B9	

Figure 1 Seating chart in 2017



D4	D3	E4	E3	F4	F2
D7	D2	E7	E2	F6	F2
D6	*D1	E6	*E1	F7	*F1
D5	A3	E5	B3	F4	C4
A5	A3	B5	B3	C5	*C3
A6	*A1	B6	B2	C6	C2
A7	A1	B7	*B1	C7	C1

Figure 2 Seating chart in 2018

A few times from April, the students whose results in the April math test were poor, reviewed the fields where the test was unsuccessful. In a small group of these students, they mainly reviewed letter expressions, equations, and straight line equations. After that, everyone participated in the group learning except for proficiency tests etc. The exercise handout contained the contents according to the course syllabus.

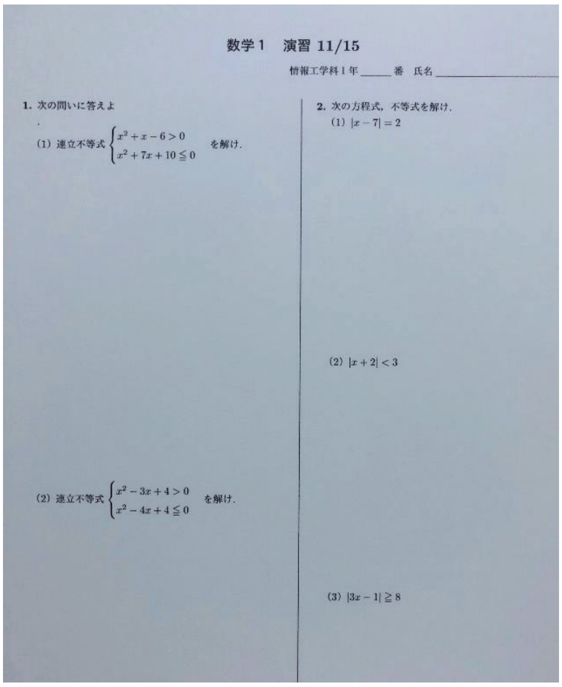
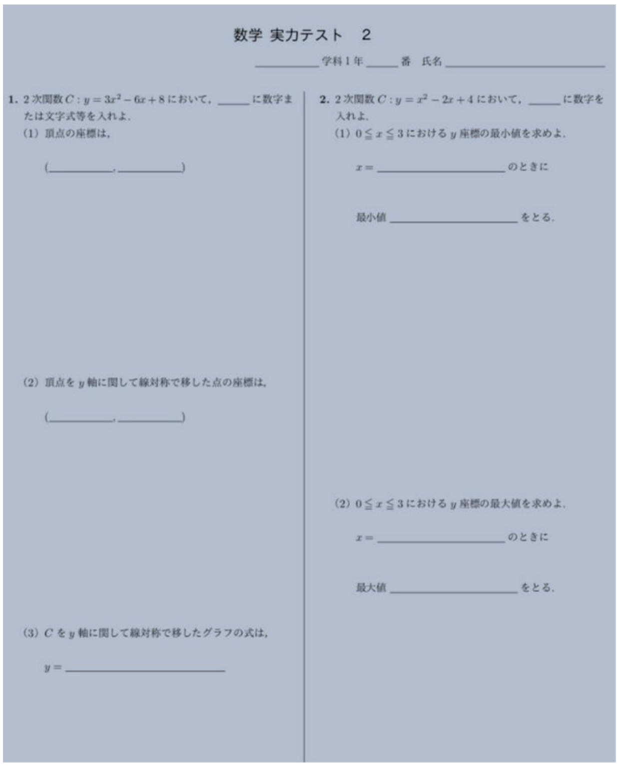


Figure 3 Practice handout

The proficiency tests were also conducted several times as the review tests, and the results were very good.



数学 実力テスト　2

______学科 1 年____番　氏名__________

1. 2 次関数 $C: y = 3x^2 - 6x + 8$ において，____に数字または文字式等を入れよ．

(1) 頂点の座標は，

(_____, _____)

(2) 頂点を y 軸に関して線対称で移した点の座標は，

(_____, _____)

(3) C を y 軸に関して線対称で移したグラフの式は，

$y =$ __________

2. 2 次関数 $C: y = x^2 - 2x + 4$ において，____に数字を入れよ．

(1) $0 \leqq x \leqq 3$ における y 座標の最小値を求めよ．

$x =$ __________ のときに

最小値 __________ をとる．

(2) $0 \leqq x \leqq 3$ における y 座標の最大値を求めよ．

$x =$ __________ のときに

最大値 __________ をとる．

Figure 4　Proficiency test

In addition, we contacted the head of the specialized department, explained the situation in detail, and also received the requests from the head. For example, we heard that many students who were not good at converting units could not write the experimental report properly. In response to the request, we carried out a unit conversion exercise. The schedule of the first year education is shown below.

Schedule of the first year education in mathematics in 2017

1.Letter expression calculation (Review of junior high school contents, Small group exercise)

2.How to solve simultaneous equations (Review of junior high school contents, Small group exercise)

3.Straight line expression (Review of junior high school contents, Small group exercise)

4.Midterm exam measures 1st (Group learning)

5.Midterm exam measures 2nd (Group learning)

6.Resolving midterm exam (Small group exercise)

7.Unit conversion (Group learning)

8.Power law, unit conversion (Group learning)

9. Fraction formula (Group learning)

10.Absolute value, rational number, square root, rationalization of denominator (Group learning)

11.Proficiency test 1 (20 minutes), calculation of numbers and formulas

12.Proficiency test 2 (20 minutes), graph of quadratic function

13.Solution of quadratic equation (Group learning)

14.Resolving the proficiency test (Small group exercise)

15.Calculation of complex number, discriminant of quadratic equation, relationship between solutions and coefficients (Group learning)

16.Factorization over complex numbers, solution of first-order inequality (Group learning)

17.Coordinates of the point of intersection of the quadratic function with the x axis, solution of quadratic inequalities (Group learning)

18.Solving simultaneous quadratic inequalities, equation and inequality with absolute value (Group learning)

19. Identity (Group learning)

20. Resolving midterm exam (Small group exercise)

21.Remainder theorem, Factor theorem (Group learning)

22. Applications of remainder theorem and higher order equations (Group learning)

23.Review of definition of trigonometric ratio (Group learning)

24.Factor theorem for substituting fractional values, proof of equations (Group learning)

25.Factorization, square completion, relation of arithmetic mean and geometric mean, proof of inequality (Group learning)

26.Relation between arithmetic mean and geometric mean, minimum value, parallel shift of graph, fractional function (Group learning)

Results and Discussion

We conducted this group learning in the 2017 first grader and the 2018 first grader of the information science and technology department, and the results of regular examinations and the proficiency tests were good. The following shows the results of the April test for the first grader and the final exams for the two classes in which the first year educations were conducted in the 2017 and 2018.

Table 1 Achievements of students enrolled in 2017

	April test (2017)	Exam1 (2017)	Exam2 (2018)
average	80.5	81.6	81.9
highest	97	100	100
lowest	56	60	40

Table 2 Achievements of students enrolled in 2018

	April test (2018)	Exam1 (2018)
average	83.0	84.6
highest	98	100
lowest	37	46

The students studied in group with tension. Although some students could not ask questions at first, many students became able to ask questions by being encouraged to ask questions. We chose one student, chose one question of the exercises, and let the student solve it on the whiteboard. If the student could not do it, the whole group would fail and all members must rework it, so the students actively talked out and taught each other. Since the rules of this group learning included game elements, the students also learned seriously to complete the game. Almost all students succeeded and a few groups failed one or two times a year.

The following several questionnaires were conducted.

(1). Did you get serious about mathematics in your first year education?
Yes. if anything, Yes. if anything, No. No.

(2). Were you able to ask questions actively in the mathematics class of the first year education?
Yes. if anything, Yes. if anything, No. No.

(3). Were you able to teach each other in the mathematics class of the first year education?
Yes. if anything, Yes. if anything, No. No.

(4). Were you able to understand mathematics problem without leaving a part of problem that you could not understand?
Yes. if anything, Yes. if anything, No. No.

(5). Do you think that the group learning had a good effect on mathematics learning?
Yes. if anything, Yes. if anything, No. No.

Here, "Yes" is 3 points, "if anything, Yes" is 2 points, "if anything, No" is 1 point, "No" is 0 point. We examined whether the results of the April math test and the regular math tests were correlated with the results of the questionnaire in the first grade of 2017 and the first grade of 2018. By using the results of the junior-high-school content-review-test conducted in April for the first grader, the results of the first-grader-year end-exam and the results of the second-grader-year end-exam in the class where the first year education was conducted in 2017 altogether, we examined the correlation between the transition of results in math tests and the results of questionnaire. And, by using the results of the junior-high-school content-review-test conducted in April for the first grader and the results of the first-grader-year end-exam in the class where the first year education was conducted in 2018 altogether, we examined the correlation between the transition of the results in math tests and the results of questionnaire. Here, the contents of the junior-high-school content-review-test are the problems of calculation of number and letter expression, linear equation, straight line equation, factorization and simple figure. The year-end exam is calculated on the average of the results of four regular exams. In each score, about 1/3 upper layer of the whole is named A group, about 1/3 lower layer of the whole is named C group, and the remaining middle layer is named B group. For example, if the result of the first grader's math test in April is in group A, the result at the end of first grader is in group B, and the result at the end of second grader is in group C, we write it by ABC.

The table below shows the relationship between the transition of grades and the results of the questionnaire for students who studied in the first year education in 2017. Group (a) shows the group of students who have good grades or who have finally become A. Group (b) shows the group of students who scored A but their grades fell. Group (c) shows the group of students who did not have good grades at first, but who achieved better grades in second grade. Group (d) represents the group of students who did not perform well at first, but whose grade remained unchanged in second grade, or whose grade further declined.

Table 3 Questionnaire results of students enrolled in 2017

	people	(1)	(2)	(3)	(4)
(a)AAA	5	2.2	1.4	2.4	2.4
(a)BAA	3	2.7	2.3	2.0	2.7
(a)CAA	3	2.7	2.0	2.0	2.7
(a)ABA	0	0	0	0	0
(a)BBA	2	2.5	2.0	2.0	2.0
(a)CBA	1	3.0	3.0	3.0	3.0
(a)ACA	0	0	0	0	0
(a)BCA	0	0	0	0	0
(a)CCA	0	0	0	0	0
(b)AAB	4	1.8	1.0	2.0	2.0
(b)AAC	0	0	0	0	0
(b)BAB	2	3.0	2.5	2.5	3.0
(b)BAC	0	0	0	0	0
(b)CAB	0	0	0	0	0
(b)CAC	0	0	0	0	0
(b)ABB	2	2.0	1.5	1.5	1.5
(b)ABC	2	2.0	2.0	1.5	1.0
(b)ACC	2	1.0	1.5	1.5	3.0
(b)ACB	0	0	0	0	0
(c)BBB	4	2.8	1.8	2.3	2.3
(c)CBB	2	2.5	2.0	2.0	1.5
(c)BCB	0	0	0	0	0

(c)CCB	3	2.7	1.3	1.7	1.7
(d)BBC	0	0	0	0	0
(d)CBC	0	0	0	0	0
(d)BCC	4	2.0	1.8	2.0	1.8
(d)CCC	6	2.3	1.5	1.8	1.8

Table 4 Questionnaire results of students enrolled in 2017

	people	(1)	(2)	(3)	(4)
(a)	14	2.5	1.9	2.2	2.5
(b)	12	1.9	1.6	1.8	2.1
(c)	9	2.7	1.7	2.0	1.9
(d)	10	2.2	1.6	1.9	1.8

The table below summarizes the sum of the four items of the questionnaire and the sum of (2) and (3), which are two of them.

Table 5 Questionnaire results of students enrolled in 2017

	people	(1)+(2)+(3)+(4)	(2)+(3)
(a)	14	9.1	4.1
(b)	12	7.4	3.4
(c)	9	8.2	3.7
(d)	10	7.5	3.5

The table below shows the relationship between the transition of grades and the results of the questionnaire for students who studied in the first year education in 2018. Group (a) shows the group of students who keep good grades or who have finally become A. Group (b) shows the group of students who had good grades at first, but whose grades fell. Group (c) shows the group of students who had poor grades at first, but who achieved better grades after that. Group (d) represents the group of students who did not perform well at first, but whose grade remained unchanged, or whose grade further declined.

Table 6 Questionnaire results of students enrolled in 2018

	people	(1)	(2)	(3)	(4)
(a)AA	10	2.8	2.8	2.9	2.8
(a)BA	3	2.7	2.3	2.3	2.7
(a)CA	1	2.0	2.0	2.0	2.0
(b)AB	2	1.0	1.0	1.0	1.0
(b)AC	2	3.0	2.0	2.5	3.0
(c)BB	7	2.7	2.3	2.1	2.6
(c)CB	5	2.6	2.2	2.0	2.8
(d)BC	4	2.8	2.5	2.3	2.8
(d)CC	8	2.0	1.5	1.6	1.9

Table 7 Questionnaire results of students enrolled in 2018

	people	(1)	(2)	(3)	(4)
(a)	14	2.7	2.6	2.7	2.7
(b)	4	2.0	1.5	1.8	2.0
(c)	12	2.7	2.3	2.1	2.7
(d)	12	2.3	1.8	1.8	2.2

The table below summarizes the sum of the four items of the questionnaire and the sum of (2) and (3), which are two of them.

Table 8 Questionnaire results of students enrolled in 2018

	people	(1)+(2)+(3)+(4)	(2)+(3)
(a)	14	10.8	5.4
(b)	4	7.3	3.3
(c)	12	9.7	4.3
(d)	12	8.1	3.7

Conclusions

As shown in Table 4 (d) and Table 7 (d), in case all the test results are low on average, the questionnaire results tend to be low. According to the data, the students with relatively poor grades tend to be unable to ask questions, teach actively, and avoid leaving unintelligible problems.

As shown in Table 4 (c), Table 5 (c), Table 7 (c) and Table 8 (c), even if the results of the April math test and the first grade examination are not so good, the students who are gradually gaining grades tend to have higher results in questionnaires than students belonging to (b) and (d).

Also, as shown in Table 4 (b), Table 5 (b), Table 7 (b) and Table 8 (b), the students who initially performed well, but whose grades are gradually declining, tend to be particularly low among the four groups in all the questionnaires.

As shown in Table 4 (a), Table 5 (a), Table 7 (a) and Table 8 (a), the students who performed well in each exam have the highest scores among the four groups in all the questionnaires.

There were several students who did not answer the questionnaire appropriately, but they were very few.

For the questionnaire (5): "Do you think that this group learning had a good effect on math learning?", the following results were obtained.

Table 9 Questionnaire (5) results of students enrolled in 2017

	(5)
(a)	2.4
(b)	1.9
(c)	2.2
(d)	1.9

Table 10 Questionnaire (5) results of students enrolled in 2018

	(5)
(a)	2.5
(b)	1.8
(c)	2.5
(d)	1.9

These results are also similar to the results of the other questionnaire items.

In Table 5 and Table 8, the sum of the four items indicates that the students who seriously worked on the group learning have improved or kept their grades. In particular, we see from the sum of two items that actively asking questions and teaching each other greatly affect their grades.

The average scores in the regular tests were over 80 % each time, so we think that the overall proficiency level is high, and there was an outcome of this group learning.

We see that the students who keep their grades high or the students whose grades are gradually improving can ask questions and actively teach each other so as not to leave problems that they cannot understand. In addition, it was found that the students with poor grades did not ask much questions or teach each other so much, so they left problems that they could not understand. So we are convinced that experiencing questions and teaching each other through this group learning is the first step in self-studying. For students who did not improve their learning results, we will appeal again the importance of asking questions and teaching.

In the future, we plan to continue investigating a relationship between changes in grades and the results of the questionnaire. In addition, we will examine the relationship between the results of the subjects other than mathematics and the results of the questionnaire in the four groups which are divided according to the change in grades.

Acknowledgements

The authors would like to thank the students and staff of National Institute of Technology, Yuge College for their patience and goodwill in regards to this project.

References

Sochi, Nobuyuki. (2018). About gamification. Bulletin of National Institute of Technology, Yuge College. No. 40, pp. 33-35.

ENHANCING PHYSICS EDUCATION USING INTERACTIVE ELECTRONIC BOOKS FOR DIFFERENTIAL AND INTEGRAL CALCULUS, MECHANICS AND AN LMS

S. Fujiwara*[a] and M. Takiguchi [b]

[a] General Arts, National Institute of Technology(KOSEN), Hiroshima College, Japan
[b] Department of Maritime Technology, National Institute of Technology (KOSEN), Hiroshima College, Japan

*sfuji@hiroshima-cmt.ac.jp

Abstract

We have developed tools to enhance the practice of physics education in differential and integral calculus and mechanics, using interactive electronic books to support graphical understanding and an LMS (Learning Management System), for third year students in national colleges of maritime technology. Using the gallery function of electronic books, we teach a graphical understanding of the mechanics of a particle. For example, in graphical terms, the slope of a tangent line at any point on a distance-time graph gives the speed at that point in time.

As a class exercise, the students took an online examination using the LMS, and could efficiently check their degree of understanding of general concepts of physics and fundamental calculations of physics quantities.

From the results of a student questionnaire given after the exercise, about 62-73% of the students found the electronic books to be helpful and about 55-69% of them found the online examinations in the LMS to be useful.

Keywords: *differential and integral calculus and mechanics, electronic book, gallery function, graphical understandings, LMS, online examination, achievement examination*

Introduction

Smartphones and tablets are commonly used in daily life, and ICT (Information and Communication Technology) education using these assistive functions is being promoted.

To introduce a student-learning style that incorporates electronic books (ebooks), we have studied test preparation for the learning achievement physics examinations aimed at third year students in our college who utilized ebooks using information from examinations given 8 years ago. Using ebooks, which are small and light weight, students can study at their own pace at any time and in any place.

From 2015, not only the distribution of electronic books from the website for distribution, but also distribution from Blackboard (LMS) managed by the National Institute of Technology, has made it possible to confirm the state of use of electronic books.

In order to establish the use of ebooks, in the regular examinations, students were asked to solve the questions used in the achievement examinations up until last year. Furthermore, during long holidays, students solved the question of the achievement examinations up to last year by referring to the ebook.

From 2016, we developed and distributed an interactive ebook (iBooks format) about differential and integral calculus and mechanics, and also checked the degree of understanding by linking to Blackboard online examinations. In this ebook, the meaning of differential and integral is explained graphically using the iBooks gallery function.

The educational results of this approach are discussed on the basis of student questionnaires and results of achievement examinations.

Development of the ebooks for differential and integral calculus and mechanics

To develop the iBooks file, we used the iBooks author software. The ebook can be accessed via the homepage, http://www.hiroshima-cmt.ac.jp/faculty/ippan/007.html or Blackboard (https://bb.kosen-ac.jp), and downloaded wirelessly to an iPad or iPhone. After downloading the ebook wirelessly from the homepage as shown in Figure 1, the icon "Open in iBooks" is tapped to open the iBook application.

The ebook is composed of a key summary of differential and integral calculus and mechanics and questions and answers from the achievement examinations. The chapter contents are shown in Table 1. A bookmark, highlight, and memo, all of which can be added by the reader, are shown in Figure 2. To make the best use of the ebook platform, which allows the reader to turn a page by touching or swiping the screen, the question and its corresponding answer were placed on alternating pages. Included in the answers are the associated formulas, laws and calculations highlighted by underbraces (Fig. 2).

Using the gallery function of ebooks, we teach a graphical understanding of the mechanics of a particle

(Fig. 3). For example, in a graphical understanding, the slope at any point on a distance-time graph gives the speed at that point in time, and the area under a speed-time graph gives the distance travelled. Such a graphical method is very useful in order to solve the problem without formulas.

Furthermore, the area under a force-distance graph gives the work, and the area under a force-time graph gives the impulse. Such a graphical method is very useful in order to understand the general concepts of work and impulse.

Information concerning a graphical understanding was retrieved from https://www.youtube.com/channel/UC_Wdv-TDEPCxMBfkYmd1pTg .

Using the study card widget (Fig. 4), students repeat the learning contents and establish the knowledge.

Moreover, the students can use the review widget (Fig. 5) to check their degree of understanding.

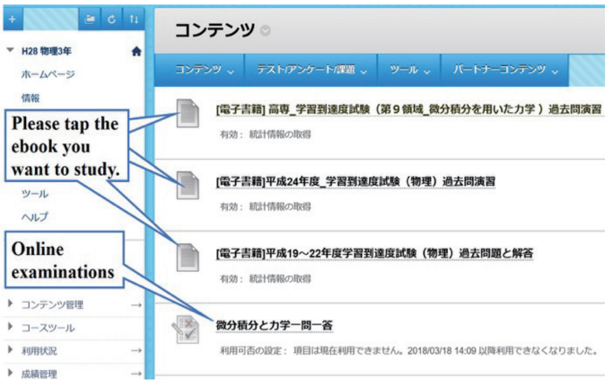


Figure 1. LMS website (https://bb.kosen-ac.jp) for downloading the ebooks and online examination

Table 1. Composition of the ebook

Chapter	Contents	Page
0	Introduction	1
1	Key summary of differential and integral calculus and mechanics	3
2	Example of questions and answers from the achievement examinations	10
3	Questions and answers from the achievement examinations in 2012	19
4	Questions and answers from the achievement examinations in 2013	28
5	Questions and answers from the achievement examinations in 2014	35
6	Review exercise widget	42
7	References	55

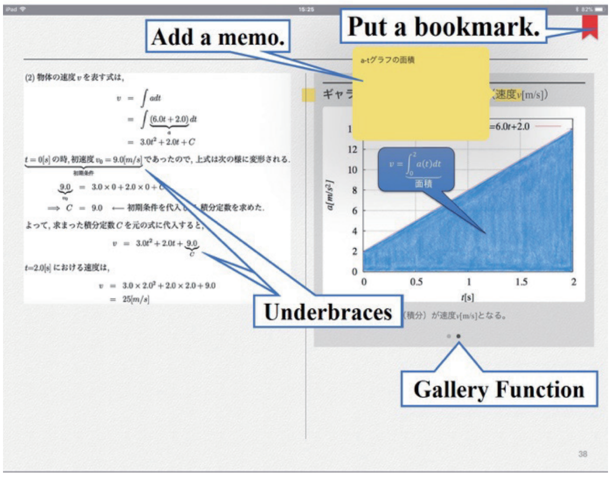


Figure 2. Place a bookmark, underbraces, and memo on an ebook page

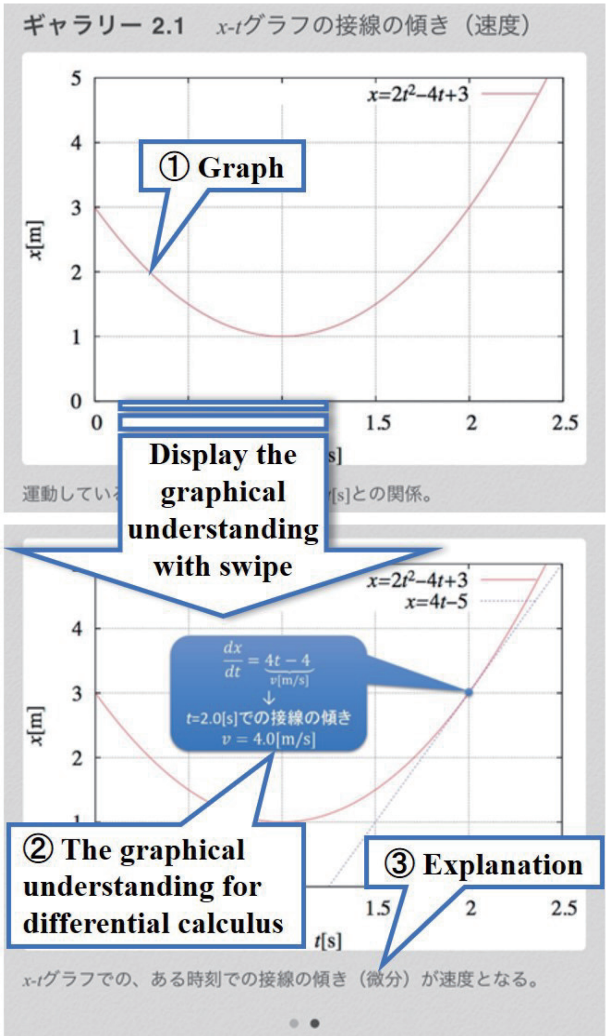


Figure 3. Gallery function of ebooks for graphical understanding

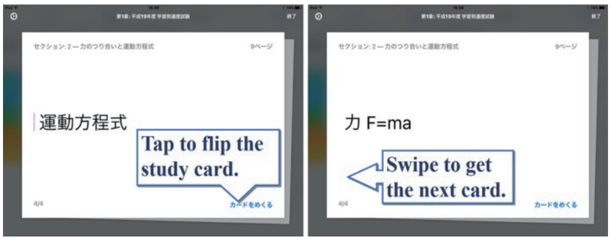


Figure 4. Study card widget

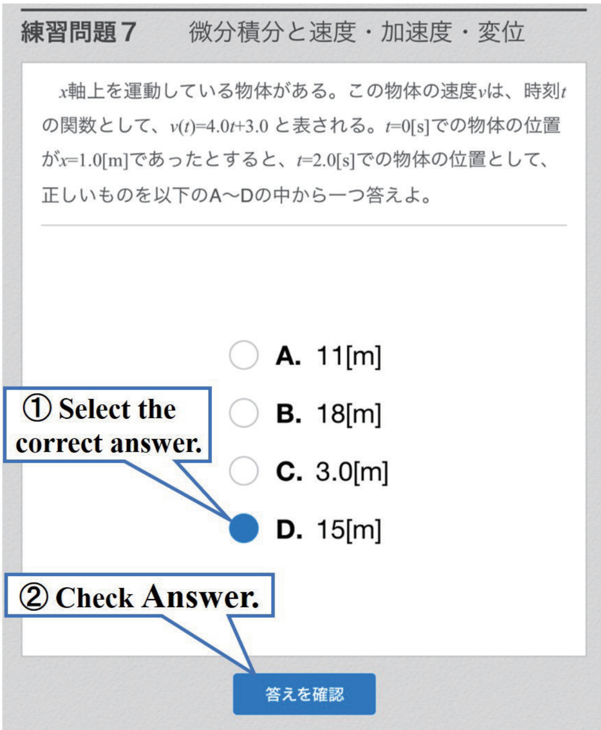


Figure 5. Review widget

Online examinations on Blackboard

In conjunction with ebooks, the students took an online examination in LMS, and could efficiently check their depth of understanding.

質問の種類の選択：すべての質問の種類　識別力の選択：すべての識別力　難易度の選択：すべての難易度　実行　フィルタのリセット

質問	質問の種類	識別力	難易度
微積と速度: 速度vを時間tで積分すると「距離x」を計算できる。	正誤問題	0.41	95.19%
微積と速度: ある時刻tにおける位置x(t)をtで微分すると「速度」が計算できる。	正誤問題	0.46	93.98%
微積と加速度: ある時刻tにおける位置x(t)をtで２回微分すると「速度」が計算できる。	正誤問題	0.65	89.16%
微積と速度: ある時刻tにおける速度v(t)をtで微分すると、「速度」を計算できる。	正誤問題	0.69	86.75%
微積と加速度: 加速度aを時間tで積分すると「距離x」を計算できる。	正誤問題	0.74	85.55%
微積と仕事: 力Fを距離xで積分すると、「力積」が計算できる。	正誤問題	0.82	81.93%
微積と力積: 力Fを時間tで積分すると、「仕事」が計算できる。	正誤問題	0.82	81.93%
微積と仕事・力積: 力の時間積分は（　　　）である。	穴埋め問題	0.81	80.73%
微積と仕事・力積: 力の距離積分は（　　　）である。	穴埋め問題	0.9	80.73%
位置エネルギーと微分: 位置エネルギーUを位置xで微分したものにマイナスを付けると、「運動量P」になる。	正誤問題	0.66	71.09%

Figure 6. Online examinations on general concepts of differential and integral calculus and mechanics

In order to check their understanding of general concepts of physics, the questions in Fig. 6 were given. In addition, for example, we gave the following calculation questions (Fig. 7).

Figure 7. Online examinations on fundamental calculations of differential and integral calculus and mechanics

After the online examinations, in order to understand the usefulness of differential and integral calculus for the calculation of physical quantities, we gave students questions that required solving using either differential and integral calculus or with formulas. We gave the following calculation questions.

$\boxed{\text{Question 1}}$: On the x-axis, an object accelerates from 0[m/s] to $4.0t$[m/s] in t[s].

1) Calculate the acceleration of the object in the first 4.0[s].
2) How far did the object travel in the first 4.0[s] ?

$\boxed{\text{Question 2}}$: On the y-axis, an object is lobbed in the air at an initial velocity of 39.2[m/s]. The height y[m] of the object is expressed as $y = 39.2t - 4.9t^2$ in t[s].

1) Calculate the velocity of the object in t[s].
2) Calculate the time to reach the highest point.
3) Calculate the highest point reached.

Results and Discussion

Questionnaires were completed by students in August 2016, August 2017 and February 2019. A summary of their responses to the following questions is described below.

1. Was the ebook for differential and integral calculus and mechanics useful as a study aid?
2. I was able to understand the velocity, acceleration and displacement calculated by differential and integral calculus.
3. Was the gallery function for graphical understanding useful as a study aid?
4. I was able to understand the work and impulse calculated by differential and integral calculus.

5. Were the online examinations of fundamental concepts of differential and integral calculus and mechanics useful as a study aid?
6. Were the online examinations of fundamental calculations of differential and integral calculus and mechanics useful as a study aid?
7. Were the questions on linear motion of uniform acceleration that can be solved using both differential and integral calculus and formulas useful as a study aid?

According to the answers provided by the students, 62~73% of them found the ebook to be useful (Fig. 8-10(1)). Additionally, 64~73% of students understood the velocity and acceleration calculated by differential and integral calculus (Fig. 8-10(2)), and 67~70% of students could understand the work and impulse calculated by differential and integral calculus (Fig. 8-10(4)).

Additionally, 57~59% of students found the gallery function for graphical understanding useful as a study aid (Fig. 8-10(3)).

In Figure 8-10(5) and Figure 9-10(6), 55~69% of students found the online examinations useful as a study aid. Additionally, ~65% of students found the questions of linear motion of uniform acceleration that can be solved using both differential and integral calculus and formulas useful as a study aid (Fig. 10(7)).

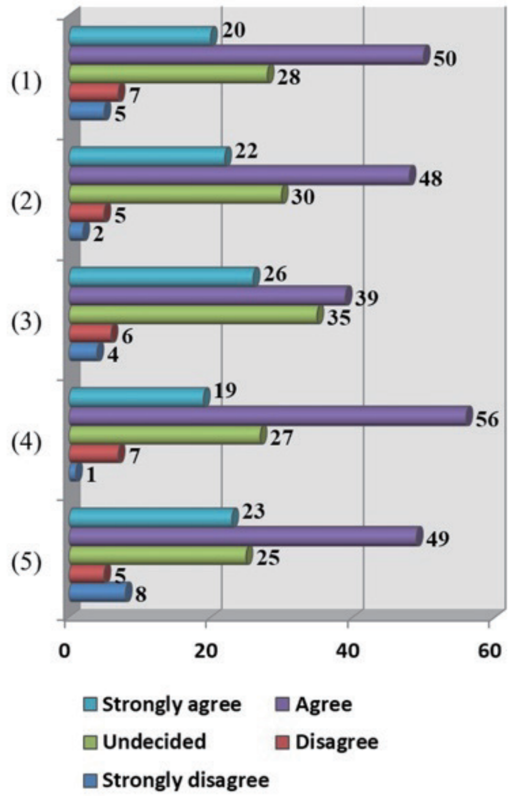


Figure 8. Results of a student questionnaire in August 2016

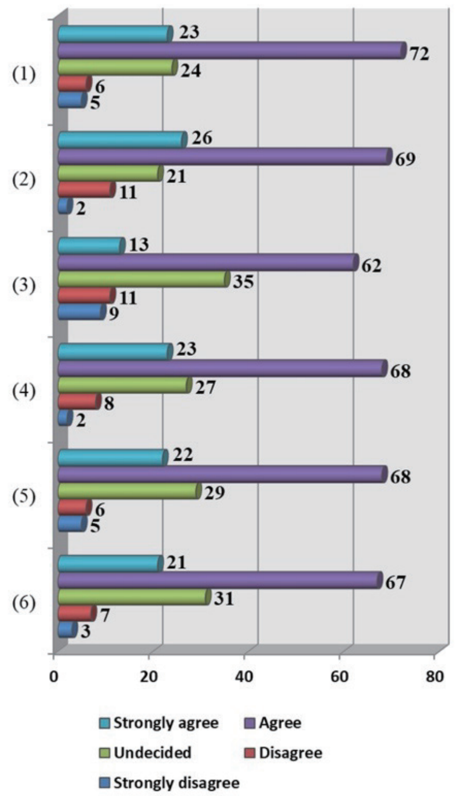


Figure 9. Results of a student questionnaire in August 2017

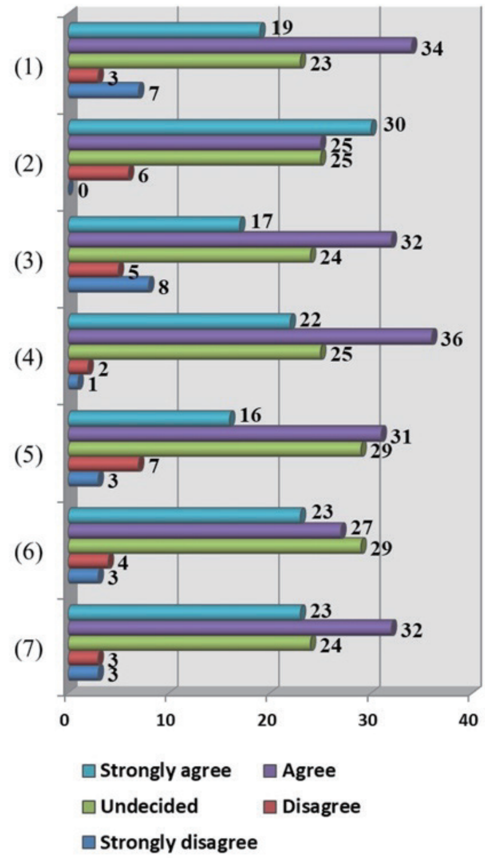


Figure 10. Results of a student questionnaire in February 2019

Impressions and evaluations from the students

Statements made by the students in the questionnaire concerning the ebook and LMS are given below. The statements are paraphrases of the original Japanese statements.

• It was easy to work while in home or dormitory.
• The point that I want to find is found immediately and the graph is easy to understand.
• It was easy to carry the ebook anywhere.
• I was able to calculate the velocity and acceleration using the differential and integral learned in the math class.
• I was able to know the characteristics of differential and integral calculus.
• Not only the calculation results, I could understand more deeply by looking at the graphical understanding of gallery function.
• It was easy to understand graphically.
• I became able to express the relationship of F, W, and I by integration, and the formula learned before became easy to understand.
• I could solve a simple question with my smartphone, and I could see the answers and scores immediately.
• In the online examination, I was able to understand deeply by calculating physical quantities.
• I understood the structure of the calculation.
• It was very useful to be able to solve the question using both differential and integral calculus and formulas.

Conclusions

According to the result of the questionnaire, More than 60% of students found the electronic books to be useful for study. And about 60% of students found the online examinations useful as a study aid.

The average score on the ninth area of physics learning achievement examinations (differential and integral calculus and mechanics) in 2017 was 18.1 and increased 1.5 points compared with the previous year (2016).

In 2018, since the learning achievement examinations was finished, the educational effect was measured using the same questions as the previous year (2017). The average score on the ninth area of physics learning achievement examinations was 21.4 and increased 3.3 points compared with the previous year (2017). It seems that the gallery function for graphical understanding coupled with the online examinations containing fundamental calculations and the questions that can be solved using both differential and integral calculus and formulas led to good results.

As a result of the online examination, it became clear that the differential calculus of a composite function and the determination of the integral constant is difficult for the students. Accordingly, we would like to add a new chapter of physical mathematics to the ebook. Along with this, we also want to add the online examinations of physical mathematics.

To advance our study of physics education using ebooks and LMS one step further, we would like to add new features to our ebooks and online examinations for ICT education. These would involve questions about converting quantitative sentences into qualitative representations by means of graphs and on understanding cause and effect in physical phenomena, topics that would make students think deeply.

Acknowledgements

This work was supported by JSPS KAKENHI Grant Number JP16K01155.

References

Information concerning achievement examinations at the Institute of National colleges of Technology, Japan retrieved from https://www.kosen-k.go.jp/about/profile/attainment.html .

The ebook could be accessed via the homepage, http://www.hiroshima-cmt.ac.jp/faculty/ippan/007.html .

Information concerning JSPS KAKENHI Grant Number JP16K01155 retrieved from https://kaken.nii.ac.jp/ja/grant/KAKENHI-PROJECT-16K01155/ .

S. Fujiwara. (2012). Preparation for Learning Achievement Examinations of Physics Using Electronic Books, 6th International Symposium on Advances in Technology Education 2012, Proceedings USB, C07_P007.pdf.

S. Fujiwara and M. Takiguchi. (2015). Development of Electronic Books for the Physics Learning Achievement Examinations: A Graduation Research Project, 9th International Symposium on Advances in Technology Education 2015, *Transactions of ISATE 2015,* p.191-195.

S. Fujiwara and Y. Hirai. (2015). A Preparation for Learning Achievement Examinations of Physics Creating Electronic Books in Graduation Research. *Journal of Education in the Colleges of Technology*, 38, 157-162.

S. Fujiwara and M. Takiguchi. (2019). A Practice of Physics Education Using Electronic Books for Differential and Integral Calculus, Mechanics and an LMS, *Journal of JSEE*, 67-2, 8-14. https://doi.org/10.4307/jsee.67.2_8

VIRTUAL AND AUGMENTED REALITY LEARNING FOR LIFT MAINTENANCE – SUBSTANTIAL ADVANCEMENT IN LIFT MAINTENANCE TRAINING

Hoi Kok Calvin CHEUNG*, Kin Sang Timothy LEE and Sai Lok Eric LIU

Engineering Discipline, Hong Kong Institute of Vocational Education, Hong Kong

*calvin.cheung@vtc.edu.hk

Abstract

Vocational Training Council (VTC) has introduced Virtual and Augmented Reality (VAR) technologies to enhance its Vocational and Professional Education and Training (VPET) programmes since 2014. Particularly, VAR Learning is found the most useful for safety related practical training programmes in lift maintenance, automotive engineering, aircraft maintenance engineering, etc. As VTC is the largest VPET provider in Hong Kong, she is also offering apprenticeship training programmes at different levels for a broad range of industries. For example, VTC trains about 250 apprentices every year, which is the largest in number in Hong Kong, in the field of lift maintenance to support the need of the industry. The lift industry provides services to about 68,000 lifts in Hong Kong in 2018, which is not a small number for an area around 1100 km^2. Moreover, VTC collaborates with a government department, the Electrical and Mechanical Services Department (EMSD), and the leading professional lift industry association, the Lift and Escalator Contractors Association (LECA), to establish a new virtual reality training and assessment platform for the lift industry. Our training platform is a substantial advancement in the history of lift maintenance training and bring a new future to education. In addition to conventional routine trainings, our platform can as well provide trainees chances to expose to various emergency situations, e.g. a fire hazard, and train them the proper way in handling these emergency situations. Furthermore, the trainings provided by our platform are recognized by the EMSD which allows apprentices gaining credits in the scheme of Continuing Professional Development (CPD) which serves to sustain and enhance the competencies of qualified professionals.

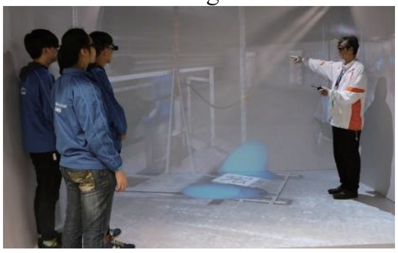
Keywords: *VPET, lift, VR, AR, training platform*

Introduction

Virtual Reality (VR) technologies replicate a virtual environment to provide users a sensory simulation of the environment being presented (Bryson and Levit 1991;Nowke, Schmidt, Albada, et al. 2013; Reda, Febretti, Knoll et al 2013; Sampaio, Henriques and Martins 2010). In the market, there are two common forms of VR systems, the cave automatic virtual environment (CAVE) system and the head mounted display (HMD) system. In both systems, the contents being presented to the users are view-dependent which are updated according to the head position and orientation to simulate what the user should see in the reality. Therefore, they impress the users the feeling of presence in the virtual environment (immersiveness).

CAVE was firstly introduced in 1992 by Cruz-Neira, Sandin, Defanti, et al. (1992); (1993). CAVE system nowadays usually comprises several screens encircling the users. It provides users with a very broad field of view that significantly improves the feeling of presence in the virtual environment. Moreover, users do not have to rely on a virtual representation of their own bodies. Instead, they could physically enter the virtual space that greatly enhances the immersive feeling (Cruz-Neira, Sandin, Defanti, et al. 1992; 1993; Kuhlen and Hentschel 2014). The immersive virtual environment allows users having a faster and more comprehensive understanding of complex spatial relationships and allows interacting with objects in the environment using more natural controllers. For example, a user can use LED gloves (motion can be tracked by a camera tracking system) to magnify and rotate the 3D brain structure data in the virtual environment (Defanti, Dawe, Sandin, et al. 2009; Kuchera-Morin, Wright, Wakefield, et al. 2014).

HMD system includes a display device worn on the head covering the user's eyes. It is compact in size and low cost comparing with CAVE system. This makes HMD system a popular choice to implement VR applications. In 2014, Vocational Training Council (VTC) introduced the Virtual and Augmented Reality (VAR) technologies to enhance its Vocational and Professional Education and Training (VPET). We established a new office called VAR Learning Project Office (VARLPO) in January 2015 focusing on developing a compilation of applications making use of VAR technologies to assist learning and teaching. (Azuma, Baillot, Behringer et al. 2001; Caudell and Mizell 1992; Feiner, MacIntyre, Hollerer et al. 1997; Milgram, Takemura, Utsumi et al. 1995; Simon, Baglee, Garfield et al. 2014; Taumura 2002; Vera, Russo, Mohsin et al. 2014; Yamabe and Nakajima 2013) We found that VAR technologies are the most useful in safety related practical training programmes. This includes lift maintenance, automotive engineering, aircraft maintenance engineering etc. For example, in lift maintenance, there is certain extent of safety risk allowing trainees to literally enter lift shaft for training. Using VR system for training, we manage to avoid the safety risk and at the same time, to allow trainees exposing to any kind of fault and impressing them with the associated consequences. This is usually not possible in conventional training method.


(a)

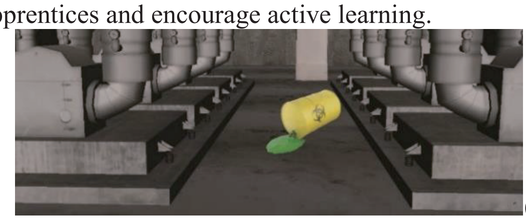

(b)

Figure 1, The STEM centre of VTC is equipped with both the CAVE system and the HMD system for teaching and learning. (a) Instructor was teaching the trainees to inspect an air compressor using the CAVE system. (b) Without the presence of instructor, a trainee was practicing the procedures in fixing a water pump using the HMD system after class.

In Hong Kong, there were about 68,000 lifts in 2018 which was not a small number for an area around 1100 km^2. As of 2015, Hong Kong had over 40 registered contractors, and over 300 registered engineers and more than 5,000 registered workers. Vocational Training Council (VTC), established in 1982, is the largest vocational and professional training and development service provider in Hong Kong. She offers a wide-range of apprenticeship training programmes at different levels for a broad range of industries. For example, VTC trains about 250 apprentices every year in the field of lift maintenance, which is the largest in number in Hong Kong, to support the need of the industry. VTC considers lift maintenance is one of the industries having the biggest adoption of immersive training making use of VAR technologies.

VAR training in lift maintenance industry

Traditionally, apprenticeship is the most common way of practical training for lift maintenance trainees. However, depending on the skilfulness of the training master, the quality of training would vary and could not be easily assured. In addition, it is not easy and safe to simulate emergency and accidental situations in the real world. Therefore, training masters usually can only verbally describe the emergency situations and tell the apprentices the proper way in handling the problems. VAR technologies manage to simulate any kind of accidents and emergency situations and to train the apprentices the actual procedures in handling the situations without any safety risk. The most skilful training masters may not have the chance to come across most kinds of lift accidents. Using VAR technologies, we manage to allow apprentices to experience them systematically and let them experience the consequence of improper operations. This is not possible in traditional training programme. At the same time, these VAR technologies maximize the training safety and assure training standard as all the apprentices go through the same training in the Unified and Standardized Immersive VR Training Scenarios. In addition, apprentices can practice their skills in the VR environment any time after class without the presence of the instructor. This substantially enhances the productivity of training and learning. In addition, from our experience, we found that VR training manages to arouse the interest of the apprentices and encourage active learning.


(a)

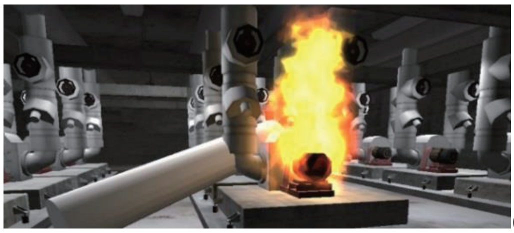

(b)

Figure 2, Trainees use the VR system to practice the procedures in handling emergency situations. A scenario with (a)chemical fluid on the floor, and (b) fire hazard in a virtual engine plant room

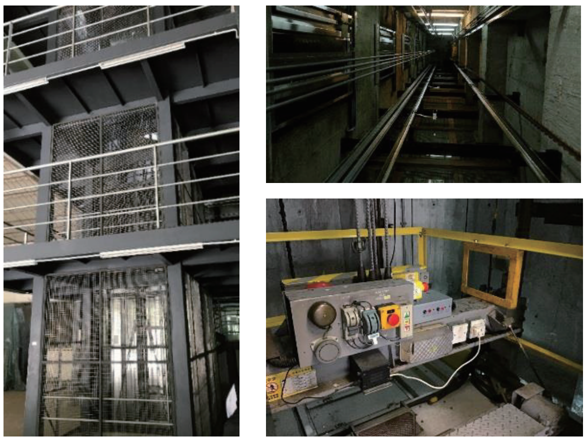


Figure 3, the equipment used for lift maintenance training

Collaborations with industry and government authority

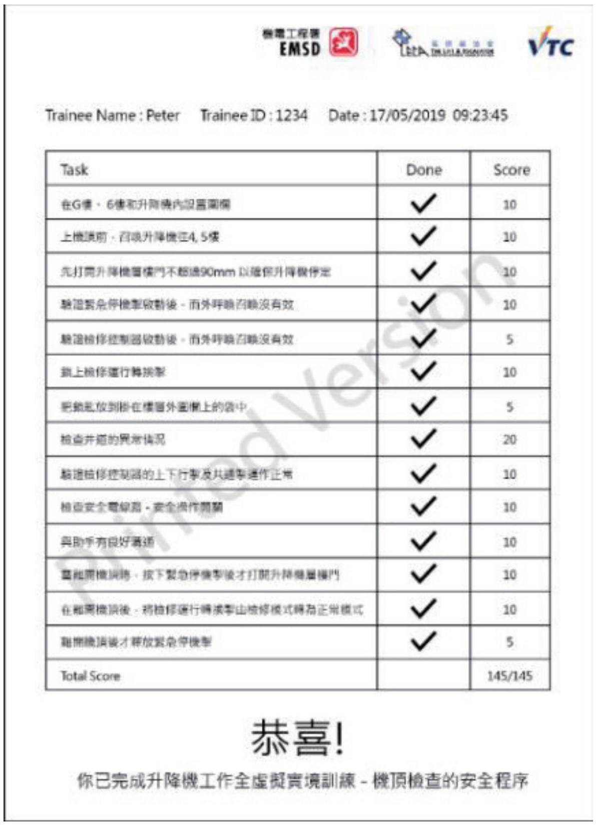
In view of the benefits of VAR training in lift maintenance, VTC collaborates with a government department, the Electrical and Mechanical Services Department (EMSD), and the leading professional lift industry association, the Lift and Escalator Contractors Association (LECA), to establish a new virtual reality training and assessment platform for the lift industry. With the tripartite model, EMSD, LECA and VTC formed a working group in which VTC and LECA work together on the design of scenarios of the VR training simulator. The contents of the training manage to fulfil the basic safety training requirements of the lift maintenance industries. VTC is responsible for the development of the simulator and EMSD and LECA are responsible to ensure the quality of the training contents is up to standard.

Figure 4, VTC collaborates with EMSD and LECA and jointly develop a VR training platform for lift maintenance industry.

In the first stage, we have identified nine scenarios for training purpose and two of them were completed in March 2019. As EMSD is the accreditation authority in the lift maintenance industry in Hong Kong, the VR training platform will be approved and recognized by EMSD after completion. Currently, the working group is working on the details of In-Service Lift Maintenance Safety Training Class. The training class will be 3 hours in length including the first two completed VR lift maintenance safety training scenarios. The automatic assessment of the training is set by EMSD and LECA to maintain professional standard. This training class will be recognized by EMSD as one of the recognized training class which is equivalent to 3 hours for Continuing Professional Development (CPD). In Hong Kong, every registered worker is required to earn himself at least 30 hours for CPD in every 5 years. This CPD scheme is essential in sustaining and enhancing the competencies of qualified professionals. This is also the first VR training platform for lift maintenance industry in Asia which is recognized by the professional lift industry association and the relevant government authority. Therefore, our VR training platform is a substantial advancement in the history of lift maintenance training and bring a new future to education, in Hong Kong.

Conclusion

VAR technolonogies have various benefits in vocational and professional education and training (VPET). VTC found that the VAR technologies are the most useful for safety related practical training programmes including lift maintenance. VAR training allows simulation of different environments and emergency situations like fire hazard and work-at-height. It allows apprentices to learn the way in handling various emergency situations and to experience the consequences for improper handling procedures. This is not possible for conventional apprenticeship training programmes. In view of these advantages, VTC collaborates with a government department, the Electrical and Mechanical Services Department (EMSD), and the leading professional lift industry association, the Lift and Escalator Contractors Association (LECA), to establish a new virtual reality training and assessment platform for the lift industry. The trainings provided by our platform are recognized by the EMSD, the Hong Kong official authority in lift industry, allowing apprentices gaining credits in the scheme of Continuing Professional Development (CPD). Our training platform is a substantial advancement in the history of lift maintenance training and bring a new future to education.



EMSD VTC

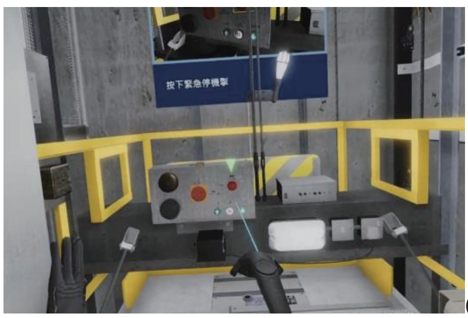
Trainee Name : Peter Trainee ID : 1234 Date : 17/05/2019 09:23:45

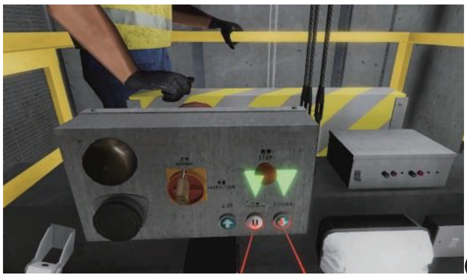
Task	Done	Score
在G樓、6樓和升降機內設置圍欄	✓	10
上機頂前，召喚升降機往4, 5樓	✓	10
先打開升降機層樓門不超過90mm 以確保升降機停定	✓	10
驗證緊急停機掣啟動後，而外呼喚召喚沒有效	✓	10
驗證檢修控制器啟動後，而外呼喚召喚沒有效	✓	5
扳上檢修運行轉換掣	✓	10
把鎖匙放到掛在樓層外圍欄上的袋中	✓	5
檢查井道的異常情況	✓	20
驗證檢修控制器的上下行掣及共通掣運作正常	✓	10
檢查安全電線路 - 安全操作開關	✓	10
與助手有良好溝通	✓	10
當離開機頂時，按下緊急停機掣後才打開升降機層樓門	✓	10
在離開機頂後，將檢修運行轉換掣由檢修模式轉為正常模式	✓	10
離開機頂後才釋放緊急停機掣	✓	5
Total Score		145/145

恭喜!

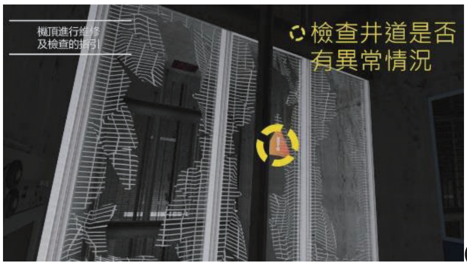
你已完成升降機工作全虛擬實境訓練 - 機頂檢查的安全程序

Figure 5, automatic computer assessment of trainee is based on the criteria co-designed by EMSD and LECA ensuring professional standard.


(a)



(b)



(c)

(d)

Figure 6, some captured images of the virtual environment in VR training and assessment platform for the lift maintenance

Acknowledgements

This project is supported by the Vocational Training Council (VTC), the Electrical and Mechanical Services Department (EMSD), and the leading professional lift industry association, the Lift and Escalator Contractors Association (LECA).

References

Azuma, R.T., Baillot, Y., Behringer, R. et al., (Nov/Dec 2001). Recent advances in augmented reality. *IEEE Computer Graphics and Applications*, 21(6),34-47.

Bryson, S. and Levit, C., (1991). The virtual wind tunnel: an environment for the exploration of three dimensional unsteady flows. *Proceedings, IEEE Conference of Visualization*, 17-24

Caudell, T.P. and Mizell, D.W. (1992). Augmented reality: An application of heads-up display technology to manual manufacturing processes. *Proceedings, Hawaii International Conference on Systems Sciences*, 659-669.

Cruz-Neira, C., Sandin, D., Defanti, T., et al. (1992). The CAVE: audio visual experience automatic virtual environment, *Communication of the ACM,* 35(6), 64-72

Defanti, T.A., Sandin, D., and Cruz-Neira, C. (1993). A 'room' with a 'view', *IEEE Spectrum*, 30(10), 30-33

Defanti, T.A., Dawe, G., Sandin, D.J., et al., (2009). The StarCAVE, a third-generation CAVE and virtual reality OptIPortal. *Future Generation Computer Systems*, 25, 169-178

Feiner, S., MacIntyre, M., Hollerer, T., et al., (Dec 1997). A touring machine: Prototyping 3D mobile augmented reality systems for exploring the urban environment. Personal and Ubiquitous Computing, 1(4),74-81.

Kuhlen, T.W. and Hentschel, B. (Oct 2014). Quo vadis CAVE: Does immersive visualization still matter? *IEEE Computer Graphics and Applications*, 34(5), 14-21

Kuchera-Morin, J., Wright, M., Wakefield, G., et al., (2014). Immersive full-surround multi-user system design. *Computers and Graphics*, 40, 10-21

Milgram, P., Takemura, H., Utsumi, A., et al., (1995). Augmented reality: a class of displays on the reality-virtuality continuum. *Proceedings, SPIE conference on telemanipulator and telepresence technologies*, 282-292

Nowke, C., Schmidt, M., Albada, S.J.van, et al., (2013). VisNEST – interactive analysis of neural activity data. *Proceedings, IEEE Symposium on Biological Data Visualization (BioVis)*, 65-72

Reda, K., Febretti, A., Knoll, A., et al., (2013). Visualizing large, heterogeneous data in hybrid-reality environments. *IEEE Computer Graphics and Applications*, 33(4), 38-48

Sampaio, A.Z., Henriques, P.G. and Martins, O.P. (2010). Virtual reality technology used in civil engineering education. *The Open Virtual Reality Journal*, 2, 8-25

Sampaio, A.Z., Ferreira, M.M., Rosário, D.P., et al., (2010). 3D and VR models in civil engineering education: construction, rehabilitation and maintenance. *Automation in Construction*, 19, 819-828

Simon, V., Baglee, D., Garfield, S. et al. (2014). The development of an advanced maintenance training programme utilizing augmented reality. *Proceedings, 27th International Congress of Condition Monitoring and Diagnostic Engineering*.

Tamura, H. (2002). Steady steps and giant leap toward practical mixed reality systems and applications. *Proceedings, International Status Conference on Virtual and Augmented Reality*.

Vera, A.M., Russo, M., Mohsin, A., et al., (2014). Augmented reality telementoring (ART) platform: a randomized controlled trial to assess the efficacy of a new surgical education technology. *Surgical Endoscopy*, 28(12), 3467-3472.

Yamabe, T, and Nakajima, T. (2013). Playful training with augmented reality games: case studies towards reality-oriented system design. *Multimed Tools Appl*, 62, 259-286.

PILOT STUDY: THE EFFECTIVENESS OF SMARTBOOK FOR FLIPPED CLASSROOM LEARNING IN SCIENCE

Tiong Wei TAN, Edmund LUI and Adrian YEO

School of Chemical & Life Sciences, Singapore Polytechnic, Singapore

tan_tiong_wei@sp.edu.sg

Abstract

The flipped classroom instructional strategy has gained popularity with instructors in recent times due to its potential merits. It creates opportunities for instructors to use class time more efficiently and most importantly, to promote self-directed learning. The commercially available SmartBook (McGraw-Hill Education), an interactive e-textbook that adapt to learner's ability can be a valuable resource for pre-class materials, which is a key component of flipped classroom. The McGraw-Hill Connect platform allow learners to test their understanding by providing instant feedback through the interactive text. This platform also provide both instructors and learners reports to monitor learning progress, therefore making it a powerful Edtech tool combination with the appropriate instructional design for flipped classroom. In this pilot study, the focus was on ascertaining the impact of SmartBook and its related resources on the student flipped learning experience in terms of adoption of Edtech tool and perception of learning when combined with different in-class active learning strategies. The research employed a quantitative-based student survey, administered at the end of the pilot study, that measures the learners' attitude and their perceived usefulness of SmartBook and Connect resources towards their learning in Chemistry (Physical Chemistry) and Biology (Microbiology – Medical Microbiology and Industrial, applied and environmental microbiology) modules. We first outline a viable model comprising of an evidence-based teaching approach in the instructional design of the learning tasks, with SmartBook and Connect resources as a technological tool combination for flipped learning. Secondly, the findings were presented together with important insights gained in this pilot implementation and concludes with a summary of the future developments of SmartBook. The findings found that SmartBook and Connect resources were potentially impactful as an Edtech tool for students' learning. Of particular significance, we established SmartBook as an effective technology tool in combination with the flipped classroom instructional strategy.

Keywords: *SmartBook, Connect, flipped classroom, instructional strategy, technology*

Introduction

McGraw-Hill Education is a commercial publisher that provides various tools in their Connect platform to enhance students' learning. They include the adaptive LearnSmart courseware (SmartBook), homework assignments and quizzes. The SmartBook is an e-textbook integrated with interactive resources such as videos, explanation slides and publisher-authored practice questions as well as an artificial intelligence that prompts learners to practice the questions. Learners will only be required to perform lower levels of cognitive work (understanding and remembering) to achieve mastery of concepts through the assigned practice questions. They answer them to the best of their ability and indicate their confidence level (I know it; think so; unsure; no idea) honestly to build metacognition. Furthermore, these questions have linked access to the relevant sections in SmartBook as remediation. A learner who answers the question incorrectly or with low confidence will trigger the system to generate a similar question, hence advancing at a slower pace compared to another student who can answer the question correctly and confidently. This adaptive feature of SmartBook creates the personalised learning experience tailored for each learner. In Connect, both instructors and learners are also able to access learning analytics that analyse performance and identify learning issues. Connect can also be integrated into the Blackboard learning management system (LMS) and is accessible through mobile devices, hence encouraging learning on the go.

SmartBook and Connect was integrated as an Edtech tool combination for the flipped classroom instructional strategy in Chemistry (Physical Chemistry) and Biology (Microbiology – Medical Microbiology, -Industrial, Applied and Environmental Microbiology) modules over the duration of one semester for both pre-employment (PET) and continuing education and training (CET) learners in the School of Chemical and Life Sciences (CLS). Physical Chemistry (PC) is a core module taught to first year students in the Diploma in Applied Chemistry (DAPC), Diploma in Food Science and Technology (DFST) and the Diploma in Perfumery and Cosmetic Sciences (DPCS) while Microbiology – Medical Microbiology (MM) is taught to second year students in the Diploma in Biomedical Science (DBS). A total of 18 students from the Specialist Diploma in Microbiology took the Industrial, Applied and Environmental Microbiology (IAEM) module.

Literature Review

The leaders of the flipped learning network collectively defines flipped learning as a pedagogical approach in which direct instruction moves from the group learning space in the classroom to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students to apply concepts and engage creatively in the subject matter (Piehler, 2014). In flipped classroom, instructors typically categorized the learning content into three stages, pre-class, in-class and post-class (Gilboy et al. 2015). Applying Bloom's revised taxonomy (Anderson and Krathwohl, 2001), students typically perform lower levels of cognitive work (understanding and remembering) outside of class, and focus on the higher cognitive work (applying, analyzing, evaluating, and creating) in class, where they have the support of their peers and instructor (Brame, 2013; See & Conry, 2014). This approach replaces the traditional transmissive lecture for pre-class preparation, active in-class tasks and post-class work (Abeysekera & Dawson, 2015), therefore providing a workable model in the flipped learning design. Instructors also cite potential strengths of flipped classroom, including increased interactive period within the class (Fulton, 2012) and more time for students collaborative learning (Hamden et al, 2013).

The flipped classroom instructional strategy is gaining popularity perhaps also due to the presence and affordance of technology tools that teachers can use to integrate into the learning design, therefore providing new opportunities for students' learning (Keengwe & Onchwari, 2015). Digital learning resources such as LearnSmart interactive and adaptive learning tools may have the potential to enhance students' learning outcomes. Adaptive learning is defined as "a more personalized, technology enabled, and data-driven approach to learning that has the potential to deepen student engagement with learning materials, customize students' pathways through curriculum and permit instructors to use class time in more focused and productive ways" (Newman, et al, 2012). Despite the enthusiasm for adaptive technology, relatively few studies have been conducted to investigate the impact of adaptive courseware adoption and results vary on students' outcome (Gebhardt, 2018).

The technology acceptance model (TAM) provides a theoretical framework to explain and assess user's behaviour and decision to adopt and use new information technology (Davis, 1989). According to this model, one's actual use of technology is influenced by the user's behavioral intention, perceived usefulness (PU) of the system and perceived ease of use (PEOU) of the system. As proposed by TAM, external factors also have an effect on PU and PEOU as depicted in Figure 1. The robustness of this model was validated in various settings (Davis & Venkatesh, 1996) and it provides an instrument for the study of the learners' acceptance, adoption and actual use of the interactive and adaptive technology such as SmartBook and Connect.

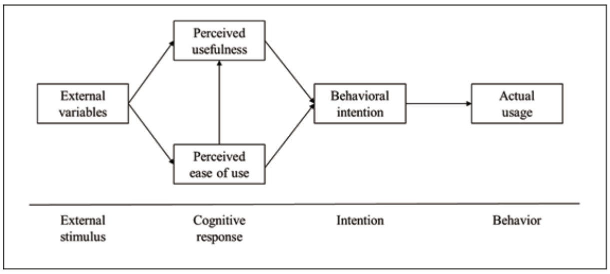


Figure 1. TAM. Adapted from Davis & Venkatesh, 1996, p.20

Materials and Methods

In this pilot study, the focus is on ascertaining the impact of the various tools in Connect such as SmartBook, homework assignments and quizzes on the student learning experience in terms of adoption of Edtech tool and perception of learning when combined with different in-class active learning tasks in the flipped classroom instruction. The research questions for this study are: (1) What factors influence the learner's adoption and actual usage of Connect platform and SmartBook adaptive reading tool for flipped learning in Chemistry and Biology? (2) How do Connect platform and SmartBook adaptive reading tool enhance students' learning outcomes in the flipped classroom instruction?

All survey participants are from students enrolled in CLS and the Professional and Adult Continuing Education (PACE) Academy in Singapore Polytechnic. 194 out of 238 students taking PC, 38 out of 40 students taking MM and 17 out of 18 students taking IAEM took part in this study voluntarily. The research employed an anonymous quantitative-based survey comprising of eleven questions that measures the learners' attitude and their perceived usefulness of SmartBook towards their learning. The survey was conducted at the end of the semester prior to their examinations. Some of the questions are broadly categorised according to the four components of TAM as shown below:

Perceived ease of use: Q1. It was easy for me to locate and use the activities in Connect.
Perceived usefulness: Q2. Thinking about the course resources in Connect, what did you find helpful for your study? Q3. The flipped classroom using Connect & SmartBook is a new implementation this semester, do you feel that it helped you learn Chemistry/ Biology better? Q4. In what ways do you think using Connect and SmartBook have helped in the flipped classroom approach this semester? (Multiple response question)
External variables: Q5. Thinking about the resources (pre/post-lecture reading, quizzes, self-directed tutorial), what influenced how much you used these?
Behavioural intention: Q6. How did you do the required readings for your class? Q7. Did you do the practice questions (adaptive) which popped up while you were reading? Q8. Did you use the reports available to help you learn what you needed to study? Q9. Would you continue to use SmartBook in the future for your reading and study purposes?

Results and Discussion

There is a strong indication that an evidenced-based pedagogy can be applied in the selection and integration of Edtech tool to enhance student learning in the design of flipped classroom instructional strategies (Sale, D., Cheah, S.M. & Wan, M., 2017). In this evidenced-based teaching (EBT) approach, the design of the flipped learning activities in Chemistry and Biology is guided by the ten cognitive scientific principles (Sale, 2015) and utilised Hattie's high effect size strategies (Hattie, 2009). Applying the Bloom's revised taxonomy (Anderson & Krathwohl, 2001) to flipped learning design, the learners are tasked to perform lower levels of cognitive work using SmartBook as pre-class activities (Figure 2). Learners are required to read the content at their own pace and achieve full credit for the open-resource practice questions. To provide instructors with certainty that students perform out-of-classroom responsibilities, the completion of these questions as a means of assessment is one extrinsic motivational strategy used in this learning experience to ensure learners achieve mastery of concepts before in-class activities. The monitoring of learner's readiness to embark on in-class learning activities through learning analytics in Connect platform allows instructors more time to engage learners for deep classroom learning, without having to authenticate if learners have performed their pre-class assignments again.

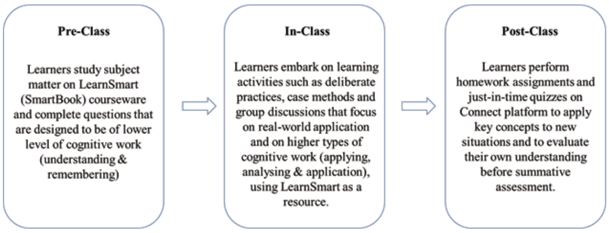


Figure 2. Integration of LearnSmart and Connect into flipped classroom model

In-class learning activities are carried out using case studies, deliberate practices and group discussions with the objective of connecting concepts to authentic applications. The instructors' role is that of a facilitator to support student's learning in flipped classroom. For PC, two case studies were developed and conducted. Learners navigate the case "A diver's worst nightware: The Diver's Bend" by analyzing an incident involving a diver suffering from decompression sickness and drawing relationships associated with the pressure, volume and temperature for gases. In the second case, learners have to evaluate the conditions used in the industrial production of ammonia by applying concepts and principles acquired in LearnSmart. For the Biology modules, in-class learning activities such as case studies for application-based scenario that mimics real world application of knowledge are used. An example of such in class activities was the case titled "One fine day in the microbiology laboratory…" where learners have to evaluate the symptoms of the patients to request for the appropriate clinical samples and the appropriate testing to solve the case. This would then be continued in the microbiology laboratory where they have to perform a series of experiments in order to identify the pathogens correctly. Other activities that build on the development of higher cognitive skills include deliberate practices where learners are presented with incorrect worked examples and are required to cooperate with other learners to re-work the solutions. For post-class activities, learners perform homework assignments on Connect where they can receive feedback instantly through guided solutions and just-in-time quizzes to evaluate their understanding. Guided by the ten cognitive scientific principles and Hattie's high effect size strategies in the flipped classroom design, students' learning is enhanced through multiple methods and presentation modes that engage the range of senses.

Perceived ease of use

Figure 3 below shows the learners response to their perceived ease of use of the Connect system to locate and embark on the learning activities (i.e. 64.4%, 81.6% and 71.0% of PC, MM and IAEM participants, respectively). The results reflect the deep integration of the Connect system with Blackboard to ensure that learners access the materials through the LMS that is familiar to them. The results also suggest that by making it easier to navigate the online learning activities, they are more willing to adopt the online learning tool.

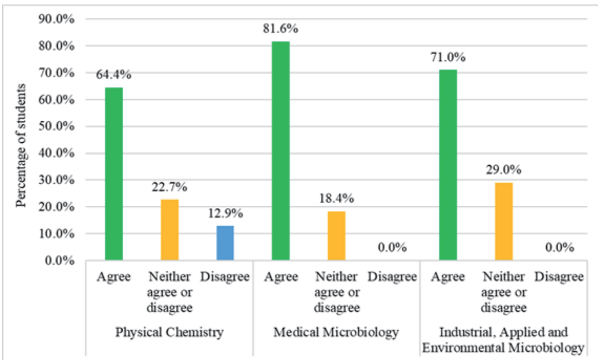


Figure 3. Responses to ease of locating and using activities in Connect platform

External variables

The participants were asked on six external factors that may potentially influence their actual use of Connect and SmartBook. These factors include, the time they had available to study, whether the assignments contributed towards their final grade, whether the activities were referred to in class, whether the materials would help them in the final examination, ease of use of activities and access to internet. Results collected suggest that extrinsic motivation to whether the assignments will contribute to their final grade strongly influenced PET students' adoption and actual usage of SmartBook and Connect. The awarding of marks for pre-class assignments maybe a suitable deliberate strategy used for Year 1 learners to cultivate discipline in completing these activities for flipped learning.

However, such a strategy may go against the notion of self-directed learning and should be discouraged at higher levels. Two other external variables that influence PET learners usage of the online learning resources are whether those materials are used in summative assessments such as exams and whether these activities are referred to in class. The results strongly suggest that incorporating elements of the resources as assessments and using it for in-class activities should be considered in the flipped classroom instructional design. For CET learners, majority of the participants are neutral and unsure what external variables may influence their usage, likely because of differences in their motivations towards learning as compared to PET learners. Further investigation is required.

Perceived usefulness

Figure 4 below shows that a very high percentage of learners (no less than 73% of all participants) felt that all the online resources were useful for their study. This can also be strongly correlated to the learners' high engagement level in SmartBook and Connect platform as evidenced through the access time, frequency of logins and assignment submission in the at risk report learning analytics. The results suggest that SmartBook and Connect are potentially useful and therefore impactful as an Edtech tool for students' learning. For the multiple-response question, a high percentage of PET learners (i.e. 61% for PC and 68% for MM) felt that getting an idea of a new concept through pre-lecture reading before coming to class helps them to learn more on their own and be more responsible with what they are learning. This compares to an extremely high 82% of participants taking IAEM who felt that the self-directed tutorial helped them understand the key concepts at their own pace. The results are slightly different compared to the PET learners, perhaps due to the time constraint that many CET learners faced. The design and structure of the lesson could also influence the CET learners in this survey. A partial flipped classroom was implemented for this group of CET learners, where SmartBook was done individually in the classroom and they are also required to go through summative assessments immediately after the homework assignments and quizzes.

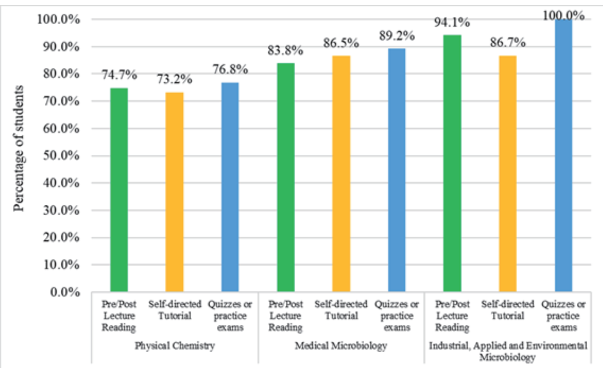


Figure 4. Responses to helpfulness of course resources to study

In Figure 5, approximately 34.0% and 60.5% of the participants taking PC and MM respectively agree that the flipped classroom using Connect and SmartBook helps them learn the subject matter better. The results are encouraging for the PET learners with about 40% being neutral with their opinion. As flipped learning is a new instruction to many of these PET learners, the results suggest that they are unsure whether this approach will lead to better learning outcomes and eventually grades as compared to traditional learning. Furthermore, time is required for the learners to get familiar with the flipped learning instruction. On the other hand, a relatively high 70% of the CET learners felt that flipped classroom using Connect & SmartBook helped them learn IAEM better. This new interactive learning tool and the teaching approach may have brought novelty to these CET learners, who are perhaps more self-directed and motivated for a different learning purpose.

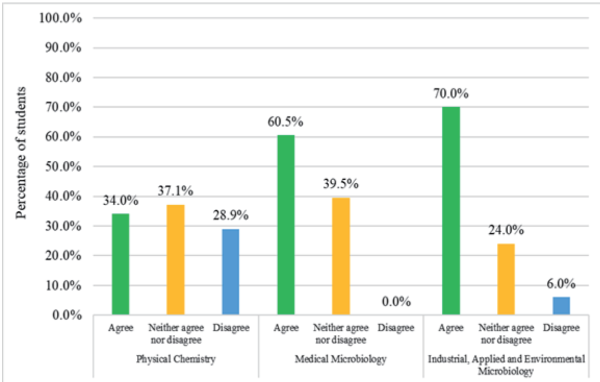


Figure 5. Perception on flipped classroom using Connect & SmartBook aiding them learn the subject matter better

Behaviour Intention

Learners are also asked if they have used the different features of SmartBook and Connect platform such as the adaptive practice questions and reports for their learning. In addition, we also investigated their preferred mode of reading the materials and their inclination towards future use of this online learning tool to understand their behavioural intention. Figure 6 to Figure 9 summarise the findings to their behavioural intention. Prior to using the SmartBook, most of the participants have little or no experience in using an e-text for reading and studying purposes. An insight into their reading behaviour as shown in Figure 6 reveals that about 80% of the learners completed the required readings using the Connect and SmartBook instead of the printed copy of the text even though they could exercise the option of copying the text to a word document or borrowing the required textbook in the library. This may suggest that most learners will have little difficulty transiting to a paperless reading and studying environment.

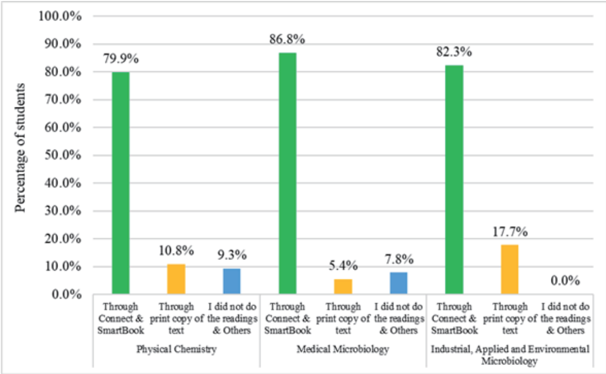


Figure 6. Responses to how the required readings are achieved

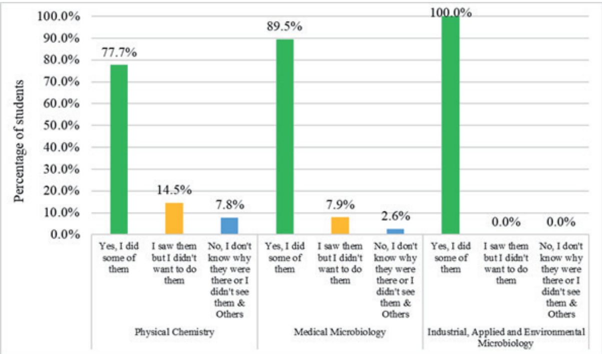


Figure 7. Responses to whether participants do the adaptive practice questions

Figure 7 shows a high percentage of learners attempted the adaptive practice questions, therefore highlighting its usefulness. However, Figure 8 below also reveals that a consistently high 71% of the participants for the Biology modules and 83% of participants for PC neither use the report, found them useful nor aware of its existence. This can be attributed to the vast resources available on the Connect platform that learners have to cope for their learning, hence neglecting a potential tool that could help them review and evaluate their learning. In addition, these learners are also new to this platform and their primary focus on utilising the resources for content is also understandable. This result suggests an area for improvement where instructors can be deliberate in advocating the use of reports to build metacognition.

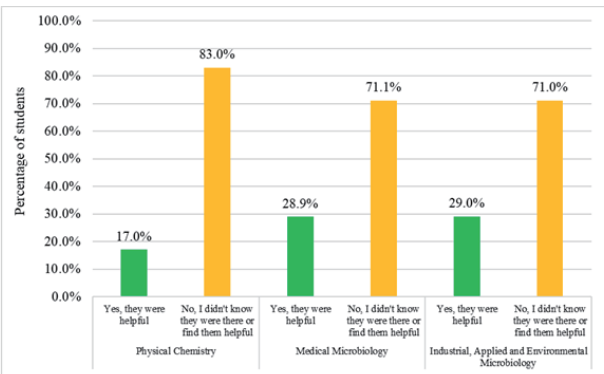


Figure 8. Responses to whether participants use the report to help them learn.

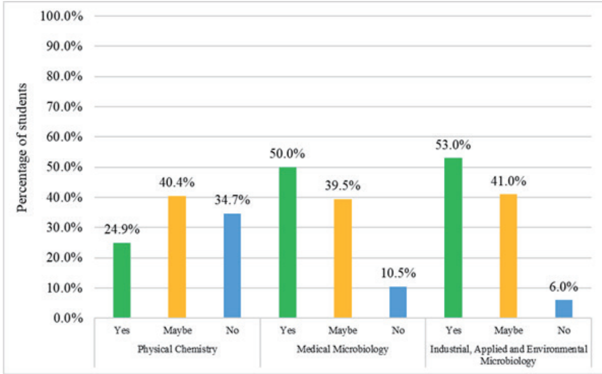


Figure 9. Responses to whether participants would use the online learning tool in the future

Figure 9 shows the participants behaviour and attitude towards future use of SmartBook and Connect for learning. About 25% of participants taking PC and a slightly more promising 50% of participants taking the MM and IAEM modules indicated they will use this tool for their learning in the future. Across all the three modules, about 40% of the participants are also undecided if they want to use the tool for their future learning. For PC, no lecture notes were given to the participants for one term and that may have influence their responses, as higher effort is required to read, study and create their own learning materials. It is also possible that the participants prefer summarised learning materials instead of reading lengthy text.

Lastly, we also explored the confidence of the participants after using the SmartBook adaptive reading tool in preparation for in-class activities. In Figure 10, it is interesting to observe that majority of the participants felt somewhat confident but require more help. This suggests that technology such as SmartBook and Connect cannot be a replacement for direct instructions. However, a synergistic effect can be potentially achieved with flipped learning where in-class activities that involves higher order thinking can be conducted to build confidence in these learners.

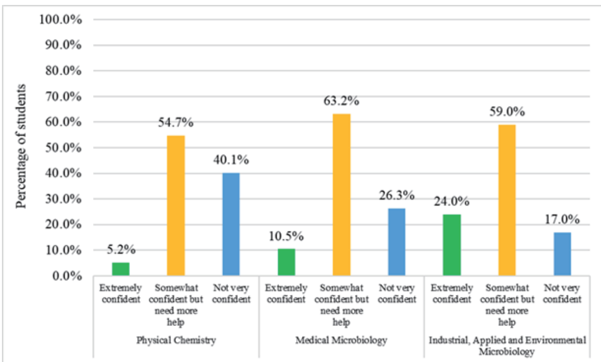


Figure 10. Confidence of the participants after using the SmartBook adaptive reading tool in preparation for in-class activities

Limitations and Recommendations

This paper recognises the limitations of some the survey questions to a 3-point Likert scale and the small sample size of participants for IAEM. In addition, the questions used were categorised into TAM instead of crafted based on the model. Using TAM as validated instrument, the questions are recommended to be recrafted using a 7-point Likert scale (Strongly agree – Disagree). Despite the limitations, this study provides a valuable insight into the learners' perceived useful of the resources and understanding of their behavioral intent in this pilot initiative of adopting SmartBook and Connect for flipped learning.

Conclusion

SmartBook and Connect are potentially impactful as an Edtech tool for students' learning as majority of the participants highlighted high perceived usefulness in these resources. The ease of using and locating the learning activities greatly influence their adoption. Through this pilot study, the three key external variables that strongly influence their adoption and actual usage are identified and these variables were exploited in the flipped classroom learning designs for all three modules. The majority of the participants can also relate to the benefits gained from using SmartBook and Connect for flipped learning, hence establishing this technology tool as an effective combination with the flipped classroom instructional strategy. While many participants believed the online learning courseware are useful to enhance their learning outcomes and is evidenced in their high engagement level in SmartBook and Connect, their behavioural intention to use them for future learning is surprising. This gap suggests for further studies on the motivation and growth mindset of the learners behind the adoption of this Edtech tool. Future work shall include studies that investigate the impact of SmartBook and Connect as technology tools to enhance both PET and CET learning outcomes, in terms of their attainment (exam results) and motivation.

References

Abeysekera, L & Dawson, P. (2015) Motivation and cognitive load in the flipped classroom: definition, rationale and a call for research, Higher Education Research & Development, 34(1), 1-14.

Ahmed, K., & Ouda, H. (2016). Flipped Learning As A New Educational Paradigm: An Analytical Critical Study. European Scientific Journal April 2016, 12(10), 417-444.

Anderson, L. W., & Krathwohl, D. (2001). A taxonomy for learning, teaching and assessing: A revision of Bloom's taxonomy of educational objectives. New York: Longman.

Brame, C. (2013). Flipping the classroom. Retrieved from https://cft.vanderbilt.edu/guides-sub-pages/flipping-the-classroom/

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319–339.

Davis, F. D., & Venkatesh, V. (1996). A critical assessment of potential measurement biases in the Technology Acceptance Model: Three experiments. International Journal of Human-Computer Studies, 45(1), 19–45.

DeLozier, S. J., & Rhodes, M. G. (2016). Flipped classrooms: A review of key ideas and recommendations for practice. Educational Psychology Review, 1-11

Fulton, K. (2012). Upside down and inside out: Flip your classroom to improve student learning. Learning & Leading with Technology, 39(8), 12–17.

Gilboy, M.B., Heinerichs, S. & Pazzaglia, G. (2015). Enhancing student engagement using the flipped classroom. Journal of nutrition education and behaviour, 47(1), 109-114.

Hattie, J. (2009). Visible Learning. Routledge, New York.

Keengwe, J., Onchwari, G. (2015). Handbook of Research on Active Learning and the Flipped Classroom Model in the Digital Age. United States of America: IGI Global.

Newman, A., Stokes, P., & Bryant, G. (2012). White Paper. Learning to Adapt: A Case for Accelerating Adaptive Learning in Higher Education. Tyton Partners, 1-18.

Ozdamli, F. & Asiksoy, G. (2016). Flipped classroom approach. World Journal on Educational Technology: Current Issues. 8(2), 98-105.

Piehler, C. (2014). FLN Shares its Four Pillars of Flipped Learning. Retrieved from http://thejournal.com/articles/2014/03/12/fln-announces-formaldefinition-and-fourpillars.aspx

Sale, D. (2015). Creative Teaching: An Evidence-Based Approach. New York: Springer.

Sale, D., Cheah, S.M. & Wan, M. (2017). Flipped Classroom Learning: An Evidence-Based Approach, paper prepared for the Redesigning Pedagogy International Conference, May 31 – Jun 1, National Institute of Education, Singapore.

See, S. & Conry, J. (2014). Flip my class! A faculty development demonstration of a flipped-classroom. Currents in Pharmacy Teaching And Learning, 6(4), 585-588

ENCOURAGING MULTIMEDIA AND DIGITAL LITERACY FOR COLLEGE STUDENTS IN RURAL JAPAN WITH PRESENTATIONS AND VIDEO EDITING

Tomek ZIEMBA and Yoshiko ASAMI

NIT Oita College, General Education Department, Oita, Japan

* z-tomek@oita-ct.ac.jp

Abstract

The purpose of this research is to find effective and suitable methods of using technological advancements for the promotion and improvement of presentation skills and digital literacy through English as a foreign language (EFL) classes at a National Institute of Technology in Japan. The lower grade students at the college have mandatory group presentations that are worth a large portion of their final marks in their EFL classes. Individual presentations (or presentations in pairs) are preferable, but are only logistically possible with lower class sizes, which are often found in higher grade students (2nd & 3rd year university level). Students are encouraged to use PowerPoint or other media software to create presentations on explaining Japanese culture to foreign visitors. After having an orientation session on effective presentation techniques and being shown examples from previous years of backlog, students were essentially free to use their class time to work in their groups or individually in the computer lab or in class using their mobile devices or any other tablets or laptops they would bring with them for production. It was found through student survey feedback and interviews that most students did not feel very burdened by the task and hoped for more opportunities in making these kinds of presentations. The source of concern was that not all students were familiar with computer usage, let alone confident in developing a slideshow with PowerPoint. Students did not let their lack of comfort with computers stop them, and actually gained confidence through trial and error in their creations of presentations. Some groups even went as far to make YouTube videos in which the recreated a skit from within their textbooks, even without any previous experience in filming or video editing. Further improvements for the future would include recommended software available in the school computer labs, as not all students have access to their own computers or have mobile devices.

Keywords: *language education, student motivation, blended learning, computer assisted language learning (CALL), English as a foreign language (EFL)*

Introduction

National Institutes of Technology (NIT) are a series of colleges across Japan that are a combined high school and university, and like a vocational school jump into specialized subjects for their future fields of work early upon entrance. Due to this factor, general education subjects are often not a focus of teaching and more emphasis are put on mathematics, science, and specialized engineering subjects. However, one of the main goals of the NIT colleges are to foster future engineers that will be able to contribute on a global scale. Without significant training and exposure to the English language, and not just in specialized subjects and vocabulary, future graduates are known to struggle when they are sent overseas for work or research purposes.

Mandatory basics of vocabulary and grammar are taught in limited English classes, however the ability to develop communicative competence and comprehension of global issues regardless of their specialised fields are still lacking. Given the current state of the Web 2.0 era, students are often familiar with IoT and media regardless of their coursework. In hopes of linking the deeper learning and usage of English as a foreign language, giving the students a way to connect their everyday online selves in an educational EFL setting was the main goal of this research. By exposing students to an entertaining, yet educational way to collaborate their everyday media use with educational aspects was expected to encourage their intrinsic motivation to learn and use the language outside of classroom settings.

At the NIT college observed, students are required to make PowerPoint presentations for their final assignments at the end of the academic year, in which they are to introduce and explain a specific part of Japanese tradition and culture in English to foreign visitors to the college and their hometown. These presentation style assignments and activities are often shown to have great benefits to EFL learners, as detailed by Kawachi (2012) in her research, which even recommended more emphasis on presentations in future English curricula, a feeling often strongly agreed with.

However, seeing as a prepared slideshow may limit student creativity in their groups, a deeper and more detailed activity with more creative freedom was pursued. This led to student-centred digital storytelling through video skits being the next step in challenging the students to express themselves in the English language.

Pedagogy and Methods

The students were all informed from the start of the school year that their final assignments would be group presentations and be worth a quarter of their final marks. Upon first instruction, many first-year students were visibly flustered by the task that awaited. However, when second year students (who have been exposed to presenting the year before) were informed, the students were more excited about the assignment than before.

Given that the first-year students for the vast majority had little to no experience in presenting, let alone in English, an orientation session was given detailing what was recommended to focus on in the making of their presentations. These included the visual, physical and speech messages as the three main focal points. The visual focused on the slides, the physical on their posture, and speech on the actual English ability. This reassured students who were not confident in their pronunciation by knowing they can still get good marks if they worked hard in the other message sections.

Marking sheets were also shown and described in advance, so students knew how they would be evaluated. Five sections on a five-point scale were added to make a total which matched the percentage of their final marks the assignment was worth. In addition to the three main messages explained in class, students were also evaluated on memorization of the prepared scripts, as well as their responses in a post-presentation Q&A session. The evaluation of their responses was not solely on the answer itself (as questions presented were based on the presentation content and varied in difficulty level) but focused on the speed and accuracy of their answers. Stalling or discussing with teammates before answering would result in lower scores, whereas an instant albeit simple response would lead to a higher evaluation score.

	POOR	OK	GOOD	GREAT	EXCELLENT
VISUAL MESSAGE Slides, images, key points pointer use, key phrases, appealing to watch	1	2	3	4	5
PHYSICAL MESSAGE Posture, eye contact gestures, expression, confidence, appeal	1	2	3	4	5
SPEECH MESSAGE Speech content, logic, grammar, pronunciation, easy to understand	1	2	3	4	5
MEMORIZATION No reading of script, not depending on slides or visual cues to talk	1	2	3	4	5
QUESTIONS & ANSWERS Speed and accuracy of response, no stalling or overthinking answers	1	2	3	4	5

FINAL MARK	**OVERALL COMMENTS**
/ 25	

Figure 1, Evaluation Sheet for Oral Presentations

As seen in the evaluation sheet in Figure 1, the five-point scales did not have a zero-point option, as just going up and confronting their fears would be worth at least one point, or in total five (or a 20 percent score just by participating). The only way to obtain a zero would be not contributing in that aspect, such as not answering a question, not having a speaking role in their group, or having an unexcused absence on the day of presenting.

For second year students, instead of making them do the exact same presentation assignment, the students were instructed to make an original video skit based on the content of one of the units covered in the textbook used throughout the year. The second-year students were visibly shocked by the assignment, as very few of them had experience or even interest in video editing, let alone acting and having it seen and evaluated by others.

Throughout the year, students were exposed to short snippets of North American dramas, and an original drama series included in the textbook that went along with the content of their studies. Having a small yet constant example of what would be expected of the students in the end was a suitable parallel which the groups would be able to mimic in their editing efforts.

	POOR	OK	GOOD	GREAT	EXCELLENT
VISUAL MESSAGE Video & sound quality, subtitles (if included), easy to follow along	1	2	3	4	5
PHYSICAL MESSAGE Posture, eye contact gestures, expression, confidence, appeal	1	2	3	4	5
SPEECH MESSAGE Speech content, logic grammar, pronunciation, fluidity, no reading script	1	2	3	4	5
PRODUCTION & EFFORT Was there balance in the team members & visible effort in quality filming?	1	2	3	4	5
SUITABILITY & INTEREST Does the content reflect what the unit was about? Is it ok to watch in class?	1	2	3	4	5

FINAL MARK	**OVERALL COMMENTS**
/ 25	

Figure 2, Evaluation Sheet for Short Skit Films

As seen in Figure 2, the evaluation sheets were again shown and discussed in advance, and focused on the same three messages, but instead of memorization and Q&A, included the production and effort as well as suitability and interest as part of their marks. This was to reassure that the content would be family-friendly and can be shown in class in following years as examples, and that students would aim for higher quality final products as they were shown throughout the year in other dramas.

Although the school did not provide any video editing software, or even materials to film with, most students already owned smartphones, tablets or their own personal computers and were encouraged to bring and use them during presentation preparation time to film, edit and develop their skits. With smartphones being the gadget of choice, most students did spend money on video editing apps and software which was not a requirement.

Most student groups spent the most time on their scripts and storyboards, with filming usually finishing in one class period and the rest of the time spent on editing. Some groups even went as far to put up teaser trailers of their presentations on social media to build up the hype of their work, which was a pleasant surprise and added a rivalry-like friendly pressure to the other groups.

Results and Discussion

The main underling goal of these presentation assignments is to encourage students to feel comfortable in speaking in English in front of other people. This in turn can influence the confidence the students have in their abilities and increase intrinsic motivation in furthering their linguistic development. As also detailed in similar work by Yamamoto (2018), students often do not have previous experience in presenting, as initially suspected, with student even detailing that they have not even had the opportunity to present in Japanese before. This is a source of concern in many ways, as developing a fundamental linguistic skill before doing so in the users native language can lead to confusion. However, most students were satisfied by the final products and felt encouraged to challenge thamselves more.

In terms of marks, a vast majority of students got the neccessary passing mark of over 60, with most getting over 80 as well. The only failing marks seen were when students submitted an unfinished project or submitted past the designated deadline. These groups of students were also seen to have not developed their group discussions very effectively during class time, and despite repeated checking and reassurance by the instructors in class, were never fully able to switch their efforts into full gear to create a successful group effort.

Another study by Hensley in 2009, students were able to create virtual portfolios of their work and be able to see and compare with others. Given that the study is a decade ago, it is something that was very much before its time and a very interesting field in current media study. The only concern, which was also met with the students observed in this study, is the permission and privacy for the students to share their work. Almost all students did not feel comfortable uploading their content to YouTube or other video sharing sites for fears of others seeing their work and leaving bad comments or other negative actions in regards to their hard work and efforts. Unlisted videos were suggested, but students also rejected that idea in the submissions and just brought USBs with video dana instead.

Future endeavours in both the first-year presentations and second-year video skits will push for an open, online component with permission forms being an option to help encourage safety and security of the students content. It is ideal for the instructor to create an open, online database of students work that can been seen and shared, and even used as reference for future cohorts in the further development and refining of their presentation materials. This database can also have students look back on their works years later, as seen a lot by students before graduation (due to assumed nostalgia).

Conclusions

Based on the surprising quality of the video materials produced by the second graders in their final skits, the positive influence of showing native media in class on student presentation skills, and the high levels of intrinsic motivation seen in students on these assignments show that it is a positive constructivist learning experience. Although some students complained that it was difficult in terms of editing and getting it to the quality that they desired, the students reflected on it still being an innovative event in which they wanted to delve into further on their own time and out of class correlation.

The results were similar to those discovered by Smithers & Matsuo (2018) in which students depended mostly on smartphones as opposed to computers, and felt more creative freedom in making videos over PowerPoint presentations, and felt greater freedom in creation and increased intrinsic motivation thanks to their efforts throughout these activites.

Due to these assignments being marked and part of the student final results in class, some students admitted to paying out-of-pocket for video editing programs and software to ensure high quality production. If schools were able to provide a common program (like iMovie) in which students had free and easy access to, it would spare the students these personal expenses, have students on the same playing field, and lead to more fair evaluation.

Although no technical training was provided in class for video editing technique, students were able to reflect from their first year presentation instructions to have a solid base regardless.

References

Hensley, J. (2009). Using Virtual Portfolios to Improve Presentations in an EFL Setting. *University of Nagasaki Journal of the Faculty of Global Communication, 10*, 31-39.

Kawachi, T. (2012). The Importance of Incorporating Student Presentations in EFL Listening Courses. *Bulletin of Seikei University, 46*(4), 1-19.

Smithers, R. W. & Matsuo, S. (2018). The Creation of Documentaries Through Project-based Learning for English Education. *Kwansei Gakuin University Researches in Higher Education, 8*, 51-57.

Yamamoto, Y. (2018). The Correlation between Self-Confidence and Achievement in an Oral Presentation Course. Urban Management: *Bulletin of the Faculty of Urban Management, Fukuyama City University, 10,* 115-128.

EFFECTS OF STEP-BY-STEP ACTIVATION LEARNING IN A PRIMARY COMPUTER PROGRAMMING CLASS

N. Fujishima[*,a]

[a] Department of Electrical Engineering and Computer Science, National Institute of Technology, Matsue College, Matsue, Japan

*fujishima@matsue-ct.ac.jp

Abstract

Primary learners often have difficulty in studying how to write program by themselves because certain basic knowledge worries them. To reduce their mental burden, the author gives students a programming class with a step-by-step activation learning method. The present study was undertaken to research effects of this method. Targets are 1st grade students, who have already learned the way to use a keyboard, mouse and some applications. In 11 lessons of this class, the author teaches computer knowledge through making a web page with HTML programming. As a 1st stage, the students are given all information including source codes and try to use it along with a teacher. Through this experience, they get used to writing the HTML language and have the base to understand other codes smoothly. As a 2nd stage, they do their assignments which require not only codes they have learned but also ones they can add. As a 3rd stage, they create original web pages with more than 5 kinds of functions which they have found from web sites, books etc. by themselves. As a final stage, they explain their works during an exhibition time. After seeing web pages created by others, they review their own achievements and improve them. Effects have been researched by a questionnaire after finishing the 4th stage for consecutive 3 years. Their opinions show that this method has made a positive experience for them to learn basic computer knowledge. The rate of the students who said that this class was difficult are more than 39%. Nevertheless, more than 86% of the students felt enjoyment when studying the contents. Furthermore, more than 92% of them thought that they had had a nice experience, and more than 95% of them reported to develop a mind-set for autonomous learning. The author concludes the proposed method is effective. Considering these results and may recommend that this method be adopted into other classes, regardless of computer usage or not.

Keywords: *step-by-step activation learning, active learning, cooperative learning, primary class, computer, HTML programming*

Introduction

Higher education turns into education which grows the power to create and use knowledge in the real world (Ramsden, 2003). Students are required to learn actively in order to acquire the power to utilize knowledge. Therefore, educational researchers promote classes giving active learning opportunities in Japan (as a review, Yamaji, 2012).

This paper discusses the author's promotion of active learning classes for 1st grade, college of technology students. The main purpose of the class is that students acquire the basics of programming and those of a computer with small mental burden, and develop awareness for self-study.

Primary learners often have difficulty in studying how to write program by themselves because certain basic knowledge (e.g. relative path) worries them. To reduce their mental burden, a teacher needs to help raise them to a level where they can learn by themselves.

The method "thinking-after-instruction" has been suggested (as a recent case, Fukuya, 2019). In this method, a teacher gives students the basic knowledge before self-study and group work time. Moreover, learning (understanding knowledge through lectures) and exploring (using knowledge along their own theme) cycles are repeated. This method's effects are confirmed in various research (e.g. Kayano, 2008).

In reference to the previous research, the author designed a primary computer programming class with step-by-step activation learning. At the beginning, a teacher teaches students all the information through demonstrations while acquiring the most important knowledge. As the lesson progresses, the teaching contents get to be focused on the point. Moreover, students have the experience of expanding knowledge through assignments. It functions as limited exploratory learning. After teaching basic knowledge, students create their own web pages. It functions as exploratory learning. As mentioned above, students can learn programming and computer knowledge with small mental burden by gradually changing to active learning. They also can learn and experience these things themselves.

As a learning method, the step-by-step activation learning method (Spelt, 2009) was confirmed. However, reports related to Japanese students studying computer science were not found. Therefore, A research needed to be carried out about the appearance of the student in a primary computer class when applying this method. In this paper, the author proposes the step-by-step activation method in a primary computer class and reports the effects.

Implementation Environment

National Institute of Technology, Matsue College (Matsue Kosen) is in Shimane Prefecture. This prefecture has the second smallest population in Japan. Matsue city is the local prefectural seat far from major cities. Many students tend to be quiet and conservative due to the regional nature and school scale relationships up to junior high school.

In Matsue Kosen, there are about 40 students per class. One lesson has 90 minutes. 15 lessons are held per class. Practical classes are given to first graders which belong to the author's department. First grade students belong to mixed-department classes, not the department class. Therefore, there is a possibility that a student does not talk with students of his/her engineering department except during the three specialized classes. They have already learned the way to use a keyboard, a mouse, an e-mail application and some Microsoft Windows applications before taking this class. Besides, almost all of students do not make computer programs.

The room used has about 50 computers equipped with Windows 7, desks and chairs. People can go to all the seats using the aisle, even if all the places are used. Computers are numbered. Students sit in the seats according to student numbers. The room is equipped with a projector and a screen. Therefore, teachers can explain things while copying their own computer screen.

HTML Programming Lessons with Step-by-step Activation Learning

The class is conducted by the author (the teacher) and one technical supporter who aids students in program writing. HTML programming is carried out 10 (in 2016) or 11 times (in 2017 and 2018) in a semester. The remaining lessons are not included in the contents of this study because they learn another language. In this study, HTML programming lessons are targeted.

HTML was chosen for the following reasons:
(1) students need to know a lot of knowledge of computer, programming and web,
(2) results of programming can be obtained visually,
(3) the program can be written simply,
(4) making original code is easy, and
(5) they can write code which contains another language in one file.

System configuration is as follows. The editor used is TeraPad. The web browsers are Internet Explorer (IE) and Firefox. IE is the standard browser in TeraPad. Firefox is for checking codes, which shows the wrong code in red when people use a developer mode. The version of HTML is 4.01 Transitional DTD. Here, the newest version, HTML5, is needed for cascading style sheets (CSS) to change fonts and make a table. Teaching two languages may be more appropriate for teaching web programming. However, this class aims to give basic knowledge of computer and programming using HTML. Therefore, the old HTML version is used because this may use font or table tags.

Figure 1 describes the overview about stages of the practical lessons. There are 4 stages. The active level rises as the stage goes up. Table 1 shows details of contents and subjects. Here, presentation slides for lectures have not been changed during the researching period.

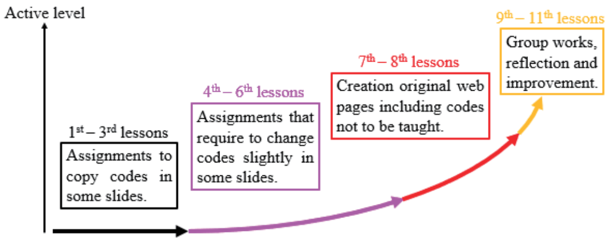


Figure1. Overview about stages of the practical lessons.

The first stage is the leading process. Students are taught all information about contents including source codes. They try to write them and confirm movements along with us. Writing codes in the presentation slides are given as assignments.

The aim of this stage is to provide students with the necessary knowledge to learn on their own. For people to act on their own, minimal knowledge is required. However, many students had learned only how to use input devices and applications prior starting this class. They do not have important terms or knowledge about how the computer works. Thus, they do not have enough knowledge to think about the code by themselves. If a teacher tells them to learn in their groups as much as possible, some of them cannot keep up with the class. To prevent this, basic skills are taught. Through this stage, they have the base knowledge to understand other codes and get used to writing the HTML language smoothly.

The second stage is the independent process. Students are taught all the relevant knowledge. However, they need to do their assignments which require not only codes they have learned but also ones they can add. The amount of code they need to add gradually increase. In the 4th lesson, they are only required to rewrite the path. In the 5th lesson, they are required to rewrite the complicated path and other codes. In the 6th lesson, they are required to put their life into a table as an assignment. The form of the table differs depending on the person. Therefore, each student needs to consider the form of the table and the code to implement it. Thus, the student must consider the structure of complicated codes.

The aim of this stage is to develop the power to think about the code based on the given information. In programming, the sample code is often modified to create a desired program. Therefore, thinking and changing codes partly is an important skill for a student who wants to be a programmer. Through this stage, they have a deep understanding of the structure of the programming code, and get the basis of modifiable skills.

Table 1. Contents and subjects.

Step	Lesson number	Contents	Subjects
1	1	Computer terms and windows shortcuts	Primary computer knowledge (file, folder, application, Windows short cuts and two screen shot functions)
	2	Browser generation	Terms of computer (HTML, browser, characteristic code, and file extension) / The way to use an editor / Basic structure of HTML
	3	Font control	Terms of fonts, the way to use tags and nested structure
2	4	Image insertion	Absolute path / Relative path / Zipped file
	5	Hyper links	
	6	Creating tables	Structure of complicated codes including nest structure
3	7 – 8	Creation of original web pages	Self-directed learning, imagination of web page contents
4	9	Presentation	Reflection and Improvement
	10	Exhibition	
	11	Revision of the web pages (in 2016, 2017)	

The third stage is the inquiry learning process. From this stage, the supporter and the author become the instructor which do not teach students unless they ask us. Some reference books for viewing are shown to them. They create their original web pages for about 3 weeks. They can use lecture slides, web sites, books and help from peers.

Students get some codes or images from their information. Moreover, a student is free to move in class and may talk with other students. There is a condition for this subject to carry out self-directed learning. Their web pages need to include more than 5 kinds of functions which are not taught in the lecture. They can use CSS or Java script. Furthermore, they must use relative path except for URL to see their works with any computer.

The aim of this stage is to grow their ability to learn programming independently and to gain their confidence to learn. The popularity of programming languages changes with age. Thus, a student will probably have to learn programming languages by themselves in the future. Therefore, the experience of researching and using some codes through web page creation is important.

The fourth stage is the self-awareness process. First, each student realizes his/her experience by thinking about the introduction of their own web pages for a presentation, as shown in Figure 2. Second, he/she realizes the difference between themselves and the others by comparing their presentation with those of the others at the presentation time. Third, the students expand their interest in technology by introducing their work and confirming those of the others at the exhibition time. Final, the students deepen their knowledge through modification of their own work.

Figure 2. Presentation of the student's own web pages.

The aim of this stage is to grow their metacognition. Metacognition means the recognition of one's own cognitive state (Flavell, 1979). This is an area which has recently received attention in cognitive research about not only people but also animals (e.g. Nakao, 2015). Reflective activities (e.g. Boud, 1985; Chi, 1994) helps to grow metacognition. Many scientists pay attention to these activities in various fields, which include information science (Saito, 2004). Through this stage, students receive feedback on their work. Moreover, they understand the difference with other students through their work. These experiences give them an opportunity to know their own ability and foster their metacognition.

Created original web pages

All the web pages created by students have originality. Moreover, some students wrote part of code in other languages as shown in Table 2. Here, the number of the students using other languages is increasing with each passing year. The most likely reason is that the instructors introduced past excellent works including CSS or Java Script and showed students the codes in the 7th lesson. They knew that they could do many things using these languages. Therefore, they likely wanted to try to write with them. The drop-down menu function was especially popular.

Table 2. The number of students using other languages.

	2016	2017	2018
CSS	1	7	15
Java Script	1	2	4

Furthermore, their works have few serious code errors. Generating browsers and tables was OK. Changing fonts was also OK. For 3 years, only 5 students made mistakes to write hyperlinks with absolute paths, causing problems of broken links. Two things can be said from these facts. One is that the students worked seriously. The other is that they did not leave things which they had not understood.

Considering the above, it can be said that almost all of the students have absorbed the knowledge which they have taught and can incorporate it into their own web pages. These facts show that the lessons played a role in understanding the basics of programming and the way to gather information.

Research on Effects

Teaching HTML programming knowledge is not the main purpose. It is getting students to know basic knowledge of computer with small burden and have skills for studying codes by themselves. Effects about these needs to be researched from students' response.

Based on the above, the effects have been researched using a questionnaire after finishing the 4th stage for consecutive 3 years. The questions related to this study are as follows:

(1) How was the difficulty of the class?
(2) Were you able to learn while enjoying the class content?
(3) Did you get a good experience in this class?
(4) Were you able to experience the feeling of learning by yourself?
(5) Were you able to learn a lot with students during the class?
(6) Write your impressions of the class format where you are going to follow the policy of "We teach you what is particularly important. Let's learn the rest by yourself." (in 2017, 2018).

(1) to (5) are the answers of 5-point Likert scale. Additionally, (6) is a descriptive one. For this, each response (positive, negative, both, other) was calculated.

Results

Figures 3 to 7 show the ratio of answers to the questions in the 5-step evaluation. Table 3 shows response trend for the class policy.

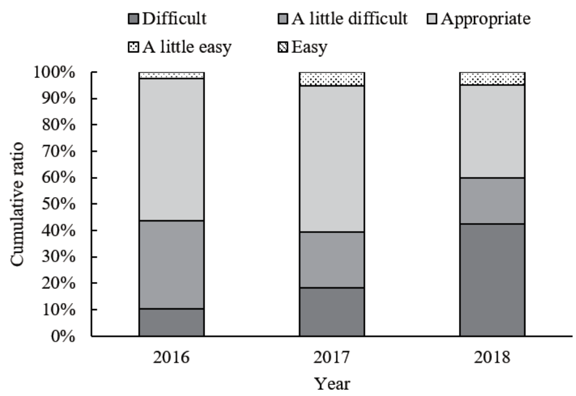


Figure 3. Answers about the contents level.

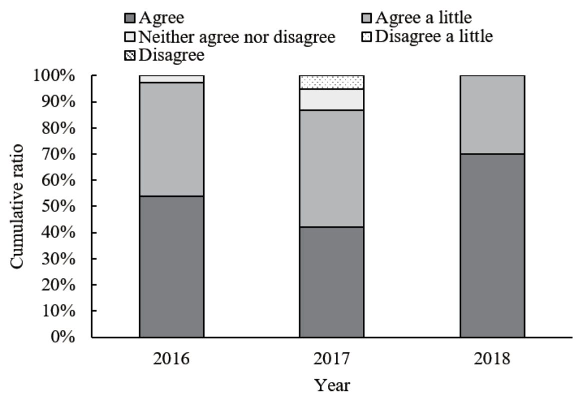


Figure 4. Answers about the enjoyment.

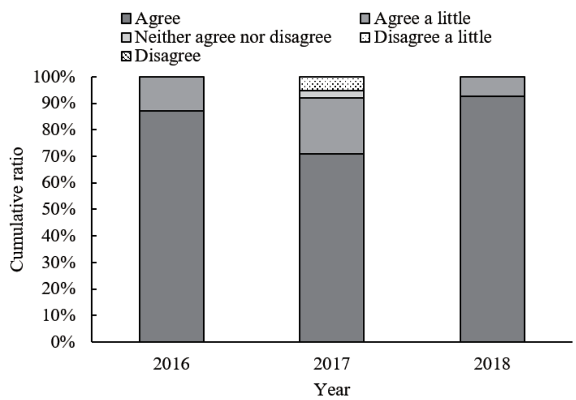


Figure 5. Answers whether the class gave the student good experience or not.

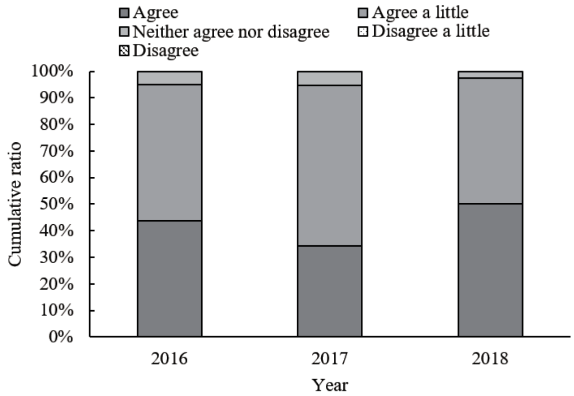


Figure 6. Answers whether the student had a feeling to try self-directed learning or not.

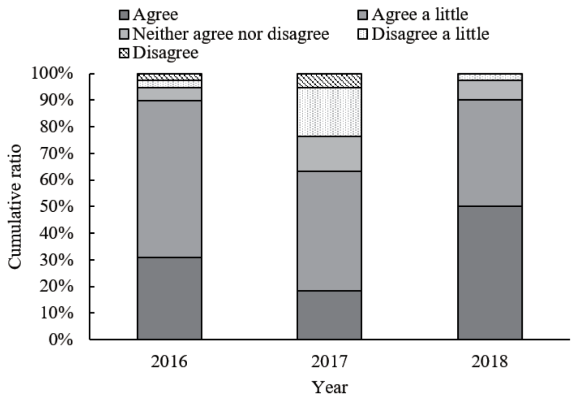


Figure 7. Answers whether the student was able to do cooperative learning or not.

Table 3. Response trend for the class policy.

Year	The number of responses (positive, negative, both, others)
2017	(32, 0, 3, 3)
2018	(36, 3, 1, 0)

First, the relationship between difficulty and enjoyment is distinctive. Figure 3 indicates that most students do not feel that the class content is easy and more than 39% of students feel difficulty. Nevertheless, Figure 4 expresses more than 86% of students enjoy the class. Thus, the students enjoyed taking lessons despite those contents' difficulty. This means that they were able to learn enthusiastically about contents they could not easily understand. Moreover, this also means that this class can support the students to reduce their mental burden.

We can think that the motivation of the students makes this situation. Figure 5 shows that more than 92% most of them were positive in class. That feeling would have been a force to try to follow the class without failure.

Second, no students denied self-directed learning and more than 95% of them noticed the importance of it. This indicates that all the students do not think that self-directed learning was meaningless during taking the class.

Third, the degree of cooperative learning is worse obviously in 2017. There are two possible causes. One is that there is a difference in class atmosphere; the number of students who tried to learn with the others positively is different. The other is that there is a difference in the severity of self-assessment. We can consider that the former is stronger than the latter as a reason. We would not expect the results in Figures 4 or 5 to change significantly even if the self-assessment was low. Besides, these values may decrease at the same time if cooperative learning is less. Figures 4, 5 and 7 show that the students' assessment in 2017 is worse than in other years. Therefore, the former is a more appropriate reason. Nevertheless, the latter is probably affecting. Although it is not information gathered from this experiment, the class has less conversation than the other classes. In fact, students in 2017 tended not to talk. Some of them might be aware that they have not learned with classmates well.

Finally, Table 3 indicates that a lot of students agree with the class policy. The representative response is "It was good to have a feeling of growing up because assignments get harder and harder.". There were many answers about growth and pleasure.

Discussion

We will consider the effectiveness and assignments. If the proposed method is effective, this is satisfied with the following conditions for students:

(1) to acquire the basic knowledge of a computer and programming,
(2) to acquire the ability to learn by self,
(3) to reduce mental burden of the students and
(4) to grow ability while learning with others.

Furthermore, if the class method is appropriate but the student's reputation is not good, the effect will decrease. Therefore, this condition is required for students,

(5) to agree with the method.

From quality of their works and results of analysis, we can confirm that these are achieved. Therefore, the method is effective. Besides, the way of cooperative learning has problems. Figure 7 shows that 23% of the students thought they were not able to do this learning well in 2017. This problem indicates that we need to help worried students in learning with peers. At this point, excessive aid may prevent the development of student autonomy. We need to determine if we should help some of students. Therefore, the assignment is to clarify the criteria for helping.

Next, we will consider reliability of this research. Comparing the changes over three years, the trend is similar except for in Figure 7. The difference in Figure 7 is due to the reason stated in the above discussion. Nevertheless, the magnitude relationship of each answer in this figure is the same. Therefore, the results are certainly reliable.

However, the weakness of this research method is also recognized. The index is not an absolute standard because data were obtained from the students. It depends on the indicators the students have in mind. Their index is probably considered to be determined by the class atmosphere in normal times. In other words, their index is relative to normal time. Thus, the data contains hidden variables which reduce the reliability. Furthermore, detailed comparisons during years do not make sense because the criteria are different. One way to make an absolute index is creating data which counts the number of students to teach each other. More reliable information will be obtained by including this index. This is the assignment in the near future.

Conclusion

In this paper, the author proposes the step-by-step activation learning method and has researched the effects and the assignments.

The number of stages are 4. In the leading stage, the teacher teaches all the students all information about contents including source codes. Students try to write them and confirm movements along with the teacher and the supporter. In the independent stage, the teacher teaches them all the relevant knowledge. However, they need to do their assignments which require not only codes they have learned but also ones they can add. In the inquiry learning stage, they create their original web pages including codes not to teach by self-directed learning. In the self-aware stage, they expand their interest in technology by introducing their own works and confirming those of the others at the exhibition time.

The effects of the method have been researched using the questionnaire after finishing the 4th stage for 3 consecutive years. The results indicate the following:

(1) the relationship between difficulty and enjoyment is distinctive,
(2) the class can support the students to reduce mental burden,
(3) no students denied self-directed learning and more than 95% of them noticed importance of it,
(4) the degree of cooperative learning is different every year, and
(5) a lot of students agree with the class policy.

Through the discussion process, we have confirmed that the proposed method is effective for learning basic computer knowledge, reducing students' mental burden and having a mind-set for self-study. A further assignment is to clarify the criteria for helping students in order to encourage group work and make absolute index.

This method will be adopted into other classes, regardless of computer usage or not. These recommendations can be applied to all classes and subjects.

References

Boud, D. K. & Walker, D. (1985). *Reflection: Turning Experience into Learning*. London: Routledge.

Chi, M. T. H. & Leeuw, de N. & Chiu, M. H. & Lavancher, C. (1994). Eliciting self-explanations Improves Understanding. J*ournal of Cognitive Science*, 18, 439-477.

Flavell H. J. (1979). Metacognition and Cognitive Monitoring A New Area of Cognitive –Developmental Inquiry. *Journal of American Psychologist*, 34, 10, 906-911.

Fukuya, T. & Uesaka, Y. & Ichikawa, S. (2019). Investigating the effects of Thinking after Instruction approach, *Journal of Educational technology research*, 41, 1, pp. 1-11.

Kayano, A. & Hashimoto, M. (2008). Practical Report of "The Class to Make it Think by Teaching": In Cases of High School Science and Mathematics. *Journal of Hokkaido University of Education at Kushiro*, 40, 131-140 (in Japanese).

Nakao, H. & Goto, K. (2015). Methodological problems in animal metacognition research. *The Japanese Journal of Animal Psychology*, 65, 1, 45-58 (in Japanese).

Ramsden, P. (2003). *Learning to Teach in Higher Education*. London: Routledge.

Saito, H. & Miwa, K. (2004). Supporting Reflective Activities in Information Seeking on the Web Construction of a Search Process Feedback System. *Transactions of the Japanese Society for Artificial Intelligence,* 19, 4, 214-224 (in Japanese).

Spelt, E. J. H. & Biemans, H. J. A & Tobi, H. & Luning, P. A. & Mulder, M. (2009). Teaching and Learning in Interdisciplinary Higher Education: A Systematic Review. *Springer*. DOI: https://doi.org/10.1007/s10648-009-9113-z.

Yamaji, H. & Kawagoe, A. (2012). Case Reports of Systematic Implementation of Active Learning in Japanese Universities. *Journal of Research and Development Center for Higher Education, Nagasaki University*, 3, 67-85 (in Japanese).

AN ONLINE-BASED EDUCATIONAL FRAMEWORK FOR KOSEN SPACE ACADEMY: THE FIRST YEAR'S RESULTS (2018)

T. Takada[*,a], K. Kitamura[b], J. Nakaya[c], Y. Kajimura[d], M. Tokumitsu[e], M. Wakabayashi[f], Y. Murakami[g], N. Hirakoso[h], K. Imai[a], A. Kudo[i], and M. Shinohara[j]

[a] National Institute of Technology (KOSEN), Kochi College, Department of Social Design Engineering, Nankoku, Japan
[b] National Institute of Technology (KOSEN), Tokuyama College, Department of Mechanical and Electrical Engineering, Shunan, Japan
[c] National Institute of Technology (KOSEN), Gifu College, Department of Mechanical Engineering, Motosu, Japan
[d] National Institute of Technology (KOSEN), Akashi College, Department of Electrical and Computer Engineering, Akashi, Japan
[e] National Institute of Technology (KOSEN), Yonago College, Department of Electrical Control Engineering, Yonago, Japan
[f] National Institute of Technology (KOSEN), Niihama College, Department of Electrical Engineering and Information Science, Niihama, Japan
[g] National Institute of Technology (KOSEN), Kagawa College, Department of Electrical and Computer Engineering, Takamatsu, Japan
[h] National Institute of Technology (KOSEN), Gunma College, Department of Mechanical Engineering, Maebashi, Japan
[i] National Institute of Technology (KOSEN), Tomakomai College, Department of Engineering for Innovation, Tomakomai, Japan
[j] National Institute of Technology (KOSEN), Kagoshima College, Liberal Arts and Sciences, Kirishima, Japan

*takada@ee.kochi-ct.ac.jp

Abstract

The KOSEN Space Collaboration was organized by teachers from the National Institute of Technology (KOSEN) who specialize in space science and engineering. Since KOSEN does not have a dedicated department for space science and engineering, there are limited opportunities for interested students to develop skills and expertise in these fields. Members of the KOSEN Space Collaboration have organized the KOSEN Space Camp every summer since 2015, where students attend lectures delivered by researchers on the frontlines of their field and compete in creating a model rocket and a pico-satellite model of CanSat. KOSEN teachers also use this opportunity to exchange study materials concerning space science and engineering. Since 2017, we have employed a new educational framework under a three-year grant-in-aid from the Ministry of Education, Culture, Sports, Science and Technology (MEXT). In 2018, the KOSEN Space Academy was founded using online conference systems. Once every month throughout 2018, Space Academy provided lectures and practical training about space science and technology, which included the opportunity to meet and learn from Space Camp students during summer vacation. Throughout the activities of several years, the KOSEN Space Collaboration has developed new teaching materials such as a CanSat kit for beginners, a CanSat mounted model rocket, a Model CubeSat with functions comparable to those of genuine satellites, and a simple receiver with a software-defined radio (SDR) for satellite transmission. Using these tools, our students can experience a complete series of events, which includes the development of a satellite, a rocket launch, and then subsequent data reception from the satellite. We also mentioned the results of online engineer training for CanSat Construction in 2019 and summarized some feedback of them, on the from the viewpoint of online engineering training. In this paper, we describe the results from the first year of the KOSEN Space Academy and summarize the online training course.

Keywords: *space technology, space science, CanSat, model rocket, Model CubeSat, SDR*

Introduction

Currently, space development by universities and private companies are increasing, and many artificial satellites are being launched. Due to the cheap cost and high precision of electronic parts, there are even nanosatellites that can be manufactured to perform plenty of functions.

The possibility of observation systems that use many small satellites are currently being considered. To further develop skills and expertise that can be utilized in the space development fields, nanosatellites, called CubeSats, as they are based on 10 cm cubes, have been developed and manufactured at many universities (e.g., Nakasuka et al., 2010; Miyazaki & Yamazaki, 2013). On the other hand, CubeSat, as an actual spacecraft, is exceptionally cheap compared to the conventional, large size of satellites, but it is expensive enough that it cannot be distributed to each student. Therefore, CanSats (Tsubouchi et al., 2018), or the CubeSat models, which function on the ground, are available as teaching materials that are specialized for satellite development (Yamazaki, 2016).

In support of this growing field, KOSEN Space Collaboration was organized by teachers who specialized in space science and engineering from the National College of Technology (KOSEN). The purpose was to help both university and high school students develop skills and expertise through training in technical fields such as space development. Some KOSEN graduates are active in domestic space agencies or space-related manufacturers. In fact, several space agencies and manufacturers of space equipment in Japan are highly inclined to hire KOSEN students. Since KOSEN does not have a dedicated department for space science and engineering, however, there are limited opportunities for aspiring students, who want to join related institutions and companies, to develop their experience and knowledge in these fields.

KOSEN Space Collaboration has been holding an educational event called KOSEN Space Camp, every summer since 2015 (Wakabayashi et al., 2019a; 2019b; Kitamura et al., 2019). At Space Camp, there are group competitions and practical training courses conducted using teaching materials that have been developed by KOSEN Space Collaboration. Although the teaching materials are mainly related to the development of satellites and rockets, the material is refined and expanded annually. In each camp, there are about 40 students who participate nationwide from across Japan. They are interested in space and engaged in the activities.

Beginning in 2017, a new educational framework was instituted under a three-year grant-in-aid from the Ministry of Education, Culture, Sports, Science and Technology (MEXT), as a way to reach out to interested students, qualified teachers, and lecturers across Japan. The new framework resulted in the creation of KOSEN Space Academy, which was created in 2018 using an online conference system. KOSEN Space Academy enables students to attend lectures and practical training that involve space science and technology. In this paper, we describe the results of the first year of KOSEN Space Academy and discuss future plans.

Figure 1. Space Camp, 2018, Niihama, Japan

Overview of KOSEN Space Academy in 2018

KOSEN Space Academy provides a framework for conducting lectures and practical training that are related to space development and engineering. It includes regular class periods that are held via online conference systems (Takada et al., 2018). Expanding on the know-how and educational materials that were developed for the Space Camps, we designed lectures and practical training for distance learners. This was a result of the relatively small number of interested students, teachers, and other experts of space science and engineering who were scattered across KOSEN campuses nationwide. By connecting KOSEN students with teachers online, we can provide lectures and practical training without having to create a centralized physical department on a single campus. Figure 2 shows an overview of KOSEN Space Academy.

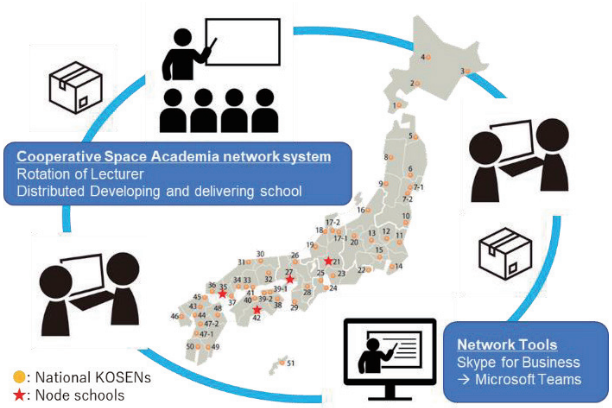


Figure 2. Online-based educational framework of KOSEN Space Academy

Since KOSEN has 51 colleges and 55 campuses throughout Japan, online video conferencing applications are utilized in KOSEN Space Academy's courses. In 2018, we mainly used Skype for Business provided by Microsoft Office 365, but currently, we are in the process of changing to Microsoft Teams instead. Basically, if a PC can be connected to the internet, a video conferencing application can be used anywhere to conduct a training course and allow students to hear a lecture in a laboratory setting. In video conferencing applications, students can use the web application even when they are not on campus, which may be the cause during long vacations.

KOSEN Space Academy's lecturers are the teachers, who are also members of KOSEN's Space Collaboration. Four of these members (Kochi, Gifu, Akashi, and Tokuyama) form the base of KOSEN Space Academy and oversee the development and preparation of the teaching materials. All KOSEN Space Collaboration members also cooperate to develop and prepare and distribute various educational materials, like printed materials and CanSat kits. Participating students choose a KOSEN teacher as their contact person for receiving deliveries, preparing online conferences, and so on.

Table 1 shows the courses that were conducted at KOSEN Space Academy in 2018. The first round started at the end of May after recruiting new students in April. In 2018, 66 students from 13 KOSENs applied to KOSEN Space Academy, with 15 teachers as a contact person. The courses have been held at a pace of one a month. In the first semester, there were training courses about model rockets, CanSats, and the introduction of a model CubeSat course for Space Camp. After the Space Camp in the second semester, a member of KOSEN Space Collaborations conducted lectures on the space field that related to their specialty.

Table 1. *2018 Schedule of KOSEN Space Academy*

Times	Date	Type	Contents
1	5/24 (2 hr)	Skype	Model rocket production
2	6/19 or 20 (2 hr)	Skype4B	CanSat production 1
-	6/27 (2 hr)	Skype4B	[free connection] Question about CanSat production
3	7/18 or 19 (2 hr)	Skype4B	CanSat production 2
4	8/28 (2 hr)	Skype4B	Introduction of Model CubeSat course for Space Camp
-	8/30–9/2	Camp (Niihama)	Special lecture Model CubeSat production Ideathon Satellite communication lecture
5	10/25 (1hr)	Skype4B	Post-reporting of Model CubeSat course
6	11/15 (1hr)	Skype4B	Overview of Space weather
7	12/13 (1hr)	Skype4B	Space weather exercise
8	1/31 (1hr)	Skype4B	KOSEN-1: first CubeSat of KOSEN adapted by JAXA
9	2/27 (1hr)	Skype4B	Astrodynamics: Orbit of Rocket and satellite
10	3/28 (1hr)	Skype4B	Data analysis of satellite data by Google Earth Engine

Skype4B: Skype for Business

Educational Materials: Satellites and Rockets

Figure 3 shows some of the teaching materials that have been produced by KOSEN Space Academy's activities, which include a simple receiver with an antenna for receiving satellite radio waves, a CanSat-mounted model rocket, a CanSat kit for beginners, a CanSat with selectable sensors, and a Model CubeSat. These teaching materials simulate the real rockets, satellites, and ground-receiving stations involved in satellite development and deployment. Students can easily access these educational tools to use them in experiments. There are important elements included that explain the functions of satellites, and these are useful teaching materials for space education. Table 2 summarizes the characteristics of each of the educational materials.

Figure 3. KOSEN Space Academy's educational materials: Simple receiver with antenna (left edge and lower left); Model CubeSat 2018 (upper left); CanSat for beginners (right); CanSat-mounted model rocket (right edge).

Table 2. *Educational Materials Developed for KOSEN Space Academy*

Items	Characteristics
CanSat for beginners	A simple, light-weighted and small model Can be easily manufactured in 3 hours
CanSat with selectable sensors	A model with a high degree of freedom Can be selected several sensors from 14
Model CubeSat 2018	Model CubeSat with main power supply, communication, and an attitude system
CanSat-mounted model rocket	Can be launched with a single engine of C11
Simple receiver with antenna	Receiver with SDR for satellite transmission

A simple receiver for genuine satellite radio waves is a device that combines a small computer board with an antenna and uses a software-defined radio (SDR) (Tokumitsu et al., 2017). After demonstrating the assembly of simple receivers, giving instructions, and receiving test waves during Space Camp (Tokumitsu et al., 2019), students can conduct satellite radio-receiving experiments at their KOSEN location. The CanSat for beginners is a small, lightweight model that is suitable for learning the basic production process of CanSat. Online production courses were held in 2018 that used this CanSat kit (Sasaoka et al., 2019). The CanSat-mounted model rocket can launch CanSats for beginners with one C-type engine (Shimomura et al., 2019). To conduct a CanSat experiment, the CanSat is dropped at a 50 m altitude from a captive balloon, and the cost is high regarding a small number of CanSat drop experiments. By using the CanSat-mounted model rocket, it became possible to launch CanSat easily and inexpensively.

Table 3. *Objective of the Model CubeSat Competition*

Functions of the Model CubeSat	Contents of Competitions
Power supply system	• To monitor the solar panel and battery • To compete in the status of long-time data acquisition
Communication system	• To complete successful communication conditions during a 5-minute flight (using a captive balloon)
Attitude system	• To determine the attitude with several sensors • To complete accurate positioning in the camera's field of view (FOV)

Table 4. *Overview of the Model CubeSat Competition*

	Power	Communication	Attitude
Objective	Stable power supply	Continuous communication	Attitude determination
Operating time	4~5 hr.	5 min.	5 min.
Installation Place	Under the sun	Hang from balloon	Hang from balloon
Data acquisition	microSD	wireless	wireless microSD
Judgment	CPU usage rate multiplied by time	Specified data receiving	Captured image GPS data

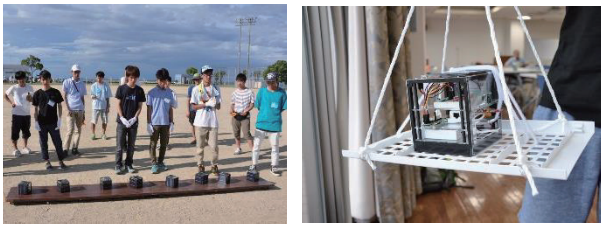


Figure 4. Model CubeSat competitions for power supply system (left), as well as the communication and attitude systems (right).

In 2018, we developed the Model CubeSat, which brings CanSat closer to a genuine satellite (Uezono et al., 2019; Nakaya et al., 2019a; 2019b). The Model CubeSat is a kit for building a box-shaped nanosatellite, which is called the CubeSat, and it is designed to operate on the ground. It is made primarily for educational purposes and has some functions that are similar to those of CubeSats released into space. For Space Camp, we produced this Model CubeSat and focused on the assembly. We had groups take part in experimental competitions and it was the first time we held the Model CubeSat competition. This gave students a structured setting to attempt the various challenges for each of the main functions of the Model CubeSat, such as the power supply, attitude, and communication systems. Then, the teachers comprehensively evaluate the data and present an analysis of the results, highlighting the uniqueness of the students' ideas, problem-solving techniques, and achievements. While the outline of the competition is shown in Tables 3 and 4, the situation of the competition is shown in Figure 4. However, due to a lightning warning, communication and attitude competitions were conducted indoors without experiments that involved a captive balloon.

Online Engineer Training for CanSat Construction

In April 2019, new students were recruited to join KOSEN Space Academy from the 109 students of 19 KOSENs. In June and July, we had a CanSat production online course for beginners. We used a CanSat kit with a small can size of 160 ml. Producing a CanSat involves a lot of manual work, such as circuit connection by using a breadboard, soldering, processing empty cans, and parachute-making using plastic bags. Figure 5 shows a 2019 CanSat kit for beginners.

Figure 5. CanSat kit 2019 for beginners.

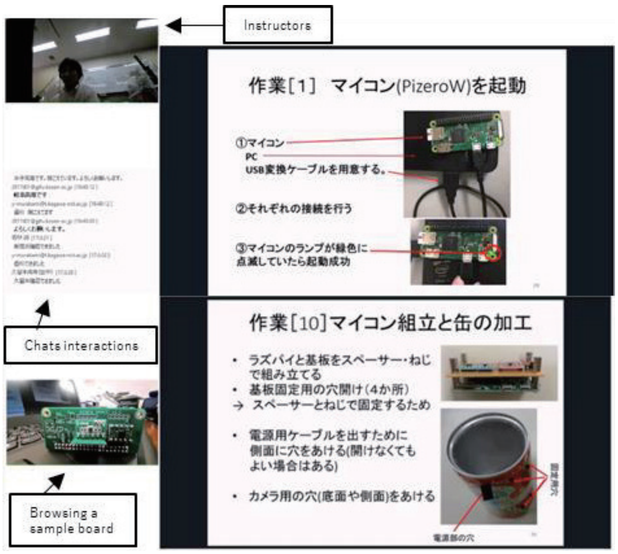


Figure 6. The online-based CanSat course 2019 in progress.

Figure 6 shows the CanSat production course in progress via the online conference, where one CanSat kit was produced by maximum four students. Since there were too many students on the schedule, the same lesson was repeated for two days, and the participants were divided into two groups. This helped us learn a lot about remote practical training. The CanSats produced will be launched by a model rocket during the summer Space Camp.

Online Engineering Training Feedback

Here, we summarize the noteworthy points when conducting a production course via an online conference. The most important thing is for instructors to grasp the participants' processes, including their progress. The instructors should try to understand the student's aptitude on a one-by-one basis so that their work does not fall behind the others. We found that it is effective to understand a student's progress during their work time and/or by using the instant message (IM) function of the application software so that the course is not delayed. It is also helpful to show the item being referred to in front of the camera before explaining it to make it easier for beginners to understand and participate. However, if the participants have problems during their work, they should report them immediately to the instructors. To proceed smoothly with the course, instructors should prepare for this situation and consider how they will deal with it in advance.

Finally, we will briefly compare the CanSat production course that is not online. On September 1st, 2017, the CanSat course with nearly identical content was held in Niihama with KOSEN students nationwide (Wakabayashi et al., 2019b). If there was ever a shortage of kits, difficulty in viewing the manual, or an insufficient explanation, then the instructors were able to notice the issue and provide support for the problem without causing major complications. On the other hand, in online courses, it is necessary to carefully prepare the details of the kits and manuals in order to be prepared in advance. To lack any parts, for example, is not permitted. Even with the burden of preparation, we still think that the online course is a better fit. If there is only a small number of participants all over the country, like what occurred this time, then the instructors would have to visit each place or gather all of the participants together to conduct a course, which involves travel and expenditures. Currently, we believe that online courses are beneficial because they reduce costs, including time spent, and they provide opportunities for participants.

Summary

To nurture space personnel who can potentially contribute to real satellite development, we have started designing, practicing, and refining an educational system called KOSEN Space Academy. It uses online video conferencing so that teachers can spread to multiple KOSEN sites to reach interested students. This paper described the activities in the first year, which included working with a simple receiver that included a software-defined radio, making a model rocket, building a CanSat for beginners, and a group competition to produce model CubeSats at the Space Camp in 2018. Currently, KOSEN Space Academy's educational focus is manufacturing and hands-on training, which is implemented through long-distance lectures, practical training sessions, and discussions via online video conferencing. We can confirm that our online-based system functions well. We hope to enhance our expertise in delivering practical lectures and hands-on training using the online conferencing system and continue to build a fulfilling curriculum.

Acknowledgments

We acknowledge the members of KOSEN Space Collaboration group and the participants of KOSEN Space Academy in 2018 through 2019. We are very grateful to the students of the National Institute of Technology at Tokuyama College, Kochi College, and Akashi College for the help we received in preparing the CanSat kits. The KOSEN Space Technology Education Project was supported by the Human Resource Development Program of MEXT, Japan, in 2017. This work was supported by JSPS KAKENHI Grant Number JP17K01169.

References

Kitamura, K., Sakuramoto, I., Ikeda, M., Takada, T., Imai, K., Wakabayashi, M., & KOSEN Space Collaboration group (2019). An engineering design education program as an inheritance of space technology education project. *Transactions of JSASS Aerospace Tech. Japan*, *17*(1) 39-42.

Miyazaki, Y., & Yamazaki, M. (2013). A practical education of space engineering by using CanSat and pico-satellite—Fruitful collaboration with UNISEC for success of student satellite program. *Recent Advances in Space Technologies (RAST), 2013 6th International Conference of IEEE*, 1081–1086.

Nakasuka, S., Sako, N., Sahara, H., Nakamura, Y., Eishima, T., & Komatsu, M. (2010). Evolution from education to practical use in University of Tokyo's nano-satellite activities. *Acta Astronautica*, *66*(7-8), 1099–1105.

Nakaya, J., Takada, T., Kajimura, Y., Kitamura, K., Ueta, S., Tsuchiya, H., Uezono, N., & Sasaoka, Y. (2019a). Development and application of a CubeSat ground model for space technology education: 2. Design and implementation of the competition. *Journal of Japanese Society for Engineering Education*, *67*(2), 101-106 (in Japanese).

Nakaya, J., Takada, T., Kajimura, Y., Tsuchiya, H., Uezono, N., Sasaoka, Y., Ueta, S., Wakabayashi, M., & Kitamura, K. (2019b). Development of the CubeSat ground model extended from CanSat: Application to space education at KOSEN. *32nd International Symposium on Space Technology and Science*, 2019-u-06.

Sasaoka, Y., Uezono, N., Kajimura, Y., Nakaya, J., Kitamura, K., Ueta, S., & Takada, T. (2019). Example of an online manufacturing course in engineering: The CanSat production course in space technology education. *Journal of Japanese Society for Engineering Education*, *67*(2), 63-68 (in Japanese).

Shimomura, K., Tsubouchi, R., Sasaoka, Y., Ueta, S., Nakaya, J., & Takada, T. (2019). Development of a CanSat-mounted model rocket with a single C-type engine and its educational use. *Journal of Japanese Society for Engineering Education*, *67*(3), 56-61 (in Japanese).

Takada, T., Nakaya, J., Kajimura, Y., Tokumitsu, M., & Kitamura, K. (2018). Overview of start-up activities within the online-based educational framework of KOSEN Space Academia. *Transactions of ISATE*, ID:249.

Tokumitsu, M., Asai, F., Takada, T., Wakabayashi, M., Kitamura, K., & Imai, K. (2019). A report on satellite communication lectures in the KOSEN space group. *32nd International Symposium on Space Technology and Science*, 2019-u-08.

Tokumitsu, M., Asai, F., Kusakabe, M., Ogura, S., Aoki, S., Takada, T., Wakabayashi, M., & Ishida, Y. (2017). A prototype of an integrated telemetry receiving system with volunteers: designs of a simple receiver, a protocol, and an intelligent information processing. *Procedia Computer Science*, *112*, 2445–2454.

Tsubouchi, R., Nakahira, K., Shimomura, K., Ueta, S., Hirakoso, N., & Takada, T. (2018). Mission planning variation of CanSat student group education: Development, course design and practice. *Journal of Japanese Society for Engineering Education*, *66*(2), 79-84 (in Japanese).

Uezono, N., Sasaoka, Y., Nakaya, J., Tsuchiya, H., Kajimura, Y., Kitamura, K., Ueta, S., & Takada, T. (2019). Development and application of a CubeSat ground model for space technology education: 1. Body development and production course. *Journal of Japanese Society for Engineering Education*, *67*(2), 95-100 (in Japanese).

Wakabayashi, M., Takada, T., Imai, K., Kajimura, Y., Nakaya, J., Kitamra, K., Murakami, Y., Asai, F., Tokumitsu, M., Shinohara, M., & Shimada, K. (2019a). Report on KOSEN Space Camp 2016 for space engineer education. *Transactions of JSASS Aerospace Tech. Japan*, *17*(3), 392-397.

Wakabayashi, M., Takada, T., Kitamura, K., Nakaya, J., Kajimura, Y., Tokumitsu, M., Murakami, Y., Shinohara, M., Imai, K., Asai, F., & Shimada, K. (2019b). Report on the KOSEN space camp in 2017 and 2018: Mission CanSat to CubeSat model. *32nd International Symposium on Space Technology and Science*, 2019-u-07.

Yamazaki, M. (2016). Space systems engineering education by providing hands-on practices using pico-satellite training kit. *30th Annual AIAA/USU Conference on Small Satellites*, SSC16-XIII-6, 1-7.

EMPOWERING WOMEN IN STEM: COLLEGE STUDENTS AND SCHOOL PUPILS

Kaori Tsukazaki*[a] and Tamiko Ohshima[b]

[a] National Institute of Technology, Kagoshima College, Department of Liberal Arts and Sciences, Kagoshima, Japan

[b] National Institute of Technology, Sasebo College, Department of Electrical and Electronic Engineering, Sasebo, Japan

*tukazaki@kagoshima-ct.ac.jp

Abstract

"Gender equality" is one of the SDGs of the United Nations by 2030. Gender issues in the STEM fields are a serious problem in terms of imbalance in Japan. For example, the percentage of female undergraduate students in engineering is only 15% and that of female researchers in engineering and technology is only 5.3%, which is the second smallest number among 75 OECD countries. It follows that there are very few female role models within the STEM fields and this may be a reason why many females in younger generations are refraining from choosing paths in these areas. It is necessary for us to change this situation and increase the number of female students in STEM. The purpose of this paper is to introduce some examples of innovative approaches to the gender issues in STEM by two national colleges of technology: National Institute of Technology, Kagoshima College and National Institute of Technology, Sasebo College. They have been working hard to empower female students in their own colleges and impact younger generations. First, female college students regularly hold workshops to teach robot programming to younger generations, especially girls, for example. The goals of events by female students of both colleges are to show female role models to children and eventually to foster interest in STEM. Lastly, the two colleges sometimes work together to empower their own female students. Thanks to leaders in the industry who appreciate empowerment of female engineers, they have opportunities to experience the latest technology in Japan.

Keywords: *Sustainable Development Goals, gender equality, empowerment of female students, role models in STEM, programming education for younger generations*

Introduction

"Gender equality" is one of the Sustainable Development Goals (SDGs) of the United Nations, which need to be achieved by 2030. "SDG5" is to "achieve gender equality and empower all women and girls" (UNESCO 2017a, p. 13). Gender equality is defined as follows (p. 29):

> Gender equality exists when women and men enjoy the same status and have equal conditions, treatment, and opportunities for realizing their full potential, human rights and for contributing to and benefitting from economic, social, cultural and political development. Equality does not mean that women and men will become the same but that women's and men's rights, responsibilities and opportunities will not depend on their sex or gender. Gender equality is therefore the equal valuing by society of the similarities and differences between women and men and the different roles that they play. It is not about sameness (UNESCO, 2014) [sic].

"Science, technology, engineering and mathematics - STEM - is used to characterize the corresponding fields of knowledge and study. It refers to the formal education and qualifications individuals acquire throughout their training in the fields of science, in technology, engineering and mathematics (UNESCO 2017a, p. 30)." According Gender Summit 15 in London in 2018, the percentage of female students in the STEM fields in higher education is low in the global context. It is regrettable to say that the situation is the same in Japan. Gender issues in STEM are a serious problem in terms of imbalance in Japan. For example, the percentage of female undergraduate students in engineering is only 15%. In addition, *the UNESCO Science Report* (2017b) says that the percentage of female researchers in engineering and technology is only 5.3%, which is the second smallest number among 75 OECD countries.

The purpose of this paper is to introduce some examples of innovative approaches to the gender issues in STEM by two national colleges of technology in Japan: National Institute of Technology, Kagoshima College (NIT, Kagoshima College) and National Institute of Technology, Sasebo College (NIT, Sasebo College). Although they are located in perhaps the most conservative region in Japan, they have been working hard to empower female students in their own colleges and impact younger generations so that they can choose their path in STEM.

STEM Workshops for Children by Female College Students

Since the percentage of female students is limited, there are very few female role models within the STEM fields and this may be a reason why many females in younger generations are refraining from choosing paths in these areas. It is necessary for us to change this situation and increase the number of female students in STEM. For this reason, some efforts have been undertaken by the leadership of the National Institute of Technology in Japan. We would like to change the situation and increase the number of female students up to 30% in all national colleges of technology within a couple of years.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan has focused its attention on teaching computing skills from the earliest stages of compulsory education lately. As a result, computing skills will be taught at elementary schools in 2020 and junior high schools in 2021. The curriculum at all elementary schools and junior high schools needs to be designed to suit the government guideline. In this way, it is getting more and more important to provide programming education for younger generations than in the past.

Some students in NIT, Kagoshima College launched a chapter of an international volunteer organisation which teaches STEM to girls. Since then, they regularly hold workshops to teach robot programming to younger generations, especially girls. NIT, Sasebo College also holds workshops for girls in younger generations in which they conduct experiments with female college students. The goals of both events are to show female role models to children and eventually to foster interest in STEM. In the next section, let us look workshops in both colleges in detail.

First, in NIT, Kagoshima College, there are some tools to teach children how enjoyable it is to learn STEM. To take an example, a line-trace robot is used in order to teach programming a computer (See Figure 1). At the beginning of a two-hour workshop, female college students show children how a robot traces a black line on a white sheet of paper. And then, children do it themselves. To enable their robot to move properly without falling or going off the line, they are asked to check on figures of a program on the computer in order to adjust the robot's speed and turns. At the end of the workshop, their robot moves with a melody that they programmed. As for the size of a workshop, the number of 'teachers' varies from 3 to 13, and participants are from 20 to 80.

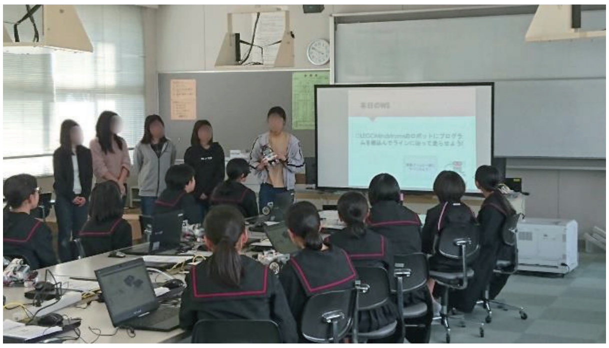


Figure 1: A Workshop by NIT, Kagoshima College

Second, NIT, Sasebo College holds a variety of attractive STEM workshops for young girls regularly all through the year. The number of 'teachers' varies from 3 to 21, which sometimes includes male students. For instance, with the help of female college students, participants make a musical box and an LED lampshade. In December, children have an opportunity to make such seasonal items as a Christmas tree with 3D pens (see Figure 2) and a Christmas card with a melody (see Figure 3). In another workshop, only three college students teach as many as twenty children how to programme a robot with a computer. From 20 to 60 elementary or junior high school students, sometimes including boys, attend each workshop. In addition, children can learn how energy works by conducting an experiment with the college students.

Figure 2: A Workshop by NIT, Sasebo College (1)

Figure 3: A Workshop by NIT, Sasebo College (2)

Lastly, NIT, Kagoshima College and NIT, Sasebo College sometimes work together to empower their own female students. In order for the college students to teach STEM to children, they need to be efficient in STEM themselves. Thanks to leaders in the industry who appreciate empowerment of female engineers, they have opportunities to experience the latest technology in Japan. For example, female students from both colleges paid a visit to a hotel in 'Huis Ten Bosch', which is one of famous amusement parks in Japan. It is located near NIT, Sasebo College in Sasebo City in Nagasaki Prefecture.

The purpose of this visit was to take a joint tour in the hotel to see how the latest technology is used there. A great number of robots, whether it is big or small, are used in the hotel for the purpose of cutting down the number of workers in the facility and increasing entertainment for the customers. For example, three robots, one woman and two dinosaurs, greet you and help you check in at the reception. A big arm robot which is normally used in a factory lifts your suitcase and puts it in a locker which looks like a big drawer. More than thirty small robots play a song together like an orchestra and dance.

The latest technology is used in a smart convenience store in the hotel. You are allowed to enter the store with facial recognition and pay the items that you purchase by credit card. There is no shop assistant even at the till, although the security camera is active. This facial recognition system is one of the latest technologies in Japan and are supposed to be used in the security system during the Tokyo 2020 Olympics and Paralympics. A leader in the industry provided NIT, Kagoshima College and NIT, Sasebo College with the opportunity to take their students to experience this. In Figure 4, a female college student is trying to use a facial recognition machine at the entrance of a smart convenience store.

Figure 4: A Joint Tour at a Smart Convenience Store in Sasebo

Results and Discussion

First, attending a STEM workshop by female students at NIT, Kagoshima College or NIT, Sasebo College made an impact on the participants; both school children and their parents. A mother of a participant in Kagoshima said that she did not know that female students belong to a national college of technology and that she did not expect to meet them at the workshop. She was also amazed how great female college students were doing while they were teaching STEM to children in the workshop. Likewise, in Sasebo, both children and parents who attended a STEM workshop by female college students were satisfied with the workshop. Table 1 shows how the children felt after the workshop. 18 children out of 20 said that the workshop was very good (90 %).

Table 1: Children's impression on NIT, Sasebo College's workshop

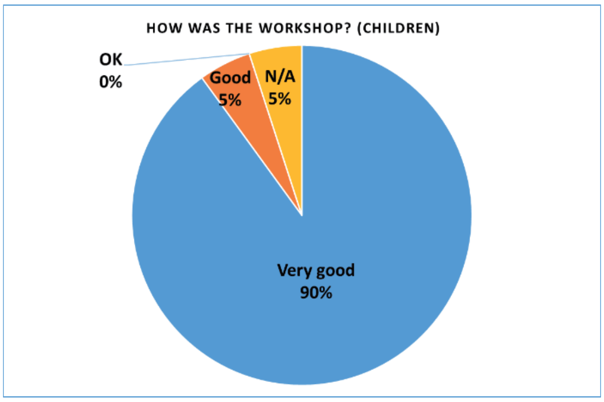


Table 2: Parents' Impression on NIT, Sasebo College's Workshop

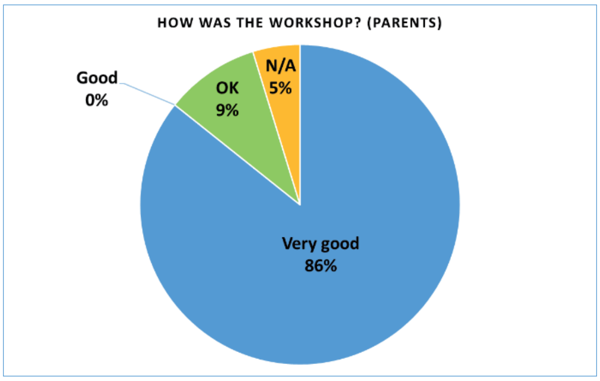
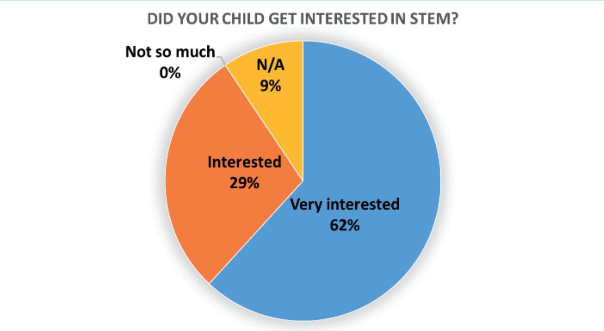


Table 2 shows the impression of their parents on the workshop. 18 parents out of 21 said that the workshop was very good. This implies that in addition to children, most of the parents were satisfied with the STEM workshop by NIT, Sasebo College. As Table 3 shows, 91 % of parents thought that their children got interested in STEM after the workshop. This suggests that female students at NIT, Sasebo College were successful in fostering children's interest in STEM even with a short workshop.

Table 3: Did a Workshop by NIT, Sasebo College foster Interest in STEM?



Lastly, according to Japan Science and Technology Agency (2018), Development Bank of Japan found that "the patents produced by the gender blending teams have a higher value in the economy that the patent produced from the male-only teams by 20% on average [sic]". This finding in Japan was shared with researchers and government officials in gender issues from all over the world in Gender Summit 15 in London in 2018.

UNESCO and GRC also point out the importance of diversity in research as follows (Elsevier 2017, p. 10):

> Diversity is integral to innovation. In both academic and private-sector research, the diversity of research teams ensures that new perspectives and ideas are brought to the table. Diversity adds to the collective intelligence of a research group, and not only enhances creativity, but also provides new contexts for understanding the societal relevance of the research itself. One of the key aspects of diversity is gender. The unique perspectives and contributions of women to scientific research teams have been recognized globally. Increasing the participation of women in the STEM fields to drive innovation and achieve excellence in research is a stated goal of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and Global Research Council (GRC).

For these reasons, it is meaningful to have both men and women whether it is in a team of engineers or a research group. We need to make every effort to impact as many girls as possible so that some of them will be involved in STEM in the future.

Conclusions

To some extent, female students at both NIT, Kagoshima College and NIT, Sasebo College have contributed to empowering younger girls in order that they can choose the STEM fields as their career path in the future. They have been teaching girls how fun it is to learn STEM through workshops.

In conclusion, we need to continue working in order to increase the number of female students in the STEM fields from the perspective of diversity in a team of engineers in the industry. It is also very important to empower female college students as well so that they can be good role models in STEM for young generations, especially girls.

Acknowledgements

This work was supported by JSPS KAKENHI Grant Number JP17K18686.

References

Elsevier. (2017). *Gender in the Global Research Landscape*.

Japan Science and Technology Agency. (n.d.). *Gender Summit London 2018 (United Kingdom) – Participation Report*. Retrieved from http://jst.go.jp/diversity/en/OurEfforts/report/report20180618.html

Ministry of Education, Culture, Sports, Science and Technology, Japan. (n.d.). Shin gakushu shido yoryo. Retrieved from http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2018/03/30/1375607_01.pdf [In Japanese]

National Institute of Technology. (n.d.). Retrieved from http://gender.kosen-k.go.jp/information/

The United Nations. (n.d.). *Sustainable Development Goals*. Retrieved from http://sustainabledevelopment.un.org/sdgs

UNESCO. (2017a). *Measuring Gender Equality in Science and Engineering: The SAGA Toolkit Working Paper 2.*

UNESCO. (2017b). *UNESCO Science Report Towards 2030.*

Using Eye-tracking Equipment to Improve Reading Strategies on Standardized Tests

M.K. Higa* and J.C. Herbert**

* National Institute of Technology (NIT), Matsue College/Humanities, Matsue, Japan
** NIT, Akashi College/General Studies, Akashi, Japan

*higa@matsue-ct.jp

Abstract

The Test of English for International Communication (TOEIC) is one of the most widely recognized tests of English worldwide. Students at Japanese institutes of technology (KOSEN) are often required to take the TOEIC during their college career for various purposes such as job-hunting, university transfer, and class requirements. One common problem students face in attaining their desired score, is not being able to read quickly enough on the reading sections of the TOEIC in order complete each section within the allotted amount of time. Often times, Japanese learners attempt to read texts linearly, word-for-word instead of scanning or skimming as a native speaker might and are therefore unable to complete the entirety of the reading section before running out of time. This study will investigate the use of open source eye-tracking equipment and software as a means of aiding students in improving their scores in the TOEIC test. Participants are fourth-year college students at a technical college in Japan, enrolled in a TOEIC preparatory class and one fifth-year exchange student. Throughout the duration of this study, students are given tasks aimed at improving their reading efficiency by introducing scanning and skimming strategies. A pre-test and post-test of reading sections on the TOEIC are used to determine whether these strategies are helpful for improving their reading efficiency. Eye-tracking equipment is utilized in order to help students raise their own awareness about the manner in which they view the contents of the reading section and identify the areas that can be improved such as their English lexicon, understanding of grammar and reading strategies specific to the TOEIC test. While eye-tracking equipment can be quite cost prohibitive for non-commercial use, this study utilizes cost-effective equipment, which relies on open source software to analyze eye movements. As a secondary aim, this study investigates whether this equipment is suitable for the purposes of eye tracking in an EFL context.

Keywords: *EFL, eye-tracking, TOEIC, scanning, skimming, L2 reading, Pupil Labs*

Introduction

The use of eye-tracking equipment can be an effective way of gaining information about reading styles and strategies individuals may have when reading text and may be particularly useful when applied to an educational context. Instructors, researchers and learners can all benefit from being able to observe, first hand, the way in which one reads from a text. In previous studies, the authors conducted eye-tracking experiments with students studying English as a foreign language (EFL). Particularly, eye-tracking equipment was used as a means to more effectively support students in Japan with specific learning difficulties (SpLDs) in EFL testing (Herbert et al., 2018; Higa & Herbert, 2017) by studying various layouts of tests and observing how students manage reading the said layouts. This study will also consider readings styles of EFL learners in a Japanese context, but will focus on the reading portion of the Test of English for International Communication (TOEIC), which is a ubiquitous test throughout Japanese higher education. Furthermore, this study does not address students with SpLDs. Two research questions guide this study:

1. In what ways, and to what extent can eye-tracking equipment inform teachers and students to improve reading strategies on the TOEIC test?
2. Is the equipment used in this study suitable for eye-tracking in an EFL context?

Materials and Methods

In previous studies, the authors carried out similar experiments with an eye-tracking device known as the Mirametrix S2, which is now discontinued and no longer supported. The Mirametrix S2 was used to compare the suitability of testing layouts commonly used in technical colleges in Japan. By comparing different formats, the researchers were able to gain insights about how students responded to changes in formatting with regard to elements such as font, line spacing, font size, etc. However, one of the limitations of previous studies was that the software used was only capable of eye-tracking when participants were viewing a computer screen. This limited the ability of the researchers to observe students in a more realistic setting, in which eye-movements could be tracked as students took tests on paper. While this is possible, eye-tracking equipment with this capability tends to be outside of the financial capabilities of EFL researchers. Capable commercial platforms such as Tobii, cost far more than the Mirametrix S2, prohibiting many researchers from utilizing the platform. Therefore, this study aims to explore the possibilities of utilizing low-cost, open source eye-tracking equipment for observation of students' reading strategies when taking standardized tests.

A relatively low-cost (1285 Euro at the time of purchase in 2018), open source eye-tracker produced by a German-based company Pupil Labs was used for this experiment. The specific model is a monocular eye-tracker known as the Pupil Core Eye Tracking Headset as shown in figure 1 below:

Fig. 1. Example of Pupil Core Eye Tracking Headset (Kassner, Patera & Bulling, 2014)

The related software is open source, developed by users of the Pupil Labs device. The software is used to calibrate, record and playback videos of the user's eye-movements in relation to their gaze fixation. While the software provided with the device is adequate for basic analysis including eye-tracking, taking stills of fixation points and limited heat mapping capabilities, more advanced analysis such as tracking the order of gaze fixations, and heat maps of gaze fixations require intermediate to advanced knowledge of the programming language, Python. It is believed by the authors that this study is the first to be conducted using this headset for a study in an EFL context.

Participants: The participants in this study were 4 students at a technical college in Japan. 3 of them were 4th year (university freshman equivalent) Japanese students and one was a 5th year (university sophomore equivalent) exchange student, whose third language is English. Their TOEIC scores taken within one year prior to the time of the study were 435, 440, 655, and 985 respectively. Only the exchange student had received formal, in-class instruction related to portion of the TOEIC studied in this research.

Tasks: Students were asked to answer a series of questions related to single-passage problems as seen in part 7 of the TOEIC test. Part 7 of the TOEIC test generally consists of short (less than 1 page) reading passages followed by two to five questions based on the passage. The materials used in this study are practice tests provided by Tactics for the TOEIC Practice tests included in the introductory course textbook, Tactics for the TOEIC® Test, Reading and Listening Test, Introductory Course (Trew, 2017). First, students were asked to take a practice test, with the only instructions being that they had to complete 15 questions, comprised of 4 related passage and were limited to 15 minutes to answer all 15 questions. At the completion of the practice test, the participants were then instructed on strategies for taking the test. The strategies taught were comprised of test strategies advocated by various TOEIC preparation texts from leading publishers Kaplan, Oxford and ETS publishing companies (Kaplan Publishing, 2017., Rogers, 2018., Trew, 2007., Trew, 2017). After reviewing the various strategies proposed by these texts, the author chose a total of seven strategies due to these being present in each of the publications reviewed the strategies are as follows:

1. *Skimming*: Skim the passage to get the main idea. Read only the first few sentences. Look for repeated words or phrases.
2. *Read the questions*: Read the questions, but not the answer choices. Do this before reading the passage in depth.
3. *Answer each question*: Answer each question in one's own words before reading the answer choices.
4. *Scan the passage*: Look for key words and phrases. This is possible because the questions are already known in advance.
5. *Evaluate the answer choices*: Find the answer choice that is the closest match to the expected answer
6. *Eliminate answer choices*: If the answer is still unknown at this stage, proceed to eliminating the answers.
7. *Tackle shorter passages and vocabulary questions first*: For this study, this point turned out to be irrelevant because of the short amount of time and also the eye-tracking setup, which did not allow for the order of passages to be switched in an efficient manner.

After receiving instruction from the researcher on testing strategies, students completed practice problems and engaged in self-study totalling 2 hours before taking the test again two days later. At the time of the test, students were instructed to try to answer the questions using the tactics they had studied after the previous test.

Results and Discussion

Based on the limited data collected in this study, it was evident that for the student with the lowest TOEIC score, following the advice outlined in many of the leading TOEIC preparation textbooks was not feasible to put into practice due to reading ability. The student appeared to be unable to scan effeciently enough to utilize that strategy. The reasons for this were out of the scope of this study, but it is presumed that the student may not have sufficiently understood the questions to an extent that they could scan for the answer. By reading the entire text first, the student may have had a better chance at understanding the meaning of the question. Furthermore, while all of the students were able to answer all of the questions within the time limit, a review of the recorded attempts make it clear that the Japanese students rushed to answer the latter portion of the test. Furthermore, the student with the second lowest TOEIC score seemed unable to follow the order of reading strategies suggested. When asked why, the student remarked that they didn't have the confidence in reading comprehension to utilize the skimming and scanning strategies. Therefore, the student simply read in a linear fashion, and answered the questions in the order of appearance. The exchange student, who scored a 985 on the TOEIC test within one year prior to this experiment also did not follow the suggested strategies but for a different reason. Rather, the student opted to read the questions before reading any part of the text. Based on video observations, it seems that the student rarely read through entire portions of text, but rather chose to scan the entire time, comparing portions of the text to the questions and answer choices. This is presumably because his reading comprehension abilities allowed him to comprehend the main ideas of a text even when skimming and scanning through a text. Thus, while the sample size was limited, by using the Pupil Labs eye-tracking package, the researchers were able to attain basic observations that may help inform the method of teaching this portion of the TOEIC in the future. It seems that without a certain proficiency in reading speed and comprehension, the strategies suggested by some of the major TOEIC preparation textbooks may not be suitable for lower level EFL learners. On the other end of the spectrum, students with extremely high levels of reading comprehension might also benefit from exploring alternative reading strategies.

In regards to whether the equipment being used is suitable for this type of study, there were mixed results. Initially, one of the main motivations for choosing the Pupil Labs platform and moving away from that of the Mirametrix equipment was to better simulate a natural environment during the experiment. The equipment was adequate in allowing the researchers to observe some basic tendencies of the participation when reading text and answering the related questions. Through individual video observation, general reading speed and the order of completing the assigned tasks could be revealed. However, there were several problems the researchers encountered that could be improved upon in future studies. First, the eye-tracking equipment used in this study was quite difficult to use and requires a fairly advanced knowledge of programming and the equipment used. While the calibration is accurate enough for many studies where the participant views objects at a distance greater than that of this study, it was very difficult to attain the amount of accuracy necessary to observe participants' eye movements when taking a tests with a font size of 12 or less. Despite spending large amounts of time calibrating the device, it was difficult to achieve pinpoint accuracy. In Figure 2, though the subject is looking at the tip of the pen, the calibration of the device shows the gaze point (the circle hovering just above the tip of the pen) to be slightly higher:

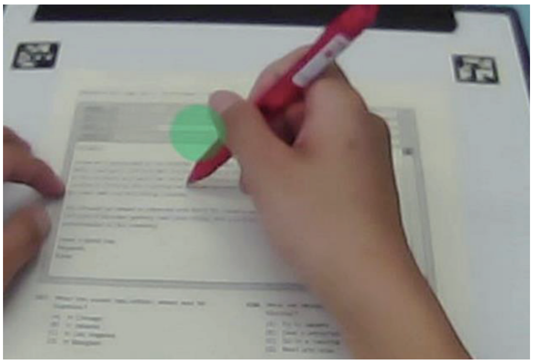


Fig. 2. Gaze point calibration in relation to actual point of view.

In order to compensate for the lack of accuracy, the researchers opted to use a chinrest (see Fig. 3) to minimize head movement and the possibility of the calibration being disrupted due to the position of the headset changing during the experiment.

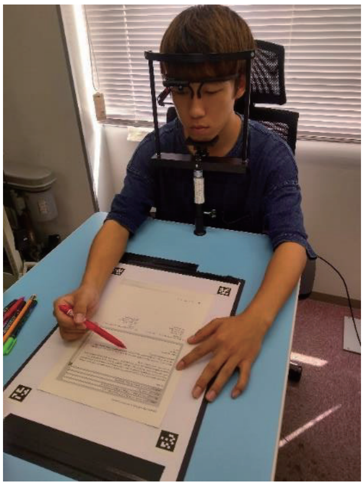


Fig. 3. Use of a chinrest to minimize head movement

Furthermore, in order to attain a suitable amount of accuracy during calibration, the chinrest was utilized in combination with a stand to support the text in order to set the gaze position in a fixed position (see Fig. 4).

Fig. 4 Setting the text at a fixed distance and height

While this setup achieved a great deal of accuracy in comparison with the previous setups tested, it was inadequate in achieving one of the main goals of this study, which was to create a more realistic environment for observation. Despite this shortcoming, the equipment used did improve upon the equipment used in previous studies due to the fact that eye-tracking was achieved while viewing actual paper, where in previous studies, it was only possible to perform eye-tracking while the subject was viewing a computer monitor.

Conclusions

This study clarified that the students' reading styles could be fairly accurately observed and helped give both the student and researcher insights as to why the student may be having difficulty in part 7 of the TOEIC test. The study also highlights the need for instructors to evaluate the strategies being taught in many TOEIC preparatory textbooks and consider whether the advice is suitable to the level of students being taught.

Due to the scope of the test, generalizable findings were unable to be obtained, but the preliminary findings in this study indicate that a future study with a more robust sample size and improved eye-tracking methods should be carried out.

In future studies, the authors intend to continue working towards improving the capabilities of the eye-tracking equipment used in this study to more accurately mimic a realistic testing environment. Furthermore, future studies will aim to include a larger sample size with a more varied range of English abilities. Finally, this study only utilized a small portion of the TOEIC Listening and Reading test. In the future, the authors will attempt to expand the eye-tracking observations to other portions of the test, including the listening portion in order to help better inform students, researchers and teachers about test taking strategies and considerations.

Acknowledgements

This work was supported by the JSPS Grant Number 17K03042. The authors would also like to acknowledge Tomek Ziemba, David Taquet, Anis Rehman and Mark Pileggi for their collective insights, support and research related to this study.

References

Herbert, J. C., Higa, M., Pileggi, M., Rehman, A., Taquet, D., & Ziemba, T. (2018). Altering English Test Layouts to Cater to All Students. *The Council of College English Teachers*, *37, 205-214*

Higa, M. K. & Herbert, J. C. (2017). Inclusive practices in EFL testing protocol at technical colleges in Japan. ISATE 2017 Proceedings. Retrieved from http://isate2017.sg/index.php/Author/file?name=091mar ready_full_paper.pdf.

Kaplan Publishing, a division of Kaplan, Inc. (2017). Kaplan Toeic premier 2018-2019: with 4 practice tests: online book Cd. New York, NY.

Kassner, M., Patera, W., & Bulling, A. (2014). Pupil. Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing Adjunct Publication - UbiComp'14 Adjunct. https://doi.org/10.1145/2638728.2641695

Pupil Labs. (n.d.). Retrieved September 18, 2019, from https://pupil-labs.com/

Rogers, B. (2018). Complete guide to the Toeic test (4th ed.). Boston, MA: National Geographic Learning.

Trew, G. (2017). Tactics for the TOEIC® Test, Reading and Listening Test, Introductory Course: Student's Book: Essential tactics and practice to raise TOEIC® scores. London: OUP Oxford.

Trew, G. (2007). Tactics for TOEIC® Listening and Reading Test: Student's Book: Authorized by ETS, this course will help develop the necessary skills to do well in the TOEIC® Listening and Reading Test. London: OUP Oxford.

ANALYSIS OF CORRELATION BETWEEN CLASS ACTIVITY AND STUDENTS' ATTENTION IN ACTIVE LEARNING CLASS FROM BIOLOGICAL VIEWPOINT

Y. Ichikawa[a], K. Moriya[b], R. Komura[c], M. Morimoto[d], K. Yajima[e], and M. Nakagawa[f]

[a] General Education Department, National Institute of Technology (NIT), Tokyo College, Japan

[b] Department of Production Systems Engineering, NIT, Hakodate College, Japan

[c] Department of Electronics and Information Engineering, NIT, Ishikawa College, Japan

[d] Department of Natural Science, NIT, Akita College, Japan

[e] Department of General Engineering, NIT, Sendai College, Japan

[f] Department of Science Technology Innovation, Nagaoka University of Technology, Japan

*yuko@tokyo-ct.ac.jp

Abstract: In this paper, we attempted to objectively visualize the effects of the educational efficacy of changing the activity in an Active Learning classs by measuring students' physiological parameters during classes. In our previous experiment, we measured students' cerebral blood flows and numbers of their blinks and observed a higher level of brain activity and concentration in students who were engaged in Active learning compared to those who took conventional lectures. This time, we prepared mathematics class engaged in Active Learning way, which has several parts, teacher's lecture, watching a video and group work. During the class, we measured three students' blinks, eye movements and head movements with special type of glasses. We analyzed the data and found that when the activity in the class changes the strength of students' blinks are getting stable. This shows their level of the attention and concentration increased as the change of the activity. In order to keep the students' attention high level, teacher should change the activity properly in a class. The importance of the class design is figured out from the experiment. It is the accepted notion that in the Active Learning class the levels of students' attention and concentration do not decrease. Teachers subjectively estimate students and ensure the notion is true through observing them how the students cope with their task in class. There are some studies of objective estimation for the efficacy of Active Learning. In this study we objectively gave another visualization of their empirical finding and propose the better class design based on our results. Since our result is obtained from small sample size, we will need to conduct further studies with bigger sample sizes to verify these results.

Keywords: *Active learning, number of blinks, strength of blinks, students' attention.*

Introduction

The National Institute of Technology (NIT) of Japan has recommended the introduction of AL to ensure the quality of education. The aim of incorporating AL is to get away from the mere imparting of information (considered as passive learning) and to provide a program where students can proactively participate in classrooms instead. Many teachers in NIT are striving to conduct their classes using AL methods but they are only a part of the teachers. We aimed to visualize the advantage of AL class in our previous study. We measured and compared the biological data of students in AL classes against those in conventional lecture (CL) classes for the efficacy of AL using objective indicators of cerebral blood flow and eye blinks. Our results demonstrated that the brains of students exhibited a higher level of activation in the AL classes than the CL classes and the number of blinks exhibited a deeper concentration. Now we reached the stage that we consider how we conduct an AL class.

Every teacher who conducts AL classes must have found that it is very important that what and how teachers let student do in the class, that is, class design. In this study, firstly we will investigate a correlation between the biological data of students in AL classes and changes of activities in the class. Secondly, we will compare the difference of groups when teachers let them do a work with a different way. We will also propose a better class design based on our results.

Experimental Methods

2.1 Procedure

We conducted a 75-minute Mathematics classes for the experiment, of which topic is recurrence formula of numerical sequence. Students have studied basic theory of numerical sequence but haven't studied recurrence formula. Table 1 shows the actual time process of the class we mined from the video. Eight students who are 16-17 years old were split in two groups of four which is a suitable number for carrying out a group work. In the group work the teacher hands the answer of the question which they solve. In this experiment, teacher handed the answer in different timing. To the first group she hands it from the beginning of their work and to the second group she hands it after a while. Our second aim is to observe how affect the concentration according to timings that students will get answers.

2.2 Measurement of Eye Blinks and Head Movement

The strength and the speed of eye blinks and the head movement of three students were tracked with a special type of glasses (JINS MEME, n.d.). The data is recorded 20 times per hour. We believe that people will blink lesser when they are concentrating on the task at hand and the strength of eye blinks will be more stable.

Figure 1: Group Work

Figure 2: Watch a video

2.3 The questionnaire

We conducted a 5-point Likert-scale questionnaire on the students (see Table 2). It is the same questions in our previous experiment. Students were asked to evaluate the items on five levels: 5 – Extremely well, 4 – Very well, 3 – Somewhat well, 2 – Slightly well, 1 – Not at all well.

Table 3: Items in the questionnaire

Questionnaire
1. How interested were you in the class?
2. How much did you concentrate on the class?
3. How deeply did you think about the class?
4. How satisfied are you with the class?
5. Any comment about the class?

Results and Discussion

In this study, we investigated the eye blink data during classes and found that gets there are some correlations between the data and changes class activities.

Figure 3 shows the strength of eye blinks in our experiment. The red, blue and yellow lines in the charts are the average strength of three students. Red and blue lines are of the first group students, and yellow is of the second group. The vertical lines in the chart are the time when the activities are changed and the letters A to I are corresponding to them in Table 1. The strength of eye blinks in the charts are the average strength for every thirty seconds.

Right after the vertical lines, in the interval E, G, I we can observe that the strength of students' eye blinks got stable while they were not stable in interval D. To ensure

Table 1: Time process of the class

	Time(mm:ss)	Teacher	Students	
	00:00	Start	Start	
A		Lecture(Review)		A
	05:30			
B		Watch a video	Watch a video	B
	10:00			
C			Solve a review question	C
	15:00			
D		Lecture(How to solve a recurrence formula)		D
	30:00		Start group work	
E			Solve a similar question	E
	41:00			
F		Explain the question		F
	44:00	Hand the answer of questions	First Group get the answer	
G				G
	60:00	Hand the answer of questions	Second group get the answer	
H				H
	70:00			
I		Watch a video again	Watch a video again	I
	74:00	End	End	

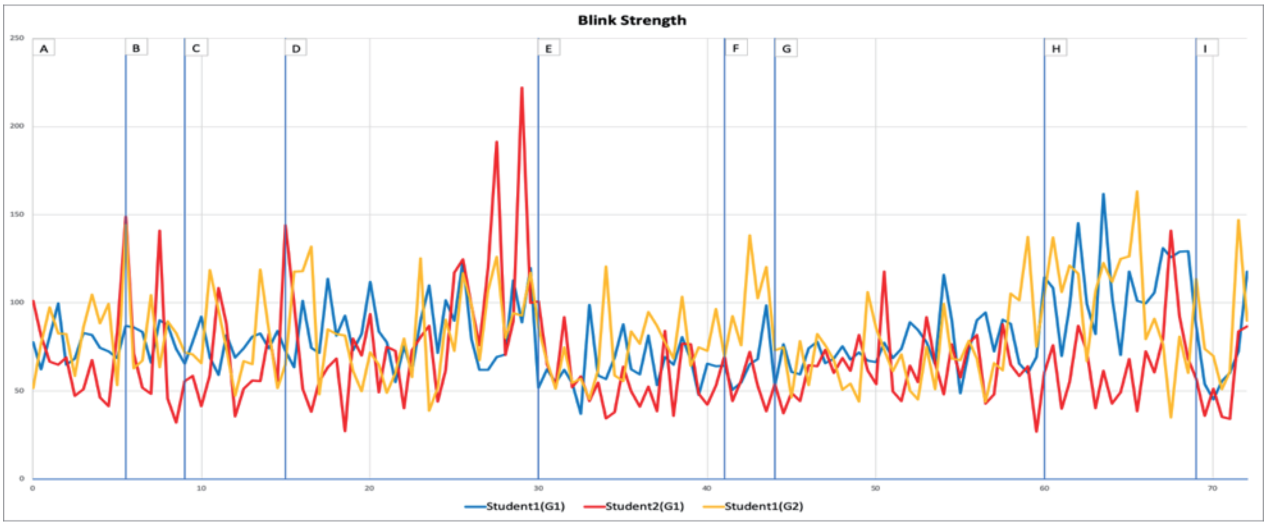


Figure 4 : Numbers of students' eye blinks

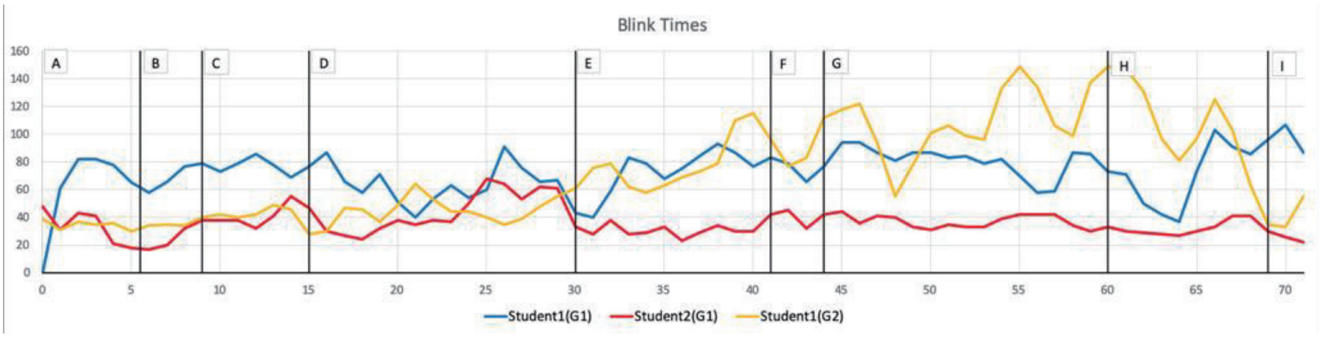


Figure 3: Strength of students' eye blinks

these stabilities we applied F-test for the data and the result is shown in Table 3. The variations overall class and only in interval D, E and G are compared in Table 3. The F-test revealed that the variations of each student are quite lower in interval E than in over all the class. The p values of student 1 to student 3 are 0.008, 0.007, 0.028 respectively. The blue cells show that students get concentrated and the yellow ones don't. Though the p value of Student 2 in Interval D is 0.002 less than 0.005, the variation in interval D is bigger than overall variation. (See green cells) In interval D, the teacher gave lecture about "how to solve the recurrence formula" and students only listened to it. In interval E student started calculating with group work and cooperate each other. This calculation was a part in a suit of lecture from interval D and the teacher explained step by step. Hence, students didn't have any trouble to get the answer.

In interval F, the teacher finished the lecture part and student start calculating a recurrence formula of numerical sequence by themselves. This time students had a little trouble. At the beginning of interval F the teacher gave only to the first group the answer of the question that students were going to calculate. Then we can observe that the first group students kept their concentration but the second group student didn't. When interval G started, the teacher gave the answer to the

Table 3: Comparing strength variations

	Student 1		Student 2		Student 3	
	Overall	Inverval D	Overall	Inverval D	Overall	Inverval D
Average	79.558	83.696	67.343	86.591	81.989	83.507
Variation	445.176	391.115	849.082	1765.569	678.397	700.540
Ratio of variations	1.138		0.481		0.968	
p Value	0.350		0.002		0.430	
	Overall	Inverval E	Overall	Inverval E	Overall	Inverval E
Average	79.558	64.107	67.343	57.586	81.989	74.000
Variation	445.176	179.428	849.082	337.317	678.397	333.958
Ratio of variations	2.481		2.517		2.031	
p Value	0.008		0.007		0.028	
	Overall	Inverval G	Overall	Inverval G	Overall	Inverval G
Average	79.558	77.232	67.343	63.049	81.989	74.544
Variation	445.176	240.594	849.082	309.631	678.397	594.418
Ratio of variations	1.850		2.742		1.141	
p Value	0.022		0.001		0.341	

second group. But the student in the second group didn't turn into a centered state. She might have been in lapse in concentration after some work. Here we note that these stabilities continue only for 10 minutes or a little more.

The numbers of their eye blinks are shown in Figure 4. These numbers are total per two minutes which are overlapped one previous minute in order to cut out the high frequency content. These numbers show that student 2 was getting more concentrate as the class progressed but student 3 was getting distracted. We didn't find any correlation between these numbers and the change of class activities.

Table 4: Result of the questionnaire

Items	1	2	3	4	Average
This Class	4.226	4.375	4.500	4.750	4.463
Previous Class in AL	4.415	4.339	4.071	4.679	4.376
Previous Class in CL	4.040	2.857	3.143	3.286	3.331

Table 4 shows the average scores of the items in the questionnaire. Students consistently gave high scores and there is no difference between the first group and the second. The other scores in the Table 4 are the one in the previous experiment. (See Ichikawa *et al.* 2018) We have gotten the result that students consistently gave higher scores for AL classes than CL classes last year and the scores of this time are highest of all. In our previous experiment the class was 20-minute long while this time it was 75-minite long. Even in the longer class students were interested in the class and satisfied.

Conclusions

In this study, we investigated students' concentration by measuring their eye blink data. Students are under much lesser strain wearing the eyeglasses measuring eye blinks, so it was possible for us to measure their eye blinks data throughout the entire 75-minute long classes. Due to a limited number of measurement devices, we could only perform measurements on three students only. However, our results demonstrated that the students got into concentrated in tune with changing the activities in the class.

Due to our small sample size, the result may be affected the individual variability. We will need to conduct further studies with bigger sample sizes to verify these results.

It is said that student keep concentrated only for ten minutes, at most fifteen minutes. But it is based on subjective observation or secondary sources. Our result shows objectively that it is true. Therefore teachers should change class activities around fifteen minutes. If you need 30 minutes to let student do a task, it is good to have an interrupt which is different type of the work they are doing. That leads students keep their attention for the class. It means that if teacher design the class with suitable activity and change the activity properly sometimes then students can sustain their concentration. We proved by objective data that the class design is really important.

We intend to verify the importance of class design with bigger sample sizes in future studies and discover class activities that would be more efficient in enhancing the students' level of concentration. We are also interested in the correlation between the quantity of students' talk or cutaneous electrical potential and their concentration in AL classes. Especially students don't talk in the conventional lecture class so it may lead some interesting results. Our eventual goal is to propose a new way to evaluate AL's educational efficacy using biological data as objective indicators.

Acknowledgements

This study was supported by the collaborative research grant of National Institute of Technology and Nagaoka University of Technology.

References

Y. Ichikawa, K. Moriya, R. Komura, M. Morimoto, K. Yajima, and M. Nakagawa(2018),. Investigation of Educational Efficacy of Active Learning: Estimation from Biological Viewpoint, *Proceedings of ISATE 2018*.

K. Moriya, I. Kurimoto, N. Ezaki, M. Nakagawa (2017). Influence of Listening to Music in Study Break on Brain Activity and Parasympathetic Nervous System Activity, *Journal of the Institute of Industrial Applications Engineers*, Vol. 6, No.1, 34-38

K. Yajima, R. Iwatsuki, S. Takahashi (2016). Development of Measurement of Degree of Concentration Using BIO-Information, Knowledge-Based and Intelligent Information & Engineering Systems: *Proceedings of the 20th International Conference KES-2016, Procedia Computer Science,* Vol. 96, Pages 1447-1453

K. Yajima, S. Takahashi (2017). Development of Evaluation System of AL Students, *Procedia Computer Science* 112, 1388-1395

Y. Miyanishi, T. Nagahama, Y. Morita (2017). A Trial on Measurement of Stress using Finger Plethysogram on Learning Activity, *Japan Journal of Education Technology*, Vol.41 149-152 (in Japanese)

https://jins-meme.com/en/, JINS MEME: The world's first wearable eyewear that lets you see yourself.

https://www.shidaikyo.or.jp/riihe/research/582.html (in Japanese)

ICT IN TECHNICAL TEACHING TO ENGLISH AS FOREIGN LANGUAGE LEARNERS

Huiyu Zhang[*,a], Linda Fang[b] and Hidetoshi Nakashima[c]

[a] Temasek Polytechnic/ School of Informatics & IT, Singapore
[b] Temasek Polytechnic/ School of Engineering, Singapore
[c] National Institute of Technology, Kumamoto College/ Control and Information Systems Engineering, Japan

*zhanghy@tp.edu.sg

Abstract

A plethora of Information and Communication Technology (ICT) tools have been used in language education, in particular the English as Foreign Language (EFL). Research had shown that positive effects had been observed as the ICT tools led these learners to a variety in English content, media, and contexts, making the language learning environment interactive and flexible. Literature also reported that the EFL learners were more motivated as ICT fostered autonomy and self-directed learning. To the best of our knowledge, the domain of using ICT for EFL learners in learning technical subjects in English has not be well explored. This qualitative study thus aimed to determine the impact of ICT tools in supporting technical teaching through providing authentic situations, real-life learning environment, and student-centred pedagogical methods. In October 2018, 12 final-year KOSEN students from National Institute of Technology, Kumamoto College, attended a five-day Digital Image Processing workshop conducted by a lecturer from Temasek Polytechnic. It was supported by a specially-created online dictionary, video annotations, and individual video recordings accompanied by individual feedback from the lecturer via email. Data were collected through pre- and post-workshop surveys, summative assessment performances, and lecturer's observations. Findings suggested that some ICT tools were more relevant than others to the participants' learning processes, especially if supported by tutor's input. The technical literacy presentations in English showed improvement, participants' self-perceived competence had also improved after the ICT interventions, albeit much lower rating than their actual progress.

Keywords: *habits of mind, ICT, self-perceived competence, technical teaching,*

Introduction

There has been a rapid growth of using ICT in the teaching and learning of English as a foreign language (EFL). In enhancing EFL learning, there are ubiquitous reviews on how ICT had been effective in supporting the curriculum. Aside from providing interactivity and engagement (Houcine, 2011; Zhao, 2013), enabling collaborative work (Ferreira, 2013) and learner autonomy (Okazaki, 2015), ICT-enabled methodologies such as the use of multimedia texts assisted learners to familiarise with vocabulary and language structures (Patel, 2013) and these different media also allowed learners to understand both language and contexts (Mahfouz & Ihmeideh, 2009).

English as the language of globalisation can be used in different contexts. Communicating for diplomatic or business context can be very much different from communicating for leisure or cultural context. The situational contexts affect the nature of the language structure and vocabulary that one makes. Thus, for EFL learners, apart from being exposed to some contextual examples during their language lessons, their communication ability can be even better harnessed if they are constantly immersed in the situational context.

Background

The KOSEN education system in Japan, is a five-year engineering education for students from 15 years old, with the possibility of continuing further study in the two-year advanced course. KOSEN students at the National Institute of Technology (NIT), Japan, receive vocational training to take on active engineering roles both locally and globally. NITs constantly create diverse learning opportunities through, e.g. student and staff exchange with their international partners. In Oct 2018, a lecturer from Temasek Polytechnic (TP), Singapore (who learnt English as a first language) was invited to conduct a five-day Digital Image Processing workshop in English, for fifth-year KOSEN students in the Control and Information Systems Engineering (CISE) programme at NIT, Kumamoto College. As students learn best when actively engaged in an authentic learning experience, what could be more relevant than solving workplace problems, with habits of mind in the English medium (Koura & Zahran, 2017), for vocational training as an engineer with global mobility?

Compared with the richness and great diversity of research in using ICT for language education, those for technical teaching in second language (L2) or EFL are relatively far and few between. Thus the purpose of this qualitative study was to determine the impact of ICT tools in technical teaching for these EFL or L2 learners through examining the following questions:

1. How did the ICT tools improve the students' self-perceived competence?
2. How did these tools help the students acquire the desired learning outcomes?

Methodology

Participants: A total of 12 students who had selected the image processing elective '画像処理' participated in this study. They consisted 10 males and 2 females, with a mean age of 20 years. These KOSEN students had been taking English classes weekly since their first year. Out of these 12 students, only one had prior experience in formal presentation in English in a non-language/technical based subject.

Prior to this workshop by the TP lecturer, they underwent 14 lessons of small group teaching, each 90 minutes, to familiarise themselves with the foundational knowledge with their NIT professor.

Data Collection: The students' reaction to the ICT-enabled activities were captured in a survey. Their self-ratings of the competency in technical presentation in English were also obtained at two different junctures - at Day 1, before the start of the workshop; and at Day 5, the end of the workshop (see Fig. 1).

III. Synthesizing- Feelings, senses, and experiences coming together to form a cohesive knowing when we refer that 'a concept or knowledge is understood'. When students were made to deliver and present their mini-projects (to be elaborated further), they were given the platform to consolidate how they felt and experienced and synthesize into a new artefact.

Structure: To enable these habits of mind, the workshop was structured as follows. Students needed to complete 11 labs and two mini-projects with oral presentation. The topics covered were 'Contrast enhancement', 'Noise reduction', 'Numerical analysis', 'Geometric shape recognition', 'Geometric transformation' and 'Object detection'. The labs were sequenced such that the content and skills required for the respective mini-projects were covered before the project tasks were revealed (see Fig. 1). The students needed to complete each mini-project individually within two hours and were given ten minutes to present.

The students were assessed based on three components: their class participation (20%), mini-project 1 performance (40%), and mini-project 2 performance (40%). In 'Class Participation', students were graded based on their Lab skills and confidence in using the software and computer; and their discipline and attitude in class. In each mini-project, the students were given on the spot a corrupted digital image to perform some processing to achieve certain outcomes, such as segmentation or numerical analysis, in sync with the typical industry problem statement. Students were graded on their algorithm, functionality and execution of the plugin and their oral presentation.

Figure 1: Timeline of the workshop.

Workshop Design (supporting Habits of Mind): Mishra, Koehler & Henriksen (2011) summarized the 13 traits of thinking by Robert and Michele Root-Bernstein (1999) into seven cognitive skills, also known as habits of mind. Three habits had been infused into the workshop design:

I. Patterning- The ability to recognize a pattern and construct new ones. By providing a pattern to the student, e.g. sentence structures used in oral presentation, we hope that once the students were comfortable with this pattern, they would be able to construct new one(s) (way(s) to articulate technical content).

II. Embodied thinking- The act of empathizing, or imagining oneself in another's position. When students devised their image processing algorithm and arrived at various outcomes, their peers were made to 'think in their shoes' and express (in English) why they think the algorithm was constructed in that particular manner.

Enabling with ICT tools

Each student was given both printed and electronic copies of the 'Student Guide Book', and all other materials, such as slides, presentation template, test images, source codes, etc, were uploaded in the Google Drive. Apart from these, four ICT-enabled activities were used in this workshop to support the above mentioned habits of mind: the use of online glossary and Padlet, viewing of annotated videos and noting asynchronous lecturer's feedback on video recordings via email.

The lecturer's intervention in curating and annotating the videos, and providing professional feedback on their evidences of learning, was deemed necessary as opposed to letting the students navigate and explore video content on their own. Erroneous content and overwhelming information can impede student learning. However, literature (Laurillard, 2012; Snelson et al., 2012) reported that such skills to be learnt intelligently via the online media require guidance and time to develop. Hence, the following said scaffolding was needed.

Online glossary and Padlet: Google Sheets were put in place for the lecturer and students to collaboratively build the image processing glossary where they would key in what they understood about the term (in both English and Japanese), the lecturer would then provide an audio link from the online Cambridge dictionary for each term for the students to learn the pronunciation, and also how these terms are commonly used in sentences. The Padlet was just an online bulletin board for students to post any queries real-time in class.

Video annotations: Web 2.0 tools such as YouTube and Vimeo, have been used in supporting learning in many contexts, such as to engage and motivate learners, transmit new knowledge, and addressing special education needs (Panopto, 2018). One advantage is their ability to perform annotation.

Video annotation refers to 'identifying specific time codes in a video as well as metadata, tags, and working notes associated with a particular selection, or clip, of video' (Bossewitch and Preston, 2011). Other innovative ways of using video annotations also include using them as evidences of the learners' skill and understanding in specific components, in particular to support the reflective practice (UCA Teaching & Learning Center, 2017; Pérez-Torregrosa et al., 2017).

In this study, the students were provided interactive annotated videos of how presentation of technical content could be done. Using the Edpuzzle platform, videos from YouTube were extracted. Annotations at different instances were inserted to make the students pause and take special note of the content and techniques that would follow suit. There were altogether 5 annotations in a video (see Fig. 2). The annotations highlighted to them what are some techniques that they could use in an oral presentation of technical content.

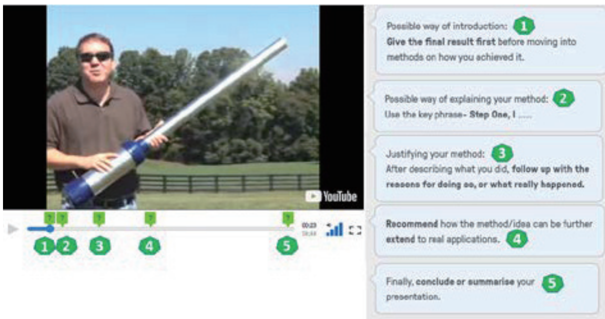


Figure 2: Snippet of the annotated video of "HowStuffWorks Videos How Engines Work" in Edpuzzle.

Video recordings (supported by asynchronous feedback): Complementary to video annotation, was to have the guest lecturer provide asynchronous feedback on the participants' first oral presentation for mini-project 1. This was done by first recording the students' performance on a mobile device and followed up with an individualized written feedback through email sent before the following day. The focus of the feedback was on self-perceived problems that the students had, using the data collected in the pre-workshop survey. As the mini-project 1 was completed in Day 3, the students had one day between reviewing their feedback and the following mini-project 2 (in Day 5). Since the workshop concluded in Day 5, the lecturer only provided her

Table 1. How habits of mind were supported with the ICT tools.

Habits of Mind	Video annotations	Video recordings
Patterning	Presenters are often required to explain their artefacts. The annotations provided a guide of the four general sections to cover, i.e. 'Introduction', 'Methodology', 'Results', and 'Recommendations/ conclusion'. Participants can thus recognise this 'pattern' of presentation and use it as a reference. Methodologies presented verbally often follows the 'pattern' of listing, e.g. using ordinal 'first, second, third…'. The video annotation highlighted this to the participants.	Although students had some prior experience in language-based subjects, they may not be aware that in oral technical presentation, it would be easier if they articulate in a more colloquial manner. Students reviewed their own recordings to check if they followed the 'pattern' too rigidly, such as listing in ordinal numbers. As EFL learners, their smooth delivery was hampered when trying to accomplish both proper 'pattern' and technical content articulation.
Embodied thinking	Although not implemented, students collaboratively annotate in videos helped in inculcating this habit. Some studies (Colasante, 2011; Lingard et al., 2015) used role modelling to let students construct their own meaning.	In class, the students were made to suggest why certain (algorithmic) decisions were made by the presenter.
Synthesizing	Not supported.	To optimise learning, some cognitive scientists suggested providing deliberate practice through well-defined task that is challenging yet achievable, and a platform that allows immediate feedback, corrections and repetitions (Ericsson, 1996; National Research Council, 2000). This is in nature 'synthesizing'. The asynchronous feedback before the next task (mini-project 2) allowed students to consolidate their reactions and experiences, and create the next artefact.

feedback on their second performance when she returned to Singapore.

With the tools and design already described and explained, we will discuss how they supported the habits of mind in Table 1 (in page 3).

Findings

The usage of the online glossary and Padlet were not high. The participants did not make use of the online dictionary, specially designed and implemented by the guest lecturer using the Google Sheet, as there were other similar tools that the students were more familiar with, such as the Google Translate. The initial intent to implement Padlet was to encourage the reticent (or reserved) or shy (or anxious) Japanese students (Anderson, 1993; Townsend & Danling, 1998) to 'ask' online anonymously. With this class, the Padlet was found to be redundant as they were able to speak up when in doubt. Henceforth the findings in this study will only reflect the impact of the two activities - video annotation and asynchronous lecturer feedback. Not only did their self-perceptions increased, their presentations and grades also improved.

Self-perception as a speaker: In Day 1, the 12 participants indicated their prior experience in presenting in English and what they perceived as their ability to present in English.

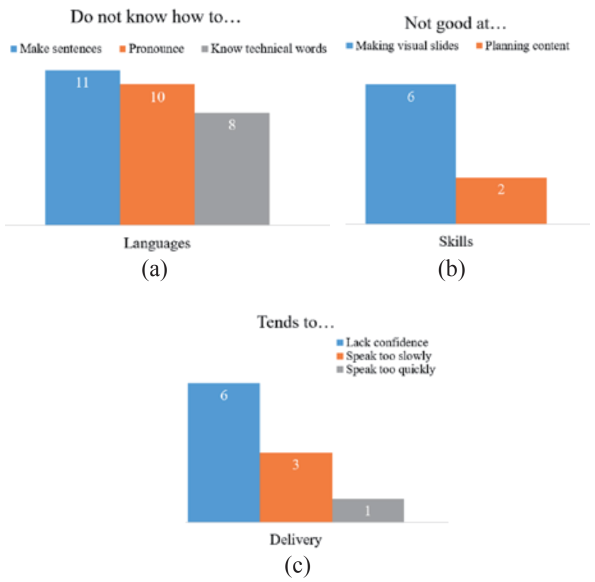


Figure 3: Problems anticipated by the students.

Of the 12 participants, only Participant 1 had presented formally in English for a non-language subject. She considered her next attempt would be 'poor' as she would require using notes, lack the right technical words to use and 'did not know how to make the right English sentences'. Eight others also predicted that their performance would be 'poor' because of limited language ability and vocabulary, the lack in ability to communicate message clearly and fluently. They also lacked confidence because of inherent shyness, memory lapses and nerves. Participant 5 and Participant 8 predicted 'satisfactory' presentations but highlighted the lack of training and nerves respectively as barriers. Participant 7 predicted an 'excellent' presentation because he had loved English. The overall anticipated problems were as firstly language- did not know how to make sentences, pronounce words and the technical words; secondly, skills- did know how to make visuals/slides and plan the content; and lastly, pace- lacked of confidence, spoke too fast, spoke too slow. See Figure 3 for tabulation.

Self-perception of Presentations 1 and 2: On Day 3, participants self-rated their first presentation performance. Only three participants 3, 4 and 6 rated themselves better, from previous 'prediction' of their performance of 'poor' to 'satisfactory', while Participant 7 downgraded him from previous 'excellent' to 'satisfactory'. The rest perceived themselves the same. On Day 5, nine participants rated themselves higher (five from 'poor' to 'satisfactory', and four from 'satisfactory' to 'good'), while three had unchanged rating (two at 'satisfactory' and one at 'poor').

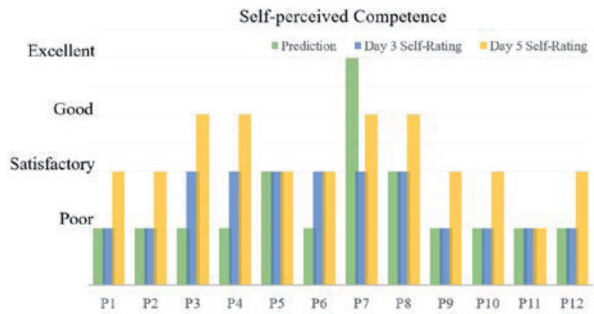


Figure 4: Self-perceived competence over the three settings.

Performance in Presentations 1 and 2 grades: Overall the participants did well. Their grades improved from their first presentation to the next presentation in both marks and grades. Presentation 1 grades averaged 75.83%, with a range of 65 to 90, while Presentation 2 grades averaged 82.08% with a range of 70 to 95. Participant 10 improved two grades (from 'C' to 'A+'), Participants 2, 9 and 11 improved from 'B' to 'A' grade and Participants 6 and 7 improved from 'C' to 'B' grade. Only Participant 3's grade slipped from 'A' to 'B'.

Lecturer's feedback: Based on the students' oral presentations, the guest lecturer did not find major problems in the quoted areas of difficulties, such as construction of sentences and pronunciation. On the contrary, the students were able to structure their sentences by using appropriate technical 'action' verbs, e.g. 'Run' 'Set' 'Get', 'Adjust', 'Apply', and 'Invoke'; and even include more sophisticated phrases to highlight causal relationships such as 'The reason for ...', 'The … provided…', 'If we do not perform…, it is not possible to …". Transitional words were also used to illustrate the sequence and list, such as ordinal numbers, 'Then' or 'Next'. These simple yet proper structures were able to effectively bring out the technical message, in particular the protocols and processes done for image processing. In terms of pronunciation, while not perfect, did not hinder the understanding of the presentation. The participants were sufficiently intelligible as the lecturer did not need require to view the text on the slides in order to understand them.

While participants rated themselves lower in their overall ability compared to their grades; what tallied with the tutor's rating and their self-perceptions was the lack of confidence in most of the presenters.

Discussion

The two best performers could converse casually in English, so they were able to articulate the technical content in English with a higher level of mastery as compared to the other students. The remaining did fairly well from the learning from video annotation, scaffolding of the activities such as first gaining experience through practice labs before moving into the mini-projects; providing presentation template, to the feedback that reinforced their concepts and boosted the confidence level. These various measures supported the autonomization of the students to work more effectively in their learning (particularly observed in Participant 10 as he researched on other different methods to present).

In addition, the results suggested that the students preferred to learn through examples and lecturer's feedback. Winne & Butler (1994) defined that 'feedback is information with which a learner can confirm, add to, overwrite, tune, or restructure information in memory, whether that information is domain knowledge, meta-cognitive knowledge, beliefs about self and tasks, or cognitive tactics and strategies' (p. 5740). However, literature evidences demonstrated that feedback can impact learning and achievement, both positively and negatively. How feedback is administered is then a concern. With the student-centric approach, Tan (2018) found that prompt, detailed and personalized feedback given by teachers on the formative assessments were very much appreciated by the students. Fang (2017) also found that students preferred feedback via technology from their tutor, compared to that of their peers/seniors.

The improvement in self-perceptions after this workshop appeared to be attributed to the increased awareness from the feedback. The feedback model adopted drew reference from the work of Hattie & Timperley (2007) to answer three questions for the students- 'Where am I going?', 'How am I going?' and 'Where to next?'. In lieu of the time-constraint (to turn over within a day), the feedback focused only on the 'Task (how well task is performed)' and 'Self (positive evaluations and affect about the student)'. The written feedback always began with 'I like that you …', followed by reinforcement of what went right, before concluding with how else they could further improve, to direct the praise to the effort, self-regulation, and processes relating to the technical presentation competencies.

One interesting observation was that the students perceived some improvement but were not fully aware of how well they improved, evident from the gaps in self-ratings versus actual grades. Thus in order to inculcate self-awareness in students, to identify their strengths and abilities, the lecturer has to step in to guide them, through e.g. the above-proposed feedback model. This is especially critical for EFL students who need to grow in confidence and develop a positive self-esteem.

On a final note, it was observed that the students were quite fixated with the recommended presentation structures (scaffolded through the video annotations and PowerPoint template). They tried to emulate the use of ordinal numbers or 'Step one', 'Step two', and so forth when articulating the image processing techniques involved. When the list grew long due to the complex image processing algorithm, they lost count and required pauses to recollect and continue. Henceforth while the structures served as a good anchor, for a more colloquial and natural delivery, this rigidity should be removed. Given more time, to allow students to become less dependent on these instructional scaffolds, they should be encouraged to practise in other technical tasks or contexts and be exposed to other options.

Conclusion

The KOSEN EFL students were exposed to their familiar technical context by solving workplace problems but were made to develop the habits of mind in the English medium. This was supported by ICT tools bearing the features of interactivity and autonomy. Although four tools were put in place, it seemed that only the video annotations along with the video recordings with feedback provided a greater positive impact on the students' motivation level and learning outcomes. Their self-awareness was heightened and showed improvement of technical presentation skills over the two sessions.

References

Anderson, F. (1993). The enigma of the college classroom: nails that don't stick up. In P. Wadden (Eds). *A Handbook for Teaching English at Japanese Colleges and Universities* (pp. 101-110). New York: Oxford University Press.

Bosswitch, J. & M. D. Preston. (2011). Teaching and Learning with Video Annotations. In R. T. Scholz (Eds)., *Learning through Digital Media: Experiments in Technology and Pedagogy* (pp. 179-183). New York: The Institute for Distributed Creativity

Colasante, M. (2011). Using video annotation to reflect on and evaluate physical education pre-service teaching practice. *Australasian Journal of Educational Technology*, 27(1), 66-88.

Ericsson, K. A. (1996). The acquisition of expert performance: An introduction to some of the issues. In K. A. Ericsson (Eds). *The road to excellence: The acquisition of expert performance in the arts and sciences, sports, and games* (pp. 1-50). Mahwah, NJ: Lawrence Erlbaum.

Fang, L. (2017, Sep). *Active listening: When feedback matters*. Paper presented at MMSEE (KAMALL-STEM-ATEM) Conference, Incheon, S. Korea.

Ferreira, D. (2013). Creating Communities: The L2 Self and ICT in an EFL Classroom. *Language Education in Asia*, 4(1), 88-98.

Hattie, J. & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, 77(1), 81–112.

Houcine, S. (2011, Oct). *The effects of ICT on learning/teaching in a foreign language*. Paper presented at 4th International Conference, ICT for Language Learning, Florence, Italy.

Koura, A. A. & Zahran, F. A. (2017). Using Habits of Mind to Develop EFL Writing Skills and Autonomy. *Arab World English Journal*, 8(4), 183-198.

Laurillard, D. (2012). *Teaching as a design science: Building pedagogical patterns for learning and technology*. Abingdon: Routledge.

Lingard, H., Pink, S., Harley, J. & Edirisinghe, R. (2015). Looking and learning: using participatory video to improve health and safety in the construction industry. *Construction Management and Economics*, 33(9), 740–751.

Mahfouz, S.M. & Ihmeideh, F. M. (2009). Attitudes of Jordanian university students towards using online chat discourse with native speakers of English for improving their language proficiency. *Computer Assisted Language Learning*, 22(3), 206-227.

Mishra, P., Koehler, M. & Henriksen, D. (2011). The 7 trans-disciplinary habits of mind: Extending the TPACK framework towards 21st Century Learning. *Educational Technology*, 51(2), 22-28.

National Research Council. (2000). *How People Learn: Brain, Mind, Experience, and School: Expanded Edition.* Washington, DC: The National Academies Press.

Okazaki, R. (2015). Five Japanese students' self-directed learning with ICT: An exploratory study. In P. Clements, A. Krause, & H. Brown (Eds). *JALT2014 Conference Proceedings* (pp. 606-617). Tokyo: JALT.

Panopto. (2018). *10 video trends you should know about that enhance the student learning experience.* Retrieved from https://www.panopto.com/blog/10-video-trends-that-can-enhance-the-student-learning-experience/

Patel, C. (2013). Use of multimedia technology in teaching and learning communication skill: An analysis. *International Journal of Advancements in Research & Technology*, 2(7), 116-123.

Pérez-Torregrosa, A-B. Diaz-Martin, C. & Ibáñez-Cubillas, P. (2017). The Use of Video Annotation Tools in Teacher Training. *Procedia - Social and Behavioral Sciences*, 237(1), 458-464.

Root-Bernstein, R.S, & Bernstein, M. (1999). *Sparks of genius: The thirteen thinking tools of the world's most creative people*. Houghton Mifflin: New York.

Snelson, C., Rice, K. & Wyzard, C. (2012). Research priorities for YouTube and video-sharing technologies: A Delphi study. *British Journal of Educational Technology*, 43(1),119-129.

Tan, Y-C. (2018). Student voices: Feedback that students want. *SingTeach*, 66. Retrieved from http://singteach.nie.edu.sg/issue66-contributions02/

Townsend, J. & Danling, F. (1998). Quiet students across cultures and continents. *English Education*, 31(1), 4-25.

UCA Teaching & Learning Center. (2017). *Video Annotation Guide.* Retrieved from https://uca.edu/music/files/2017/09/Intern-II-Video-Annotation-Guide.pdf

Winne, P. H. & Butler, D. L. (1994). Student cognition in learning from teaching. In T. Husen & T. Postlewaite (Eds). *International encyclopaedia of education* (pp. 5738-5745). Oxford, UK: Pergamon.

Zhao, Y. (2013). Recent developments in technology and language learning: Literature review and meta-analysis. *CALICO Journal*, 21(1), 7-27.

ONLINE COLLABORATIVE LEARNING: STUDENTS' PERCEPTION AND LEARNING EXPERIENCE - A MIXED METHODS STUDY

L. Cai*, C.H. Chye and Y.A. Fattah

School of Health & Social Sciences, Nanyang Polytechnic, Singapore

cheryl_cai@nyp.edu.sg*

Abstract

The purpose of this mixed methods study was to explore the perception and learning experience of nursing students undergoing online collaborative learning (OCL) in a Year 2 nursing module (HS2231) from a 3-year Diploma in Nursing course in a public polytechnic in Singapore. 192 of 325 students (95% confidence level) who were actively enrolled in the module participated in the survey. 18 students who completed the survey volunteered to participate in a Focus Group Discussion. OCL activities over 16 weeks were introduced during lectures and tutorials. The OCL activities included quizzes and discussion forum. A modified quantitative student perception survey was conducted at the end of 16 weeks. The survey form comprised 3 sections: student background information, learning experience in OCL, and satisfaction towards OCL. The Focus Group Discussion was guided by 3 standard questions: 1) How was your OCL experience? 2) What impact(s) your OCL experience? 3) What impact(s) your satisfaction with OCL? The analysis of quantitative data revealed that age, gender and prior clinical exposure in nursing were associated with their overall perception and satisfaction towards OCL. Three major and sub-themes deriving from factors that had critical impact on the students' OCL experience were identified via inductive approach during thematic analysis of the qualitative data: 1) students' individual characteristics, such as (a) perceived usefulness of OCL activities, (b) students' individual learning styles, and (c) students' motivation; 2) instructional design; 3) students' engagement. There was no evidence of correlation between students' perceived computing skills, country of origin and OCL experience and satisfaction. This study highlighted the impact of students' individual characteristics on learning experience, as well as the pertinent role of an educator in designing positive learning experience and facilitating students' active engagement. Further studies looking into how students' individual characteristics (such as age, gender, prior exposure/experience, learning styles, expectation, etc.) influence their satisfaction and experience in OCL will provide more insights for educators designing OCL activities.

Keywords: *Online collaborative learning (OCL), student engagement, learning experience, instructional design*

Introduction

Online collaborative learning (OCL) is a complex cognitive and social process (Macdonald, 2003). In today's world, learning no longer depends on individual knowledge acquisition, storage and retrieval (Magen Ngar & Shonfeld, 2018); rather, it is through interactions with various sources of knowledge such as synchronous and/or asynchronous participation in learning communities formed by people with common interest, group task and learning needs. Thus, if online learning is implemented, students' satisfaction ought to be considered when evaluating its effectiveness (Zhu, 2012). Understanding students' perception and learning experiences in OCL is, therefore, an essential and pertinent first step to enable educators to enhance and support students' learning experience.

In the School of Health and Social Sciences, the use of OCL activities helps educators overcome the physical and space constraint in lecture theatres with affixed rows of chairs and tables; enabling the possibility of collaboration in a lecture venue with more than 150 students. When bilateral real time feedback is facilitated in smaller classrooms, educators can spend more time responding to students' individual learning needs and queries.

Literature Review

OCL contributes to option building and expression in a platform where quantity, content and quality of interaction and participation are encouraged (Yucel & Usluel, 2016). The conversation, multiple perspectives and arguments among learners facilitate greater cognitive development than the same individual working alone (Gress et al., 2010). Besides, not only does OCL stimulate students' critical thinking and deepen the processing of subject matter, it facilitates opportunities in developing 21st Century Skill among students (Slof, Nijdam & Janssen, 2016; MOE, 2010). In a study (Kumi-Yeboah et al., 2017) on perception of students towards OCL activities, it was discovered that the OCL platform offers opportunities for minority students to take an active role in learning and discuss their life experiences and cultural backgrounds with classmates. Here, students from different cultural background have opportunities to work collaboratively with others, deepen their understanding of content and enhance their problem-solving skills; hence, better preparing them for their future career (Zhu, 2012; Margaliot et al., 2018). Moreover, OCL has been reported to be the pedagogy of choice in overcoming students' negative emotion in online learning (Lehman & Conceição, 2010; Turkle, 2012).

Undoubtedly, OCL may evoke negative emotions and experiences when learners feel conflicted between the opportunities of collaboration with others versus the outcome of collaboration (Capdeferrio & Romero, 2012). Example, a sense of ambivalence was reported among learners when they appreciated the opportunities of interaction and work with peers yet found their collaborative outcome to be less satisfying. Learners often feel reluctant to participate in OCL activities due to previous negative experiences such as unequal distribution of workload and unfairness in assessment (Harasim, 2012). Additionally, the difference in students' level of commitment towards OCL, the difference in students' contribution and the differing interpretation of contents were other main sources of frustrations reported by students (Capdeferro & Romero, 2012; Margaliot et al., 2018). In relation to the difference in students' contribution, perception of asymmetric collaboration among teammates was reported by students as the most significant source of frustration (Capdeferro & Romero, 2012). Other sources of frustration were related to group organization, lack of common goals among teammates, variance in the level of commitment and quality of contributions, conflict in reaching consensus, imbalance between individual expected mark and group mark and too much time spent on OCL tasks (Capdeferro & Romero, 2012; Margaliot et al., 2018).

Cultural difference in the learning experience of students from different background was also reported. When comparing Chinese and Flemish students, Zhu (2012) found that Flemish students spent more time in OCL and were more satisfied with the collaborative outcome. Although Chinese students spent less time in OCL, they were more satisfied with their group members' contributions. However, they were most dissatisfied with the lack of teacher guidance and interaction. It could be that minority students often feel marginalized as their comments and posts tended to be ignored by other students (Kumi-Yeboah et al., 2017) and teachers.

Although there have been numerous studies examining the process and effectiveness of OCL worldwide, there are limited studies examining students' perception of OCL and their OCL experiences in Singapore.

Purpose of Study

Hence, the purpose of this mixed methods study was to explore the perception and learning experience of students undergoing OCL in a 45-hour Year 2 nursing module (HS2231) from a 3-year Diploma in Nursing course over 16 weeks during lectures and tutorials in a culturally diverse public polytechnic in Singapore. With the result, the researchers hope to provide insights for educators to facilitate and enhance OCL experience among students from different background.

The study aims to answer these research questions:

1. What is the students' perception about OCL?
2. How are students' learning experiences in OCL platforms?

Data Collection

The study comprising an online survey and focus group underwent IRB approval. 325 students were enrolled in this module. Based on the Raosoft Sample Size Calculator, the recommended sample size for this study was 177 to achieve a 95% confidence level for generalizability of results. However, a total of 192 students participated in the online survey through purposive sampling; thereby meeting the required number of participants which met statistical significance for the quantitative component. Potential participants were briefed on the nature of the study and ethical considerations related to consent and assurance of anonymity and confidentiality.

A modified online survey form based on a validated OCL instrument from So and Brush (2008) comprising 3 sections covering 25 items - 6 items on student background information, 11 items on OCL experience and 8 items on satisfaction towards OCL – was used. Participation in the online survey was deemed as informed consent given by students. 18 out of the 192 students who completed the online survey volunteered to participate in the three Focus Group Discussion (FGD)s using an interview guide.

Each focus group discussion was facilitated by 2 educators who were not directly involved in the teaching and assessment of the participants and supported by another educator who acted as scriber. Consent and permission for audio and script recording of the FGD interviews were given by students. All audio and text data related to the FGDs were kept in the main researcher's working computer which was user ID, password protected and encrypted and locked in her office.

Data Analysis and Findings

Quantitative data

Participating students' demographic data is as detailed in Table 1:

Table 1: Participants' Demographic Profile (n = 192)

Gender		Age		Country of Origin	
Female	84.90 %	≤ 25 y.o.	70.31 %	Singapore	58.85 %
Male	15.10 %	> 25 y.o.	29.69 %	International	41.15 %
Years of Prior Clinical Exposure in Nursing			**Self-reported Level of Computing Skill**		
2 years & below		64.58 %	Intermediate & above		53.13 %
Above 2 years		35.42 %	Novice & below		46.87 %

Crosstabulation and Chi-Square were performed using SPSS 12.0. The Likelihood Ratio Chi-Square results were considered in view of the small sample size and the fact that more than 20% of cells have an expected count of less than 5 (Cohen, Manion & Morrison, 2011; Field, 2005). The result showed no significant association between students self-claimed computing skills, satisfaction with OCL and student's country of origin. However, the students' age, gender and prior clinical exposure in nursing showed significant association with OCL satisfaction. The result showed that students' age is associated with students' overall OCL satisfaction in terms of whether the learning activities and assignment of this module met their learning expectation, with $X^2(3\ df) = 7.852$ ($P<0.05$). A significant association between students' gender and their overall satisfaction with OCL experience is revealed with $X^2\ (4df) = 12.760$ ($P<0.05$). Students' prior clinical exposure in nursing was found to be significantly associated with their perceived effectiveness of OCL, with $X^2(4df) = 10.905$ ($P<0.05$).

Qualitative data

Audio data were transcribed verbatim by each researcher. The transcripts were then cross-checked and verified against the field notes taken during FGD interviews repeatedly until the accuracy of text data was agreed by all researchers. Each participant was given a pseudonym. The final text data were interpreted back-and-forth by the researchers independently until data was merged and themes were emerging. An inductive thematic approach of qualitative data analysis was employed to: 1) condense the raw data into a summary of findings; 2) develop an in-depth and structured understanding of the underlying perception and experience of the students (Thomas, 2003; Cohen et al., 2011). The emerging themes were interpreted and analysed repeatedly until three major and sub-themes deriving from factors that had critical impact on the students' OCL experience were identified: 1) students' individual characteristics, such as the (a) perceived usefulness of OCL activities, (b) students' individual learning styles, and (c) students' motivation; 2) instructional design pertaining to the structure of the collaborative process, activities and content, and the functionality of the OCL platform; 3) students' engagement and perceived contributing factors such as the facilitators' openness and engagement techniques, peer pressure and the class dynamic.

<u>Theme 1:</u> Students' individual characteristics

The first important contributing factor frequently referred to by students when sharing their OCL experience was the individual characteristics of students and the fact that everyone was different.

Subtheme 1a: Perceived usefulness of OCL activities

Regardless of whether the OCL activities were quizzes or discussion forum, students appreciated OCL when the benefits and participation in OCL activities were clearly linked. They shared that OCL discussion forum helped them develop critical thinking and construct mind mapping, and the OCL quizzes prepared them for assessment. As what student C3 shared: "*I enjoy this (OCL discussion board) because it is a summary of everything you need to know. Lecture notes is boring because you see the 6 slides every page, with this (OCL discussion board), I get to explore more into the topic, it covers more than what is written in the lecture notes*." "*It (referring to online collaborative discussion board) helps summarize the entire topic, can cover & explore more than what is required in workbook*." Student B4 shared a similar sentiment and the reason for it: "*I can see what I have missed out, what other people have contributed….to know if I am in the right track*."

Some students saw the extended benefits of OCL beyond its desired outcome and applied their OCL experience in other areas: "*It helps us overcome language barrier, especially our international students*." (student B2) Student B1 added: "*The platform is very helpful, and my group borrowed the idea for our project work (in another module)*." One student even suggested that OCL activities should have been started earlier, such as for the first-year students and she explained that "*it will be good if this (OCL) starts in year 1 so that they can adapt to it earlier*." The rest of the participants were nodding their heads in agreement as she suggested this.

Subtheme 1b: student's individual learning style

According to Kolb and Kolb (2005), students learn differently in the given context as each student has his/her preferred learning style - either diverging, converging, assimilating, or accommodating. The student's individual learning style clearly had an impact on how they perceived OCL activities. For instance, Student C1 with an obvious diverging learning style appreciated various perspectives from other student collaborators: "*There are some interesting sharing, and not all can be found in lecture notes, some really share very detailed information from their experience*." Whilst Student C3 with accommodating style enjoyed the new ideas differently when collaborating with others and found challenging experience in OCL activities interesting: *"I enjoy this (OCL discussion board) because it is a summary of everything you need to know. Lecture notes is boring because you see the 6 slides every page, with this (OCL discussion board), I get to explore more into the topic, it covers more than what is written in the lecture notes*." Similarly, in a study comparing the impact of OCL and face-to-face learning, Rapchak (2018) noticed that although there is no marked difference, visual learners have a greater perceived learning experience through OCL than verbal learners.

Subtheme 1c: Students' motivation

In OCL activities, although the same sets of activities and instructions were given to all students, students' participation in the OCL activities varied, so did their expressed rationales in participating. Student C3 stated that "*when students are naturally motived, they are motivated regardless whether there is class active participation point or not*." Although intrinsic motivation plays an important role in self-driven students, the external rewards seemed to be a common drive for students as well: "*Award student class active* *participation (with point) based on what each member has contributed*". As Student A2 suggested this, the other students were nodding their heads. Although having a different perspective on motivation, Student A5's rationale was similar to Student C3 as both touched on the self-determined theory about self-regulatory mechanism: "*Some students don't participate, you reward or don't reward, they don't care about their grade because they are told to come to study, not because they are interested (in what they are studying)*."

Online anonymous collaboration was a more acceptable approach by students who were introverted and shy. They were no longer worried about how their peers perceived them and did not feel fearful of being wrong as the online input was not revealing the contributor's identity. Student *A5 shared:* "*Anonymous online collaboration is better for introvert type of students to participate and share…. Some students may be too shy or quiet, some are afraid of not being acknowledged by others or not supported by others, fear of not be agreeable by others.*" However, the disadvantage of anonymous online contribution was also pointed out, as Student B1 stated: "*because it is anonymous, so you won't tell who has contributed and who has not, so some people will not contribute & you won't know who*." The disadvantage of anonymous practice may discourage those who needs to be rewarded to participate in OCL activities.

Theme 2: Instructional design

The second important contributing factor towards students' learning experience in OCL was instructional design. This was very much impacted by (a) the structure of the collaborative process, (b) activities and content, and (c) functionality of the OCL platform; frequently mentioned by students from all three FGDs. As much as they appreciated how OCL activities helped them with their learning and assessment, they suggested the collaboration to be well structured so that students were clear of their roles; activities and content to be relevant and easily accessible, stimulating and not restrictive; design to be intuitive and user-friendly. They appreciated the online collaboration and related face-to-face session to be a continuum. Student C3 shared that "*when the task is given to all in general and not targeting at anyone, no one will do it because we will tend to rely on each other. But if it is assigned specifically, they will have to do it*." She suggested that "*one of the group members should be informed to update the changes as lecturer is going through so that the whole class will get the updated and correct information…*". Student A5 suggested to "*put a link at Blackboard (School Learning Management System) for students to access to Padlet, after tidying up the answers and consolidate the answers at Padlet (online collaborative board) for easier reference in future*."

Theme 3: Students' engagement

Students' engagement was impacted by (a) facilitators' openness and engagement techniques, (b) peer pressure and the (c) class dynamic. The roles played by facilitators and peers were perceived to be important contributing factors towards students' learning experience in OCL environment. Students shared that their interest to participate in the activities, to a certain extent, depended on the facilitator's facilitation skills, body language, attitude towards OCL and openness to new ideas. Whilst the influence of peers could either push them away or pull them towards engagement in the activities, depending on the class dynamic. Student A5 commented that his willingness to participate in collaborative activities "*depends on the lecturer's body language, mood, the way the lecturer presents self. When the teacher is interesting and open to different opinions, we feel more willing to participate. When the teacher is boring and very textbook style, we don't feel like participating. It really depends on the teacher's style.*" He pointed out the advantage of practising real name online contribution as "*when students are supposed to put down their name, everyone can see who has contributed and who has not, so for those who have not contributed, they will feel the peer pressure to contribute.*" Whilst, Student A2 felt the challenge during collaboration: "*Team dynamic and personality difference among the group members can be a challenge when they don't agree with other's point of view*."

Discussion

Students encountered different learning experience depending on their individual characteristics, such as their perceived usefulness of OCL, level of motivation and learning style. The qualitative data correlated with the quantitative data suggesting that students' age, gender and prior clinical exposure in nursing were associated with their overall perception and satisfaction with OCL. It can be explained that the age, gender and past experiences may, in a way, engender what the students expected from OCL, and how they interacted during OCL and managed OCL contents and activities. Whether students were satisfied with their OCL experience or not, were dependent on whether there was a satisfying match between what they expected from OCL and what they perceived participation in OCL could benefit them. The student's personal learning experience and level of satisfaction with OCL was a collaborative result of individual characteristics and level of engagement.

Similar findings suggesting the impact of students' individual characteristics on students learning experience and level of satisfaction with OCL were reported by other studies. Sun et al. (2008) found that students' satisfaction with OCL was significantly related to their perceived usefulness of online learning and instructor's attitude towards online learning. Additionally, Chen et al. (2009) and Zhu (2012) found that students' employment, social background and ethnicity had significant effect on students' online learning engagement. Four contributing factors to students' experience in OCL were identified: (1) students' confidence level in the online task and language; (2) poor instructional design; (3) poor facilitation skills of instructors; and (4) inadequate or lack of confidence with technological skills to participate in online collaborative activities (Jung et al. 2012).

Furthermore, "differences in types of extrinsic motivation were associated with different experiences and outcomes" (Ryan & Deci 2000, Pg. 73).

Students' individual characteristics may not be an easy subject for educators to intervene. However, students' learning experience can be engineered. A high quality OCL not only encourages students' active participation and in-depth exchange of ideas in an online learning community, but also facilitates positive learning outcomes (Nurmela et al., 2003; Carver, Mukherjee & Lucio, 2017; Magen-Nagar & Shonfeld, 2018). For example, linking OCL activities to student assessment can be an external motivator for students to participate actively but it can be perceived as additional stress by them too (Macdonald, 2003). While students may enjoy embracing technology, they may also experience challenges and negative emotions that are unique in a technology-aided learning environment at the same time. Therefore, when students face unique challenges and negative learning experiences, it is critical for educators to reflect on our practices and embrace new ideas and strategies that support students in their learning journey. An open and respectful OCL atmosphere is linked with teachers being able to recognize the benefits of OCL such as students' better understanding of the material and developing higher order thinking. Openness and desire to understand and accept other people and culture prepare lecturers and students alike to embrace OCL more readily (Magen-Nagar & Shonfeld, 2018). According to Ryan and Deci (2000), educators need to create a learning environment that enables students to feel belongingness and connectedness with the peers, and provide them opportunities to taste success and competence. It helps students not only develop more positive and constructive coping styles in facing challenges, but also facilitate willingness to spend and extend more effort in what they are doing.

Educators' ability to interact with students online is a crucial contributing factor to student satisfaction in OCL environment. The study by Demmans et al. (2017) revealed that instructor-facilitated online courses promoted a stronger sense of community. Students' sentiment, expression of emotion and learning behaviours were influenced by instructor behaviour. Correspondingly, lack of instructor support/orientation was reported to be one of the sources of frustration faced by the students as well.

Besides cultivating a positive and open learning environment, and interact constructively with students, educators are also expected to provide feedback to help identify the gap between students' achievement and the desired outcomes. Feedback can be during and after online work and is two-fold. Firstly, the instructor provides feedback to students to enable them to know if they are on the right track. Secondly, the instructor contributes to the study content, academic task and the social sharing that aims to develop knowledge (Margaliot et al., 2018). As much as researchers are highlighting the important role of educators in providing feedback that helps students improve, the fact that students' responses to instructor feedback vary makes instructor feedback equally challenging for instructors and students alike. Some students may feel motivated upon receiving feedback from instructors, others may feel otherwise. Kluger and DeNisi (1996) suggest that instructor's corrective feedback may increase or decrease students' motivation depending on the content and context. This similarly applies to online and face-to-face learning environment.

The influence of peers on students' learning experience is another finding in this study. Peer pressure and class dynamic positively or negatively affecting how students participate in OCL activities resonated with students' individual characteristics. According to social constructivism, the contextual and human factors are the two grounding elements when students are interacting and exchanging ideas in the learning community (Brady, 2006). A case study by Waugh and Su (2016) revealed that a positive and supportive working relationship with group members is a common sentiment shared by students who successfully completed an online course. Likewise, another study noted that group activity had a strong impact on satisfaction whilst instructor feedback had a moderate impact on students' learning progress (Ku et al. 2013). From a cultural perspective though, misunderstanding among students from different ethnic background has been reported (Shonfeld et al., 2013).

Conclusion and Recommendation

In conclusion, by understanding what students expect from OCL, what enhances their learning experience and encourages engagement in OCL activities, educators can be better informed and, therefore, enabled towards designing more effective and engaging instructional design. However, OCL alone does not engender effective group learning (Rapchak, 2018). This study highlighted the impact of students' individual characteristics on learning experience, as well as the pertinent role of an educator in designing positive learning experience and facilitating students' active engagement. Although students' tendency to receive instructor feedback and perception of teaching presence offer strong prediction of student motivation to learn in online courses (Cole et al., 2017), the fact that students who participated in online collaborative tasks reported higher level of satisfaction with OCL than students who did not (Zhu, 2012) makes students' learning experience and related satisfaction level multifaceted. This makes learning experience design even more complicated in Singapore when students are culturally diversified (Zhu, 2012; Shonfeld et al., 2013; Kumi-Yeboah et al., 2017; Magen-Nagar & Shonfeld, 2018).

Educators need to be aware that a learning environment that is supportive of fulfilling and satisfying students' basic needs for competence, autonomy, and relatedness is pertinent for students to experience an ongoing sense of well-being (Ryan & Deci, 2000). In higher education institution where students are from diverse background, more effort is needed to foster an inclusive learning environment so that the learning needs and styles of students of different age, experience, educational and cultural background can be supported. The usefulness of OCL activities needs to be made more explicit, such as linking OCL activities to student assessment as suggested by Macdonald (2012). Further studies looking into how students' individual characteristics influence their satisfaction and experience in OCL will provide more insights for educators designing OCL activities.

REFERENCES

Brady, L. (2006). *Collaborative Learning in Action.* NSW: Pearson Education Australia.

Capdeferro, N., & Romero, M. (2012). Are online learners frustrated with collaborative learning experiences? *The International Review of Research in Open and Distance Learning, 13*(2), pp. 26-44.

Carver, L. B., Mukherjee, K., & Lucio, R. (2017). Relationship between grades earned and time in online courses. *Online Learning, 21*(4), 303-314.

Chen, P.S.D., Lambert, A.D. and Guidry, K.R. (2009). Engaging online learners: the impact of web-based learning technology on college student engagement. *Computer & Education, 54,* 1222-1232.

Cohen, L., Manion, L. & Morrison, K. (2011). *Research Method in Education* (7th ed.). Routledge: New York.

Cole, A. W.; Allen, M.; Anderson, C.; Bunton, T.; Cherney, M. R.; Draeger, Jr., R.; Featherston, M.; Fisher, V. C.; Motel, L.; Nicolini, K. M. & Peck, B. (2017). Student predisposition to instructor feedback and perceptions of teaching presence predict motivation toward online courses. *Online Learning, 21*(4), 245-262.

Demmans Epp, C., Phirangee, K. & Hewitt, J. (2017). Student actions and community in online courses: The roles played by course length and facilitation method. *Online Learning, 21*(4), 53-77.

Field, A. (2005). *Discovering Statistics Using SPSS* (2nd ed.). SAGE: London.

Gress, C.L.Z, Fior, M., Hadwin, A.F. & Winne, P.H.(2010). Measurement and assessment in computer-supported collaborative learning. *Computers in Human Behavior, 26*, 806-814.

Harasim, L. (2012). *Learning theory and online technology: How new technologies are transforming learning opportunities*. New York, NY: Routledge Press.

Jung, I.S., Kudo, M., & Choi, S. (2012). Stress in Japanese learners engaged in online collaborative learning in English. *British Journal of Educational Technology*. DOI: 10.1111/j.1467- 8535.2011.01271.x

Kolb, A.Y. and Kolb, D.A.(2005). Learning styles and learning spaces: enhancing experiential learning in higher education. *Academy of Management Learning & Education*, 4(2), 193-212.

Ku, H-Y., Tseng, H. E., & Akarasriworn, C. (2013). Collaboration factors, teamwork satisfaction, and student attitudes toward online collaborative learning. *Computers in Human Behavior, 29,* 922–929.

Kumi-Yeboah, A., Dogbey, J., & Yuan, G. (2017). Online collaborative learning activities: The perceptions of culturally diverse graduate students. *Online Learning, 21*(4), 5-28.

Lehman, R. M., & Conceição, S. C. O. (2010). *Creating a sense of presence in online teaching: How to "be there" for distance learners*. San Francisco, CA: Jossey-Bass.

Macdonald, J.(2003). Assessing online collaborative learning: process and product. *Computer & Education, 40,* 377-391.

Magen-Nagar, N., & Shonfeld, M. (2018). Attitudes, Openness to Multiculturalism, and Integration of Online Collaborative Learning. *Educational Technology & Society, 21* (3), 1–11.

Margaliot, A., Gorev, D. & Vaisman, T. (2018). How student teachers describe the 0nline collaborative learning experience and evaluate its contribution to their learning and their future work as teachers, *Journal of Digital Learning in Teacher Education, 34*(2), 88-102.

Ministry of Education (2010). Teaching and learning of 21st century competencies in schools. National Institute TE21 Summit, Singapore.

Nurmela, K., Palonen, T., Lehtinen, E., & Hakkarainen, K. (2003). Developing tools for analysing CSCL process. In B. Wasson, S. Ludvigsen, & U. Hoppe (Eds.), *Designing for Change in Networked Learning Environments* (pg. 333-342). Dordrecht, The Netherlands: Kluwer.

Rapchak, M.E. (2018). Collaborative learning in an information literacy course: the impact of online versus face-to-face instruction on social metacognitive awareness. *The Journal of Academic Librarianship, 4*, 383-390.

Raosoft Sample Size Calculator. Retrieved from http://www.raosoft.com/samplesize.html

Ryan, R.M. & Deci, E.L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68-78.

Shonfeld, M., Hoter, E., & Ganayem, A. (2013). Israel: Connecting cultures in conflict. In R. Austin & B. Hunter (Eds.), *Online learning and community cohesion: Linking schools* (pp. 41–58). New York, NY: Routledge.

Slof, B., Nijdam, D., Janssen, J. (2016). Do interpersonal skills and interpersonal perceptions predict student learning in CSCL-environments? *Computer & Education, 97*, 49-60.

So, H.J. and Brush, T. A. (2008). Student perceptions of collaborative learning, social presence and satisfaction in a blended learning environment: relationships and critical factors. *Computers & Education, 51*, 318-336.

Sun, P. C., Tsai, R. J., Finger, G., Chen, Y. Y., & Yeh, D. (2008). What drives a successful e- Learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education, 50*(4), pp. 1183-1202.

Thomas, D.R. (2003). A general inductive approach for analysing qualitative evaluation data. *American Journal of Evaluation, 27(2*):237-246.

Turkle, S. (2012). *Alone together: Why we expect more from technology and less from each other*. New York, NY: Basic Books.

Waugh, M.L. & Su, J. (2016). Student perceptions of a successful online collaborative learning community. *Journal of Interactive Online Learning, 14*(1), 1-17.

Yucel, U.A. & Usluel, Y.K. (2016). Knowledge building and the quantity, content and quality of the interaction and participation of students in an online collaborative learning environment. *Computer & Education, 97*, 31-48.

Zhu, C.(2012). Student satisfaction, performance, and knowledge construction in online collaborative learning. *Educational Technology & Society, 15*(1), 127-136.

A Blended Remote Learning Approach in Electronics Technology Module

Andy Lee Chung Hong

School of Engineering, Ngee Ann Polytechnic, Singapore

lac5@np.edu.sg

Abstract

Since 2015, Ngee Ann Polytechnic (NP) has adopted Remote Learning (RL) by offering online learning in all diploma courses with the intent to develop digital literacy in learners, build the habit of self-directed and life-long learning, which are aligned closely with NP's graduate competencies. The institutional goal is to provide students with online learning experiences in at least 7 core modules (six modules with 25% RL and one module with 100% RL) by 2019. These RL experiences will replace face-to-face lessons with students learning online, leveraging on the affordances of infocomm technology (ICT) tools.

This paper presents the design and implementation of RL in Electronics Technology module in the Diploma of Automation and Mechatronic Systems (AMS) and Diploma of Mechanical Engineering (ME). This paper also shares the RL design considerations that would ensure students are provided with sufficient opportunities to be actively engaged with the content and receive timely feedback on their conceptual understanding of the module. The RL is implemented through a variety of interactive videos, embedded SCORM[1] compliant quizzes and virtual bulletin boards for backchannel discussion. Students interacted with the RL content prior to class which allows more time for practice and application during the face-to-face lessons. In addition, the concrete demonstrations of physical electronics circuits were implemented in RL to bridge students' difficulties in learning abstract concepts.

Reviews of the RL implementation including challenges and effectiveness of the RL experience are discussed in the paper. The RL surveys and focus group discussion concluded that through the implementation of RL, the learners not only acquired useful skills and knowledge, but also stretched their thinking in the process. All these lead to a good and effective learning experience.

[1] SCORM stands for Shareable Content Object Reference Model.

Keywords: *Remote Learning, Online Learning, Online Assessment, Infocomm Technology, Instructional Design*

Background

The Electronics Technology module is offered to the students of the Diploma of Automation and Mechatronic Systems (AMS) and Diploma of Mechanical Engineering (ME) in Ngee Ann Polytechnic (NP). This module focuses on providing fundamental knowledge of analogue and digital electronics circuits design concepts. The knowledge and skills learnt in this module prepare students for subsequent modules such as Industrial Automation, Mechatronics Design Practice, Microcontroller and Interfacing. Prior to this module, students would have acquired some foundational knowledge of the topics through the pre-requisite module called Electrical Technology in the previous semester.

Although students come with some prior knowledge of the topics in the Electronics Technology module, many of them still find the module challenging. Firstly, the module contains concepts that are too abstract for students to grasp without strong electrical circuits fundamentals from their pre-requisite module. Students who were weak in the pre-requisite module would find the Electronics Technology module even more difficult to understand. Another challenge for students is that they need to be conversant between different number systems, such as Binary, Decimal and Hexadecimal which can be confusing for them. Finally, students would also need to interpret complex design problems and apply the appropriate electronics concepts learnt in this module to solve the problems, which they found challenging to do so due to their lack of understanding of the concepts. All these contribute to a steep learning curve for the students.

In the past, Electronics Technology module was taught with an emphasis on abstract declarative knowledge. Students' understanding was also tested declaratively through summative assessment (tests and exams). The module teaching team came to realise three shortcomings of overemphasising declarative knowledge in the module:

a) Lecturing and teaching declarative knowledge to students is not making the best use of face-to-face class time as these teaching activities could be done outside class time through Remote Learning (RL), thus freeing up class time for students to deepen their learning by applying the concepts learnt in solving complex design problems.

b) Students were unable to receive immediate help when they encountered difficult concepts while attempting tutorial questions outside class time. This would hinder their learning progress and sometimes students chose not to seek the lecturer's help later as they had either forgotten about their difficulty or copied the solution from their peers.

c) As future engineers, students not only need to have declarative knowledge but also the ability to apply the knowledge effectively to design circuits or solve problems (functioning knowledge). An over emphasis on declarative knowledge has led to students not being sufficiently prepared to demonstrate their functioning knowledge.

In order to resolve these shortcomings, the module teaching team adopted RL as a blended learning approach, whereby students receive declarative knowledge through RL before their face-to-face lessons. The objective of introducing RL is to enhance the students understanding of concepts and theories, and free up class time for active classroom participation which results in better student engagement in learning. The RL learning activities were designed to be experiential, interactive and engaging. This learner-centred learning approach encourages students to take responsibility for their own learning and develop a habit of self-directed learning, which are aligned with NP's graduate competencies.

Designing & Implementing the RL experience

The RL was designed as a self-paced learning lesson for students to learn anytime and anywhere. The underlying principles of learning in RL was adapted from Mayer (2002), which cited three critical components of learning:

a) Learning is a *process*, not a product. Since learning takes place in the mind, we can only infer that it has occurred from students' products and performances.

b) Learning is not something done to students, but rather something students themselves *do*. It is the direct result of how students interpret and respond to their experiences – conscious and unconscious, past and present.

c) Learning involves *change* in knowledge, beliefs, behaviours or attitudes. This change unfolds over time.

Learning is a process: Organising content for making connections

Students naturally make connections between pieces of knowledge, including their prior knowledge. When those connections form knowledge structures that are accurately and meaningfully organised, students are better able to retrieve and apply their knowledge effectively and efficiently. In contrast, when knowledge is connected in inaccurate and random ways, students fail to retrieve or apply it appropriately. Hence, RL content must be meaningfully organised for effective learning as shown in Figure 1. RL content should also be chunked into manageable segments and thoughtfully organised.

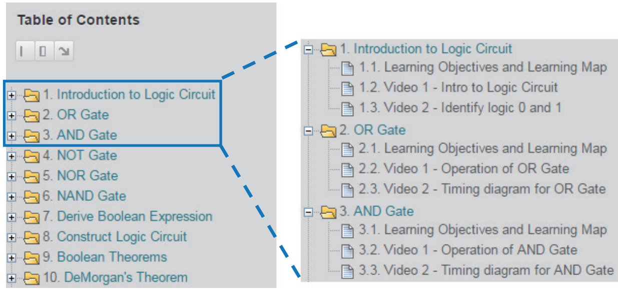


Figure 1: RL content was chunked into manageable segments and meaningfully organised

Learning is something students themselves do: Scaffolding learning & backchannels communication

Learning and performance are best fostered when students engage in RL activities that target an appropriate level of challenge or at the learners' zone of proximal development (Vygotsky, 1978). The zone of proximal development refers to the difference between what a learner can do without help and what he or she can achieve with guidance as shown in Figure 2. Vygotsky believed that when a student is in the zone of proximal development for a particular task, providing the appropriate assistance will enable students to achieve the task.

	Zone of proximal development	
What leaners can do unaided	Skills too difficult to master by learners on their own, but can be done with guidance	What learners cannot do

Figure 2: Zone of proximal development

In RL, hints were embedded in quizzes and interactive videos to provide scaffolding to students in attempting complex activities or difficult questions as illustrated in Figure 3. In addition, these interactive videos and quizzes provided useful formative feedback and concept consolidation to learners.

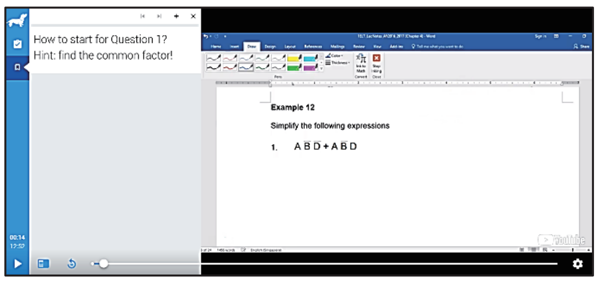


Figure 3: Hints were given to learners in attempting difficult questions.

Backchannel communication is another tool that was used to provide students a platform to seek guidance from their lecturers when they faced an issue during RL and also to learn from their peers.

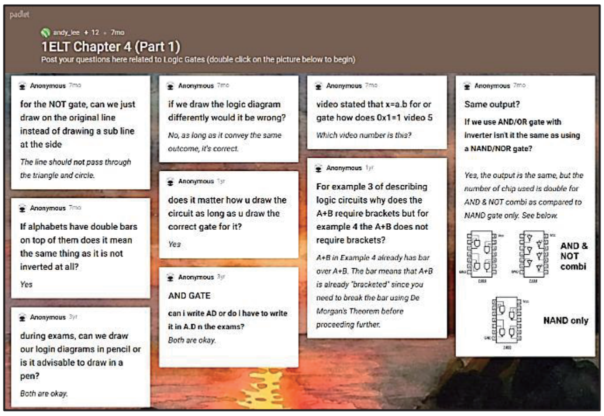


Figure 4: Backchannel communication using Padlet

At the end of every RL segment, students can post questions on Padlet to clear their doubts and seek clarification on concepts that they find challenging to grasp. While students may not be able to solve the problems they face in lessons or understand the content by themselves, Padlet provides that platform where they are able to learn by reading resources from their peers or lecturers. An example of the Padlet is shown in Figure 4, where there are opportunities for students to share their own knowledge, clarify understanding or extend their learning from the new knowledge shared.

Learning involves change in knowledge, beliefs, behaviours or attitudes: Leveraging on Predict-Observe-Explain Process and Simulations

Feedback from students show that some concepts in the Electronics Technology module was considered too "abstract" to grasp. Learning these abstract concepts through didactic lectures did not help students to learn effectively as they tend to memorise and regurgitate content that they cannot understand. Bruner (1966) proposed allowing students to interact with concrete examples first before introducing the abstract concepts to enhance learning. This allows students to construct new knowledge and grasp the new abstract concepts better as how Bruner (1966) puts it, "To learn, in short, is to learn how things are related".

Predict-Observe-Explain Process

The Predict-Observe-Explain process (White & Gunstone, 1992) was used as an instructional strategy for students to engage with the content and to construct their knowledge based on their concrete observation in the RL experience. This process improved the level of interaction for students from just watching a video to actually using information from the video to explain concepts. For example, students were shown a video on a diode circuit connected in forward bias and the light emitting diode (LED) lit up as shown in Figure 5. Subsequently, students were asked to Predict, Observe and Explain as follows:

a) Predict - students were then asked to predict what will happen when connection of the diode is flipped (polarity reversed)
b) Observe - students observed in the video demonstration what happens to the LED when the diode is flipped.
c) Explain – students reflected and explained their observation. If their prediction was different from their observation, students needed to form new ideas to bridge the inconsistencies.

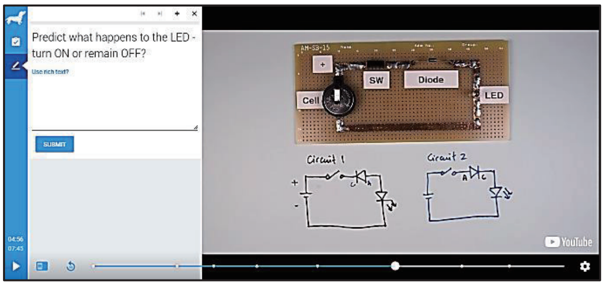


Figure 5: Instructional video on diode circuit incorporating Predict-Observe-Explain strategy

In the Explain stage, students were provided with two kinds of resources to help them form the correct ideas in explaining their observation:

a) Optional resources – for students to recap the concepts they have learned as shown in Figure 6.
b) Compulsory resources – for students to learn new abstract concepts, without which, students will not be able to form the correct explanation to their observation.

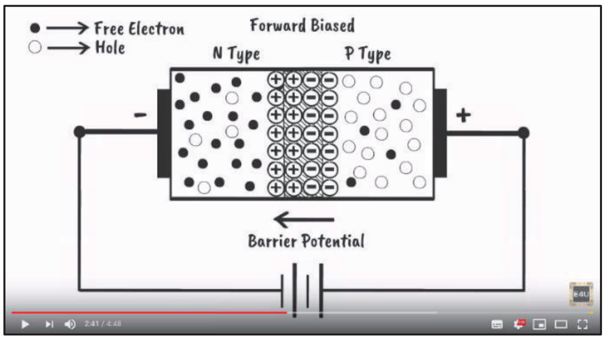


Figure 6: Optional video for students to recap the concept they have learned on diode biasing

After the students have keyed in their explanation, the remaining part of the instructional videos concluded with the correct explanation for the observation. This is an important feedback to the students to check if their understanding is correct and to have their misconception clarified immediately after their learning experience.

When leaners are exposed to a stimulus in RL before their face-to-face lesson (for example, experiencing a visual stimulus of a diode circuit lighting up a LED), their memory or recall of that stimulus is improved due to their previous experience with that stimulus. Hence, when students come for the face-to-face lessons after experiencing RL, they are primed to learn the content more effectively as they apply and deepen their existing knowledge through more challenging learning activities. With RL, students learning involves a change in their knowledge, behaviours and attitudes as illustrated in Figure 7.

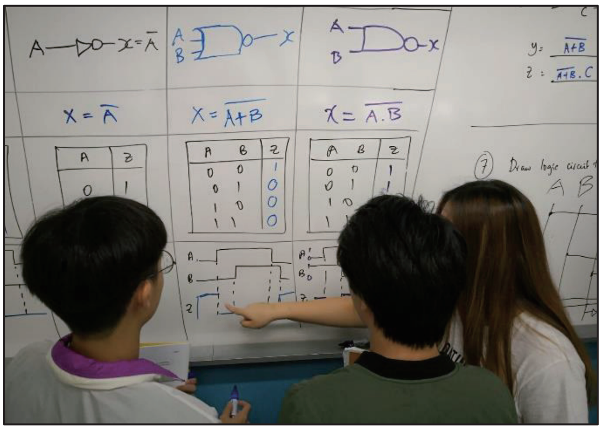


Figure 7: Students were more engaged in active discussion during face-to-face lessons after completing their RL

Simulation

The use of Simulation is another way in which students experience learning in a more "realistic" manner where they are able to see the theories come together in practice, which in many ways change how students perceive content and knowledge. In this RL experience, students were given learning activities to design a variety of circuits. For example, as shown in Figure 8, students were tasked to design a counter circuit to count down from decimal numbers 13, 12, 11 and all the way to 6. Students brainstormed circuit design ideas on paper, and they needed to test their circuit design to validate if their counter circuit meet the specification of counting down from 13 to 6. Hence, circuit simulator was used by students in RL to verify if their counter circuit can perform as intended.

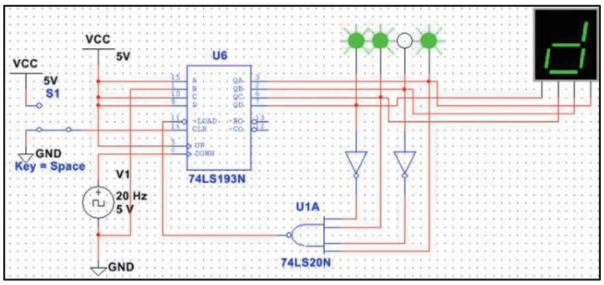


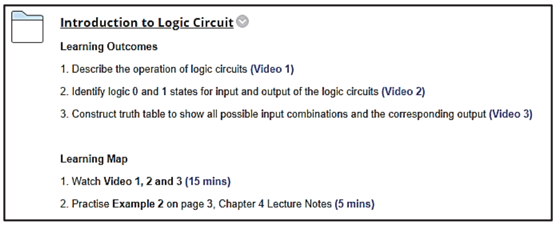
Figure 8: Counter circuit simulation

Circuit simulator provides a good resource for students to check their own understanding of circuit design. Using the simulator output results, students can make sense of what went wrong with their initial design, correct the design and run the simulation again to check. Clear and detailed instructions were given to students to submit in LMS – screenshots of all their design versions and reflection on what went wrong in their previous design as evidence of their learning and for lecturers to provide feedback. This simulation approach helped students to analyse and solve problems, which are important skills for engineers to hone.

Designing the RL Assessment: Ensuring Constructive Alignment

RL has been thoughtfully designed to allow students to engage in the learning and to meet the learning outcomes of the modules. However, it is the assessment tasks that will indicate how effective the RL experience has been in achieving the stated learning outcomes. If assessment is not aligned to the learning outcomes or teaching activities that do not encourage the appropriate learning activities to meet learning outcomes, students can easily 'escape' by engaging in unsuitable learning activities, which will not lead to deep learning (Biggs & Tang, 2011).

In constructive alignment (Biggs & Tang, 2011), the word 'constructive' refers to constructivist theory, which suggests that students must construct their knowledge as interpreted through their own existing schemata, rather than passively received learning. 'Alignment' refers to the explicit linkages of learning activities and assessment tasks to promote the attainment of the learning outcomes. Hence, for constructive alignment in RL, the learning activities were mapped to the learning outcomes and made known to the students using a simple learning map as shown in Figure 9.



Introduction to Logic Circuit

Learning Outcomes

1. Describe the operation of logic circuits (Video 1)
2. Identify logic 0 and 1 states for input and output of the logic circuits (Video 2)
3. Construct truth table to show all possible input combinations and the corresponding output (Video 3)

Learning Map

1. Watch Video 1, 2 and 3 (15 mins)
2. Practise Example 2 on page 3, Chapter 4 Lecture Notes (5 mins)

Figure 9: Learning outcomes and learning activities mapping in RL

The RL assessment tasks are aligned to accurately determine how well the students have achieved the learning outcomes. For example, the assessment task in the form of online quiz shown in Figure 10 were used to assess how well students can describe the operations of a logic gates, which is one of the learning outcomes. Figure 10 also shows how feedback were given to explain or hint to students why their answer is wrong. After receiving timely feedback on their conceptual understanding, students will attempt the same question again and make an informed choice. Students will not be penalised if they managed to get the correct answer in their second or third attempt as the online quiz served the purpose of formative assessment for students to develop their competencies.

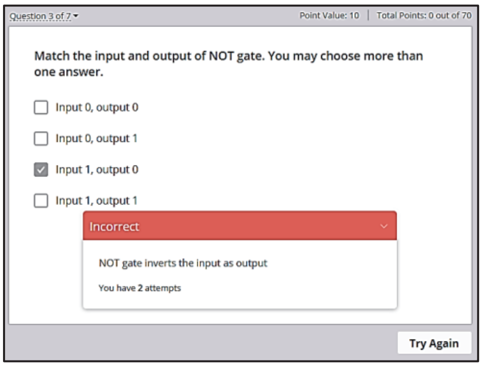
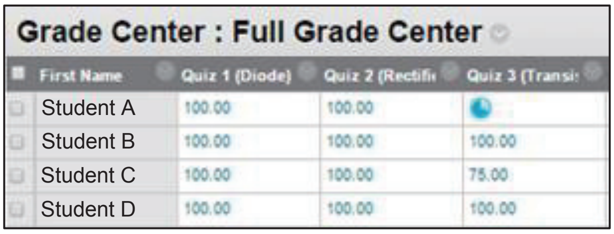


Figure 10: Assessment task aligned to learning outcomes

Since the RL quiz is a SCORM[1] compliant quiz, the quiz results for every student will be captured in the learning management system (LMS) as shown in Figure 11. The RL quiz results provide an important source of feedback for lecturers to check the degree to which learners have achieved the learning outcomes. In addition, lecturers used the quiz results to address challenging questions, misconceptions and pitch the learning activities at appropriate level for the learners during the face-to-face lessons.



Grade Center : Full Grade Center

First Name	Quiz 1 (Diode)	Quiz 2 (Rectifi	Quiz 3 (Transi
Student A	100.00	100.00	
Student B	100.00	100.00	100.00
Student C	100.00	100.00	75.00
Student D	100.00	100.00	100.00

Figure 11: SCORM[1] compliant quiz enables tracking of students' performance

Remote Learning Evaluation

The adoption of RL for the Electronics Technology module started in October 2016. Two sets of qualitative survey were conducted at the end of the module:

a) RL survey
b) module experience survey (MES)

RL survey

There were three RL surveys completed since October 2016. Students are to answer a range of questions using a Likert scale of 4.0 (strongly agree) to 1.0 (strongly disagree). Taking the mean rating of the Likert scale, the RL survey results for October 2016, October 2017 and October 2018 semesters are presented in a graphical format in Figure 12.

[1] SCORM stands for Shareable Content Object Reference Model.

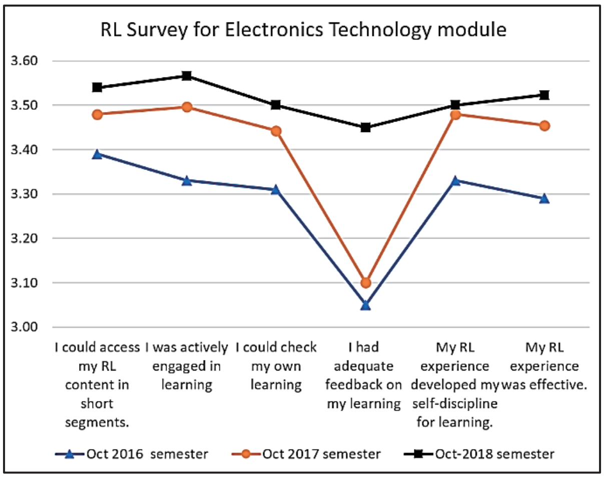


Figure 12: RL Survey

One of the key observations of the survey results is that most students are very positive about the RL experience with 80% of them agreeing with the survey questions. The responses to each of the questions were also similar, with exception of "student engagement in learning" for the 2016 cohort and low rating for "feedback" in the 2016 and 2017 cohort.

Survey results in 2017 has shown significant improvement in the area of "students engaging with content". This can be due to students being more familiar with learning through the RL and also lecturers making changes in their RL design based on feedback and comments from students, which has enhanced the RL experience for future cohort.

Another area of improvement over the years is the rating for "feedback". During the first two rollout of RL in October 2016 and October 2017 semesters, students felt that they were not given adequate feedback on their learning tasks and formative assessments. Consequently, in the third rollout of RL in October 2018 semester, students were given feedback on their work before students re-work their assignments and submit their improved work as final assessment. As a result, the RL survey results in Figure 12 showed improvement in students' receiving adequate feedback on their learning for October 2018 semester.

Module Experience Survey (MES)

This survey aims to examine the learning impact offered by the module and is conducted by the School of Engineering (SoE). A total of seven questions was included in the survey and they examined areas such as skill and knowledge, thinking, teaching and learning, approach, feedback, learning materials and activities as well as overall satisfaction. Students responded based on the rating of 6 for strongly agree and 1 for strongly disagree. The mean rating of the survey results for October 2015, 2016, 2017 and 2018 semesters are shown in Figure 13.

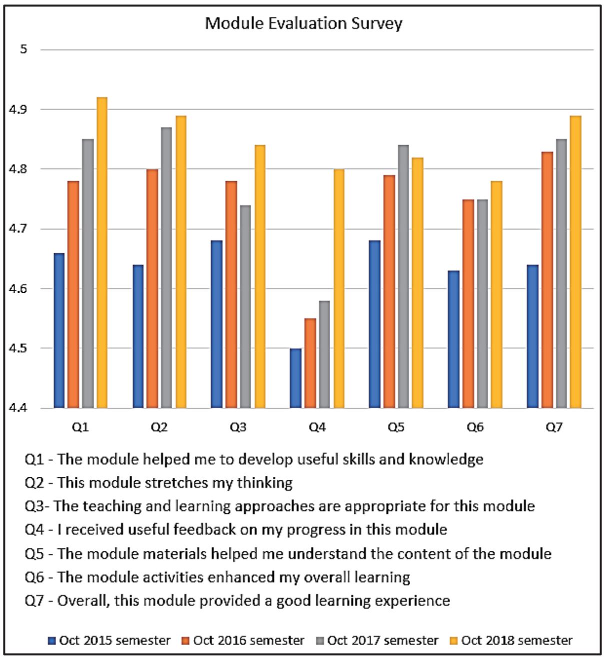


Figure 13: Module Experience Survey

For the purpose of comparison, the MES results for October 2015 semester (before the implementation of RL) was included in Figure 13. From October 2016 semester onwards, there were significant improvements in the MES results, which is attributed to the implementation of RL in this module. In the area of providing useful feedback to students, it was the third rollout of RL in October 2018 semester that yielded the most improvement, which also corresponds to RL survey shown in Figure 12. The factor that attributed to this improvement was explained earlier.

Besides these qualitative surveys, the teaching team also solicited feedback from students through focus group discussions (FGD). Students' verbatim comments on the benefits of RL are recorded below.

a) videos can be replayed until the concepts are understood
b) questions that popped up during the videos and RL quizzes helped me to monitor my own learning
c) circuit demonstrations are highly relevant and enabled me to internalise the difficult concepts
d) the explanation of concepts, working steps and solutions were clear and concise.
e) short bite-sized videos make learning easier and not overwhelming
f) RL helped me to prepare for face-to-face lesson
g) efficient learning process – a well organised RL package that allowed me to zoom into topics that I am not familiar and skipped topics that I know

In summary, the qualitative surveys and FGD suggested that through the implementation of RL, the learners have acquired useful skills and knowledge, and stretched their thinking. All these lead to a good and effective learning experience.

Conclusion

The Electronics Technology module with blended RL was designed and implemented in Ngee Ann Polytechnic. Although this module contains concepts that are too abstract for some students to grasp, this challenge was overcome by the blended approach through harnessing the benefits of RL, hence, making learning effective, engaging and efficient. This is evidenced by the survey results and FGD. It can be concluded that RL approach was effective in engaging students and have enhanced their learning experience when used for teaching Electronics Technology module.

Acknowledgement

The author would like to express his heartfelt appreciation to Centre for Learning and Teaching Excellence (CLTE), Ngee Ann Polytechnic for the support and advice he received during the design and implementation of this work.

References

Biggs, J., & Tang, C. (2011). *Teaching for quality learning at university: What the student does (4th ed.)*. Maidenhead: Society for Research into Higher Education and Open University Press.

Bruner, J. (1966). *Toward a theory of instruction*. Cambridge, MA: Harvard University Press.

Mayer, R. E. (2002). *The promise of educational psychology, volume 2: Teaching for meaningful learning*. Upper Saddle River, NJ: Merrill Prentice Hall.

Vygotsky, L. S. (1978). *Mind in society: The* development *of higher psychological processes* Cambridge, MA: Harvard University Press.

White, R. T., & Gunstone, R. F. (1992). *Probing Understanding*. Great Britain: Falmer Press.

Comparison of Hangeul Learning Methods for Japanese Learners Focusing on Vowels and Consonants

Hiroaki Kosaka[*,a], Rika Akiyama [b] and Keunyoung Pak [c]

[a] Department of Electrical Engineering, National Institute of Technology (KOSEN), Nara College, Yamatokoriyama, Japan
[b] Panasonic Corporation, Kadoma, Japan
[c] Department of Liberal Studies, National Institute of Technology (KOSEN), Nara College, Yamatokoriyama, Japan

*kosaka@elec.nara-k.ac.jp

Abstract

We experimentally taught Hangeul using two methods. In one method Hangeul vowels were taught first. In the other, its consonants were taught first. 40 beginning (or near beginning) students or faculty members of KOSEN, Nara College voluntarily joined our experiment. We divided them into Groups, A and B. Group A learned Hangeul consonants first; Group B learned its vowels first. All participants took a simple Hangeul writing examination immediately after the learning. They also answered four questionnaires to evaluate the class. We analysed the results of the learning experiment and compared the two methods. Five of the six correct answer rates of Group A's examination questions were higher than those of Group B. The total correct answer rate of Group A was also higher than that of Group B. These results suggest that our Japanese participants more easily remembered Hangeul when they learned its consonants earlier than its vowels.

Keywords: *Hangeul, vowels, consonants, learning method, learning experiment*

Introduction

Recently, effective foreign language learning methods are required because of the rapid progression of globalization. When a beginner starts to learn a language, he or she usually first studies its letters. For example, learners of Japanese generally start with its five hiragana vowels and then learn its remaining 40 letters. Japanese tend to study vowels first when they learn other languages. One leading Hangeul textbook in Japan teaches Hangeul vowels at the very early stage, even though this approach is not always beneficial for Japanese who expect to learn vowels before consonants.

Igusa and Fukuda compared the differences of eye movements when native speakers and beginning learners read Hangeul [1-2]. Their experimental results indicated that the ratio of the gaze time at consonants with Hangeul letters for Koreans was higher than for Japanese who can't read them. Their experimental results suggest that reading consonants is the key for efficiently reading Hangeul. We also assume that studying consonants first is an efficient method for learning Hangeul for Japanese beginners. Our paper reports the result of our learning method when Japanese Hangeul beginners studied consonants first.

Basic Structure

Hangeul syllables always begin with a consonant, followed by a vowel. The syllable might stop here, or another vowel might be added, another consonant, or both. A syllable begins with the initial consonant on the left or the top and vowel(s) and other consonant(s) follow to the right or on the bottom:

- 가 where ㄱ, "k" is the consonant and ㅏ "a" is the vowel, pronounced as "Ka".
- 고 where ㄱ, "k" is the consonant and ㅗ "o" is the vowel, pronounced as "Ko".

Table 1 shows the Hangeul character chart. Consonants are listed in the top row. Vowels are listed in the left column. Characters are listed in the cells.

Experiment

We experimentally taught Hangeul letters and pronunciation using the character chart in Table 1[3]. We deleted the characters from its cells before the experiment. We also deleted the consonants or the vowels from the chart. The participants wrote Hangeul consonants, vowels, or characters in the chart to learn them during the class.

We divided the participants into Groups A and B and taught Hangeul to them with Methods A and B.

Method A: The teacher first taught Hangeul consonants. We deleted the Hangeul characters from the cells and consonants from the chart's left column before the experiment. First, the teacher taught Hangeul consonants to the Group A participants who wrote them

Table 1. Hangeul character chart

子音 / 母音	ㅏ a	ㅑ ya	ㅓ eo	ㅕ yeo	ㅗ o	ㅛ yo	ㅜ u	ㅠ yu	ㅡ eu	ㅣ i
ㄱ k / g	가 ka/カ	갸 kya/キャ	거 keo/コ	겨 kyeo/キョ	고 ko/コ	교 kyo/キョ	구 ku/ク	규 kyu/キュ	그 keu/ク	기 ki/キ
ㄴ n	나 na/ナ	냐 nya/ニャ	너 neo/ノ	녀 nyeo/ニョ	노 no/ノ	뇨 nyo/ニョ	누 nu/ヌ	뉴 nyu/ニュ	느 neu/ヌ	니 ni/二
ㄷ t	다 ta/タ	댜 tya/チャ	더 teo/ト	뎌 tyeo/チョ	도 to/ト	됴 tyo/チョ	두 tu/ツ	듀 tyu/チュ	드 teu/ツ	디 ti/チ
ㄹ r / l	라 ra/ラ	랴 rya/リャ	러 reo/ロ	려 ryeo/リョ	로 ro/ロ	료 ryo/リョ	루 ru/ル	류 ryu/リュ	르 reu/ル	리 ri/リ
ㅁ m	마 ma/マ	먀 mya/ミャ	머 meo/モ	며 myeo/ミョ	모 mo/モ	묘 myo/ミョ	무 mu/ム	뮤 myu/ミュ	므 meu/ム	미 mi/ミ
ㅂ p / b	바 Ba/バ	뱌 Bya/ビャ	버 Beo/ボ	벼 Byeo/ビョ	보 bo/ボ	뵤 Byo/ビョ	부 bu/ブ	뷰 byu/ビュ	브 Bu/ブ	비 bi/ビ
ㅅ s	사 sa/サ	샤 sya/シャ	서 seo/ソ	셔 syeo/ショ	소 So/ソ	쇼 syo/ショ	수 su/ス	슈 syu/シュ	스 Seu/ス	시 si/シ
ㅇ	아 a/ア	야 ya/ヤ	어 eo/オ	여 yeo/ヨ	오 o/オ	요 yo/ヨ	우 u/ウ	유 yu/ユ	으 u/ウ	이 i/イ
ㅈ j	자 Ja/ジャ	쟈 Jya/ジャ	저 Jeo/ジョ	져 jyeo/ジョ	조 jo/ジョ	죠 jyo/ジョ	주 ju/ジュ	쥬 jyu/ジュ	즈 jeu/ジュ	지 ji/ジ
ㅊ ch	차 cha/チャ	챠 chya/チャ	처 cheo/チョ	쳐 chyeo/チョ	초 cho/チョ	쵸 chyo/チョ	추 chu/チュ	츄 chyu/チュ	츠 cheo/チュ	치 chi/チ
ㅋ k^h	카 k^ha /カ	캬 k^hya/キャ	커 k^heo/コ	켜 k^hyeo/キョ	코 k^ho/ コ	쿄 k^hyo/キョ	쿠 k^hu/ク	큐 k^hyu/キュ	크 k^heu/ク	키 k^hi/キ
ㅌ t^h	타 t^ha/タ	탸 t^hya/チャ	터 t^heo/ト	텨 t^hyeo/チョ	토 t^ho/ト	툐 t^hyo/チョ	투 t^hu/トゥ	튜 t^hyu/トュ	트 t^heu/トゥ	티 t^hi/ティ
ㅍ p^h	파 p^ha/パ	퍄 p^hya/ピャ	퍼 p^heo/ポ	펴 p^hyeo/ピョ	포 p^ho/ポ	표 p^hyo/ピョ	푸 p^hu/プ	퓨 p^hyu/ピュ	프 p^heu/プ	피 p^hi/ピ
ㅎ h	하 ha/ハ	햐 hya/ヒャ	허 heo/ホ	혀 hyeo/ヒョ	호 ho/ホ	효 hyo/ヒョ	후 hu/フ	휴 hyu/ヒュ	흐 heu/フ	히 hi/ヒ

in the chart's left column. Next she taught Hangeul vowels and characters, and the participants wrote the characters in the chart's cells. After that, they wrote their own names in Hangeul.

Method B: The teacher first taught Hangeul vowels. We deleted them the Hangeul characters from the cells and vowels from the top row of the chart. First, the teacher taught Hangeul vowels to the Group B participants who wrote them in the top row of the chart. Next the teacher taught Hangeul consonants and characters, and the participants wrote the characters in the chart's cells. After that, they wrote their names in Hangeul.

Completing Methods A or B took about 30 minutes. Next the participants immediately took a Hangeul examination. Then our participants wrote answers in romanized Japanese (romaji) and/or katakana about the pronunciation of one Hangeul character, four Hangeul words, and one Hangeul sentence. The examination sheet is shown in Figure 1. They also answered a four-question questionnaire to evaluate the class's degree of simplicity, its length of time, its level of difficulty, and the degree of simplicity for remembering Hangeul.

Our participants were 37 Japanese students from KOSEN, Nara College, two foreign students from Singapore, and one faculty member. None of our participants had ever learned Hangeul before, except only for two Japanese participants who had an experience to take a 40-minute Hangeul lesson once two years ago. 20 learned Hangeul with Method A. The others learned it with Method B. The class' teacher was a Korean native speaker and a professional language lecturer. The class scene is shown in Figure 2.

【1】 (Test)以下のハングル文字の単語及び文章の読みをローマ字、カタカナで分かる範囲で答えてください。

	① 이	② 가수	③ 나라	④ 한국말
ローマ字 /Romanize				
カタカナ /kana				

⑤ 사랑하다	⑥ 저는 일본 사람 이에요.

Figure 1. Examination sheet

Figure 2. Class scene

Results and Discussion

The correct answer rates for each question and the total correct answer rates are shown in Figure 3 which was removed the data of two Group B participants who had made cheating.

The correct answer rates of the participants who learned with Method A were higher than the participants who learned by Method B except 1 for Question 2. This result suggests that a learning method for Hangeul where students learn consonants first outperformed an approach that teaches vowels first.

The participants ranked the ease to remember Hangeul from 1 to 5, where 1 was difficult to remember, 3 was neither, and 5 was easy in the questionnaire. Figure 4 shows the distribution of the five grades in each group. The shape of the distribution of Group A resembles a standard distribution, the distribution shape of Group B does not do so. Grade 2's rate is the best in Group B. Figure 4 also indicates that the rates of the positive grades (grades 4 or 5) are 25% and over 6% in Group B. These results suggest that the number of participants who felt that memorizing Hangeul was easy after the class with Method A exceeded those who used Method B.

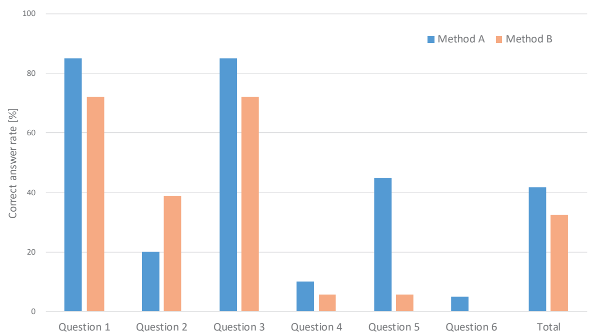


Figure 3. Correct answer rate

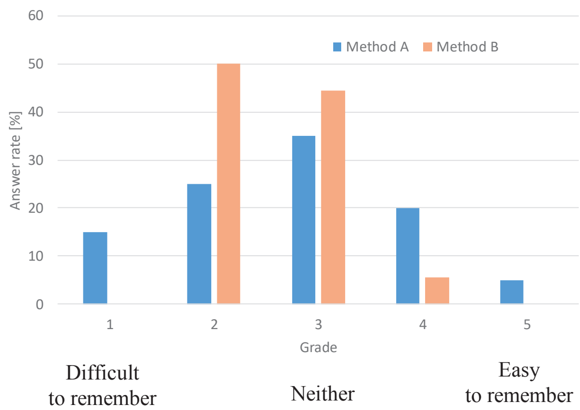


Figure 4. Answer rate: ease of remembering Hangeul

Conclusions

We proposed a Hangeul learning method for beginners who first learned consonants and experimentally evaluated its effect. Our experimental results indicated that participants who first learned consonants correctly answered more Hangeul letters, words, and a sentence, and outperformed the participants who first learned vowels. This result suggests that our Hangeul learning method that teaches consonants first is more efficient for Japanese-Hangeul beginners.

Future work will investigate the differences of eye movements when reading Hangeul between natives and beginners to identify knowledge to improve Hangeul learning methods. We will also develop a method that judges Hangeul reading skill and analyse eye movements when reading it.

Acknowledgements

The research was done only by KOSEN, Nara College.

References

[1] Makiko, I & Tadahiko, F. (1993). Eye movement while looking at Hangul. *The Japanese Journal of Ergonomics*, 29, 466-467. (in Japanese)

[2] Tadahiko, F. (1993). Visual circumstance and Eye Movement. *The Japanese Journal of Ergonomics*, 29, 82-85. (in Japanese)

[3] Yoshiyuki, N. (2018). *ABC of Korean*. Tokyo: TAKAHASHI SHOTEN. (in Japanese)

[4] Polaris. (2019). Hangeul (Korean) Hyper Introduction. Retrieved from http://thebbs.biz/menu1.html (in Japanese)

Matching Educational Programs with Skill of Students in Information Security Education

R. Komura *,a

a Department of Electronics and Information Engineering, National Institute of Technology, Ishikawa College, Japan

*komura@ishikawa-nct.ac.jp

Abstract

K-SEC (KOSEN Security Educational Community) was organized to develop educational programs for national institute of technology (KOSEN) in the field of information security and cyber security. K-SEC continues to make programs with various difficulty. K-SEC supports education of students belonging to not only information science but also other fields of engineering and there is a difference between the skills of students. It is important to match educational programs with skill of student. We planned to hold an event named "security summer school" as summer course and 40 students with various backgrounds and skills joined for studying information security. The event consists of 10 courses with various field and difficulty. We show the outlines of each of the courses to students and ask students to inform which courses they want to take beforehand. Then we compare student wishes with courses and decide the members of each courses. The "security summer school" was held on August 23 and August 24, 2018. After the event, student answered questionnaires about the satisfaction and difficulty which they felt in the event. We used these results of questionnaires to analyse how the courses adapted to the students. In the analysis, a large part of the student was satisfied to the courses. But some of the student felt dissatisfaction about the courses. There are two kinds of dissatisfaction. One is mismatch between the interest of student and the contents of the course. The other is mismatch between the skill of student and the difficulty of the course. It is necessary that we ask students to inform not only their interests but also their skills to prevent these mismatches. We start making a skill check sheet to match difficulty of educational programs with student skills. Additionally, this skill check sheet can realize estimation of growth of student's skill by asking students to inform their skills with the sheet before and after the event.

Keywords: *K-SEC, adaptive learning, information security, KOSEN, skill check.*

Introduction

The developments of ICT (Information and Communication Technology) is in progress and the information security become an important factor to keep ICT systems. But the number of engineers having the skills of information security is insufficient and the nurture of human resource is desired on the industrial societies in the world. There is same situation in Japan and NIT (National Institute of Technology, Japan) starts an education project for nurturing human resource. The project is called the K-SEC (Kosen Security Educational Community)(figure 1). K-SEC was organized in 2015. The number of the campus of NIT joining K-SEC is increasing (Kochi Kosen (2018)). Our campuses also join the K-SEC and develop the contents for information security educations.

Each Student who is belonging to KOSEN has different skills and K-SEC should provide learning courses adapted for these students. We planned to hold an event named "security summer school" and the event consisted of different difficulty and subject. Students made application to the event with their hope which course they want to take, and we decided participants attending each course. Then we inquire the difficulty and satisfaction which they felt at each course and analyze the inquiry.

Figure 1. Web page of K-SEC
(https://csinfo2018.kochi-ct.ac.jp/en/index.html)


Figure 2. Opening ceremony of
the “security summer school”

Table 1. Content of course
in the “security summer school”

course	content
A	Technology about attack and defense on cyber security
B	Analysis of log with information security incident
C	Security on information society
D	Exercise of information security with IoT car
E	Setting and maintenance of DNS server
F	Exercise of response against information security incident
G	Workshop about literacy on ICT instruments
H	First step of analysis of packet with Python
I	First step of information security on IoT instruments and cloud plathome
J	Control of IoT instruments with WebAPI


Figure 3. Students in IoT system course.

Table 2. Results of questionnaire

course	number of answer	average of satisfaction (maximum=5)	average of difficulty (maximum=5)
A	24	3.33	2.96
B	16	4.06	3.69
C	26	3.73	2.62
D	12	3.27	2.33
E	18	4.06	2.78
F	22	3.41	2.52
G	28	3.5	2.3
H	10	3	3.11
I	26	3.92	3.04
J	16	2.63	2.07

Materials and Methods or pedagogy

The “security summer school” was held on August 23 and August 24, 2018(figure 2) and 40 students with various backgrounds and skills joined for studying information security. The event consists of 10 courses with various field and difficulty. Table 1 shows contents of each course.

In the process of application for the event, students informed us of the courses which they wanted to take, and we decided the member of each courses considering their applications. Then student assembled at classroom in National Institute of Technology, Gifu College. They studied various field and difficulty subject in each course for two days (figure 3).

When all courses were finished, we ask students to fill in a questionnaire about the difficulty and satisfaction of each courses.

Results and Discussion

Table 2 shows the results of the questionnaire. On the whole, satisfaction at each course is high (more than 3.0) and it is clear that students are satisfied with “security summer school”. On the other hand, there is some different in the evaluation of difficulty. We had a hypothesis that the higher the difficulty is, the lower the satisfaction is, but that kind of hypothesis is unsuitable. In spite of the high difficulty, students felt high satisfaction on the course with adapted contents. In the answers of questionnaire, there were some descriptions that they felt an unsatisfaction about courses because of unadaptation of the course.

Conclusions

To develop skills of information security of KOSEN student, K-SEC plan and carry out thesecurity summer school. In the summer school, we provide courses which adapted to student and it is confirmed that student feels high satisfaction to learning courses adapted to skills of student in spite of its high difficulty. It can be said that the learning course adapted to student skill brings good education effects with high satisfaction and it is important to provide adaptive learning contents and examinations for the training of student.

Acknowledgements

We are grateful to members of K-SEC and trainers for great help to carry out summer school.

References

Kochi Kosen (2018). Human resource development to meet need of information security.
https://csinfo2018.kochi-ct.ac.jp/en/index.html

TEACHING TRADITIONAL JAPANESE ARCHITECTURE: HOW THE CONSTRUCTION OF AN OKOSHIE CAN LEAD THE STUDENTS TO A BETTER SPATIAL UNDERSTANDING

A.P. Higashino*, a

a National Institute of Technology, /Dep. Architecture, Akashi College, Japan

*adriana@akashi.ac.jp

Abstract

History of architecture is a course present in most school of architecture. Some school give more emphasis to the course than others, and it is usually divided into three categories: the local History of architecture, European History of architecture and History of modern architecture. Mostly the objective of the course is to provide an experience of excellence in architecture, get the students aware of aesthetics, to give the students tools to understand the meaning of architecture.

What is the best way to transmit this knowledge to the students?

To take the students to experience the building!

Field trips involve time and money and are quite difficult to be organized. Therefore, most educators use pictures in their lectures. However, to translate a three-dimensional experience into images is difficult.

Model making is also a powerful educational tool. Through the construction of models, the students can better understand the architectural space, the relation between 3D models and the 2D drawings or pictures. Although the making of models is a standard tool in studio classes, it is not often used in other courses. Many factors complicated the construction of models during history courses, such as time and cost. This study analyses the use of paper model making in Japanese architecture history course. The study uses Okoshie, which is a set of drawings, floor plan, and elevations, that can be pulled up and assembled. The method of research was to have the students build two Okoshie of two different tearooms and to ask them to compare the buildings. The analysis of the students' answers showed that the construction of the model influenced the students understanding of the space. Famous tearooms Okoshie were used: "Tai-an[1]" and "Fushian[2]" by Sen no Rikyū (1522 -1591)[3] and "Kon-nichian[4]" by Sen no Sōtan (1578–1658).

Keywords: *okoshie, paper model, traditional Japanese architecture, tearoom, design education, spatial understanding*

Introduction

This research intends to suggest ways to move from a knowledge-teaching lecture style to a student-oriented learning approach. The first-year History of Architecture course in Akashi college deals with the chronological evolution of Traditional Japanese Architecture. At first, it was a teaching-oriented course where knowledge was transmitted to the students through slides lectures. However, it was observed that using the traditional lecture-exams model, the students tended to concentrate their study time in the few days before the exam. Different approaches were tested and used along the years to improve the students learning experience. At first final exams were substituted by short tests executed at the end of each lecture. The students were also asked to read the textbook and resume the topic before each class. These two measures were effective in terms of deconcentrating the students' study time. The students were now studying for the lessons and paying attention to the lectures (Higashino 2008). Unfortunately, it did not improve their spatial understanding of the architecture explained in the lectures. Therefore, taking advantage of the college location, field trips to iconic buildings of traditional Japanese architecture were included in the course. The field trips proved to be very effective (fig.1). The students not only enjoyed the experience but also acquired a better understanding of the architectural space. Undoubtedly experiencing the architectural space is the best way for the students to understand it. However, many structures of Traditional Japanese Architecture are small and impossible to visit with a group of 40 students. Here we suggest the execution of paper models, *okoshie* as an alternative method to help the students to better understand the architectural space of small structures, such as tearoom.

The methodology used was experimental. Two groups of students were asked to build two different tea houses *okoshie* and to compare the buildings. The students' answers were analyzed, and the effectiveness of the *okoshie* as an educational tool evaluated.

This contribution starts by explaining the different paper model techniques, what is an *okoshie*, and why use the *okoshie* as the model execution technique for the lectures. Later tea houses used on the workshops and how the workshops were conducted is explained. Finally, through an analysis of the students reports the effectiveness of the *okoshie* as a learning tool is evaluated.

Figure 1: students discussing the *hanegi* beam system during the visit to Jodo temple at Ono city

Why Okoshie is the best paper modelling method to use in History of Japanese Architecture Courses

The traditional model making method in architecture uses materials, such as styrene boards or balsa wood. Both materials are lightweight and can be cut and processed easily with a cutter. Balsa wood because of its high cost is usually used to make final models. Styrene boards is less pricy than Balsa wood and often used to build design study models on studio classes. Less costly materials such as cardboard are not so commonly used because thick cardboards are difficult to cut, and thin cardboards not strong enough to construct architectural models. There are also 3D printers, but the running cost is very expensive.

Besides the traditional architectural model making technique, there are also alternative techniques to build models using paper: *origamic* architecture, papercraft and *okoshie*.

Prof. Masahiro Chatani (1934-2008) developed *origamic* architecture (fig.2) using techniques of origami (Japanese paper folding) and *kirigami* (Japanese paper cutting), to reproduce three-dimensional architecture and monuments. The method is comparable to a 'pop-up' book. The paper is cut in a way that when it is a folded at a 90-degree angle, a three-dimensional image pops-up. The origamic architecture uses cut-out and folded paper techniques and is usually cut out of a single sheet of thin paperboard paper. The result is an intricate pattern that plays with light and shadow.

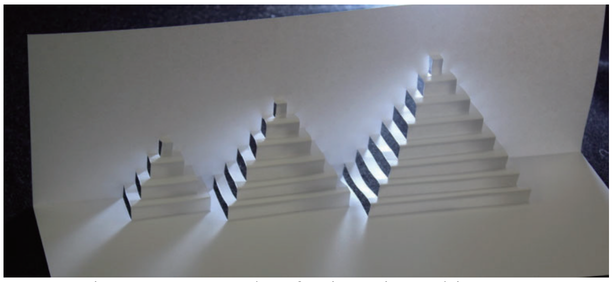


Figure 2: example of origamic architecture

Paper models, also called card models or papercraft, are models constructed mainly from sheets of paper. The first paper models appeared in Europe, in French toy catalogues in 1800. The popularity of card modelling boomed during World War II because the paper was not heavily regulated as was steel and iron. Several patterns for building paper model can be found on the internet. There are also software, such as Pepakura that develop paper model patterns from 3D graphics designs.

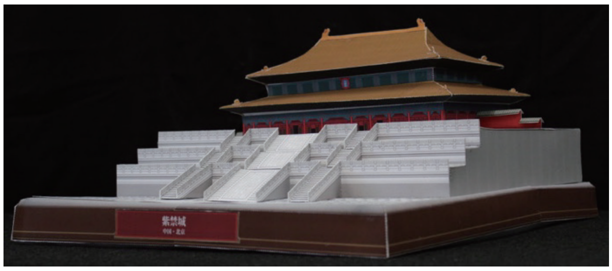


Figure 3: Example of a papercraft model

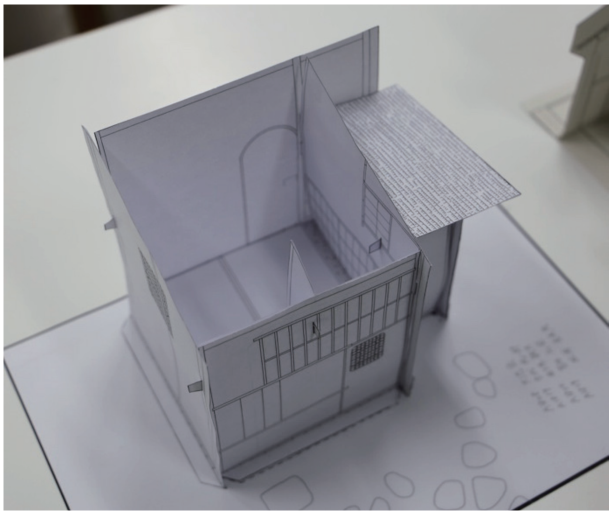


Figure 4: Example of okoshie

The *okoshie* is a Japanese traditional paper modelling technique developed for the construction of tea ceremony houses. An *okoshie* has the elevation drawings of the building pasted along the floor plan wall lines, and they can stand up, creating a 3D fold-up model. Ceilings and roof parts are made separately and can be placed over the walls and removed to view the interior. When not in use, *okoshie* can be folded flat and easily stored. During the 18th century, it became fashionable to collect *okoshie*. Matsudaira Sadanobu (1759 -1829) collected the 33 *okoshie*, now preserved at the Tokyo National Museum. This collection includes tea houses designed by Sen no Rikyū (1522-1591).

On previous research, it was studied which of the above methods let to a better comprehension of the architectural space. During a series of workshops, the participants were asked to build *origamic* architecture, paper model or *okoshie*. Through surveys with the participants, it was evaluated their understanding of the architectural space.

In the *origamic* architecture workshops, the participants had to fold buildings patterns from Chatani's book. The participants received a card already cut and had to fold it. Most of the participants folded several cards. According to the survey results, all participants enjoyed the workshop and were pleased with their work. However, they did not show a better understanding of the architecture space they folded.

Figure 5: Akashi Castle Hitsujisaru tower paper model

In the papercraft workshop, the participants had to build a paper model of Akashi Castle Hitsujisaru tower. Structurally, this paper model differs from printable paper models available on the internet. It was designed based on the castle restoration report drawings and the assemblage process resembles that of an architecture model. It is built floor by floor, and the design of the roof was simplified. Emphasis was given to the different shapes of roof gables. The survey results showed that the participants enjoyed the workshop and were pleased with the quality of the model. Some participants affirmed that despite seeing the castle every day, they have never noticed the differences in the gables design until now. Although, when asked if the model had led them to a better understanding of the castle architectural space, the answer was no. They said they were too busy cutting and pasting to notice the architectural space.

The okoshie workshop used copies of drawings by K.Nishi (Nishi, 1989) of the Kon-nichian teahouse. The participants cut and glue the elevations of the tea house and them past those walls to the tea house floor plan. In the survey, many participants affirmed that they now understood better the architectural space of the tea house.

From the analysis of the workshops survey results, we concluded that the technique that proportionated the best understanding of the architectural space was the *okoshie*. *Origami architecture* was too abstract, and papercraft was too complicated and diverged the focus from the architectural space to the crafting process.

Tea houses and Okoshie workshops

To evaluate the potential of the okshie as a learning tool, we did two okoshie workshops with first year's students and short-term international students. In these workshops, the students were divided into small groups with one international student in each group. The groups built two tea house's okoshie and later, they were asked to compare both structures.

The first workshop was in January 2019 with students from Brazil and Hong Kong. The second workshop was in July 2019 with students from Taiwan. The students were asked to build two tea houses and compare them. In the January workshop, the students built the okoshie of Kon-nichian and Taian. In the second workshop, they built okoshie of Konichian and Funsian.

Tea houses can be divided mainly into Suikya style and Soan style. Sukiya style tea houses are larger than the Soan style rooms. The design uses the traditional samurai class residential-style called Shoin, and tea ceremony performed in this kind of room is called Zashiki tea. All the tea houses used on the workshops belong to the Soan style. The Soan style reached its maturity at the hands of Sen no Rikyu. As the name suggests, the Soan style tea houses evoke images of the solitary hermit hut and use the aesthetic concepts of Wabi and Sabi.

Kon-nichian is a small tea house of 1 and a 1/2 tatami mats (ichijou daime), instead of tokonoma it has a small plank floor (mukoitaire). Besides the mukoita, there is a pillar with a hook for hanging the flower pot. Because of that, this plank floored space is believed to be a substitute for the tokonoma. The present building is as reconstruction from 1788 and is believed to preserve the original design by Sen no Sotan (1578–1658). The drawings used to build this okoshie were copied from K. Nishi drawings.

Figure 6: January 2019 workshop

The second teahouse was Taian, the most famous tea house designed by Sen no Rikyu (1522-1591). Taian is also a small teahouse of 2 tatami mats, with the hearth at the corner. It has a hook for hanging the flower pot on the wall in front of the tokonoma. The Taian okoshie was drawn based on S. Horiguchi book (Horiguchi, 1964).

The third tea house Fushian, together with Konichian, is one of the many tea houses at the Urasenke residence and has its origins back to Sen no Rikyu. The present building is a reconstruction of 1913 after the former building burnt in 1905. The floor plan has 3 tatamis mat and a daime (1/2 tatami), the tokonoma faces the entrance. The tea door is on the left of the tokonoma and leads to a preparation room (sort of kitchen). There is a post (*nakahashira*), between the 3 mats (guest's space) and the daime (host space or tenmaeza) The drawings used to build this okoshie were copied from K. Nishi book.

Both workshops took place during a 90 min class. In the January workshop, there were 43 Japanese students and 12 international students, and they were divided into groups of 5 to 6 people. After finishing building the tea houses, the students filled a survey and wrote a comparative analysis of the tea houses. The students were asked how difficult was the workshop, and 68% of the student answered that the difficulty level was just ok. They were also asked if they have enjoyed the workshop, and 86% of the students responded affirmatively. The students were asked to compare and write about the two tea houses. Although it was emphasized that the historical context of the tea house was not essential and that they were not supposed to search on the internet, 3 students did an internet search and wrote about the historical background of each house. However, most of the students wrote about how the architectural space of each house was composed. They perceived differences in the shape of the roofs, and gave concrete examples such as that one tea house had a tokonoma and the other did not. Some students used technological terms and applied the knowledge acquired from the slide lectures.

Some students got confused by the difference in the graphic expression from the two tea houses, because the okoshie were from different fonts. For example, although both teahouses have an elevated floor, in the Taian tea house okoshie the elevated floor was abbreviated, and it let the students understand that Taian did not have an elevated floor. In resume, during the first workshop, the students enjoyed working together and working with international students, and the okoshie proved to lead to a better understanding of the architectural space.

The second workshop was in July 2019, and the participants were 42 first years and six international students from Taiwan. The students were divided into six groups, with eight students per group. They were asked to build two tea houses: Konichian and Funsian. Here to prevent misinterpretation, the okoshie were chosen from the same font, with the same graphical expression (K.Nishi, 2007). The students were asked how difficult was the workshop; only 14% of the students find it difficult; most of the students answered that the difficulty level was just ok or easy. They were also asked if they have enjoyed the workshop, and 91% of the students responded affirmatively. The students were asked to compare the tea houses and strongly advised to not search on the internet. Nor the Japanese students or the international students had any knowledge about traditional Japanese architecture. Most of the students affirmed that Konichian was smaller than Fushian, which was not only bigger but also had more rooms. They said that the design of the teahouses seemed similar and included elements from traditional Japanese architecture, such as tatami mats and Akari shoji.

Moreover, the rooms on both tea houses look similar to a japanese style room (Washitsu). Many students pointed out that the irregular stone path was an expression of Japanese aesthetics and that it could be found at both structured. There were interesting comments, especially regarding the entrance of the tea house. Since the students have not learned about Japanese architecture yet and did not know about the tea rooms entrance, nijiriguchi, 6 students asked how the room was entered since there was no door, and 4 students asked why the door was so small. Students also questioned what the alcove (*tokonoma*) in the wall was, and why the floor was higher there. A few students felt the space inside the house closed and isolated from the outside. Oppositely some students said there was a connection between the garden (outside) and the tea house (inside). Two students described the design of the tea houses as reminding the image of a solitary hut in the mountains. There were also several comments on the shape of the windows, the use of waved bamboo. Some students could not understand why to have windows that cannot be open, but many students realized the windows were mostly to illuminate the tea room.

Figure 6: July 2019 workshop

Results and Discussion

Through the workshop's experiments, we can say the okoshie led to a better understanding of the architectural space. The first workshop had fewer students per group, and consequently, the students took longer to build the okoshie and had less time to write their comparisons about the tea houses. The students from the July workshop (second workshop) were much more eloquent about the tea houses them the students from the January workshop. The July workshop students were very observant and noticed essential aspects of the Soan style tea house such as the small entrance (nijiriguchi) and the disconnection/ connection between the interior and the exterior. In the January workshop, since the students had earnt knowledge about the tea houses from the lectures, they used technical terms in the tea houses description. However, the results from the July workshop showed that the lack of knowledge led the students to pay attention to details and arise more question about the architectural space. The students that built the okoshie for the tea house before attending lectures were more impressed by the architectural space of the teahouses.

Conclusions

Traditional lectures styles courses, such as History of architecture, can change from knowledge-teaching lecture style to a student-oriented learning approach. The inclusion of activities such as field trips and model making cand lead the students to a better understanding of the architectural space. Due to time and cost, instead of the styrene board traditional architecture model making, this study suggested the use of alternative methods. Papercraft, origami architecture and Okoshie methods were tested. Okoshie is the method that gives a better understanding of the architectural space. The students that had lectures on traditional Japanese architecture before building the okoshie used technical terms in their descriptions and the model construction served to fix the knowledge acquired during the lectures. The students that build the Okoshie before having lectures about traditional Japanese architecture were intrigued by the novelty of the architectural space. In both workshops, the results showed that the building of an okoshie led the student to a better understanding of the architectural space.

References

Chatani. M & Nakazawa. K (2005). Origami Kenchiku, Sekai isan wo tsukuro, Tokyo, Shokokusha

Horiguchi, S.(1964). Chashitsu Okoshiezushu, Tokyo, Bokusuishobo, Vol 4

Nishi, K. (1989). Okoshie Kenchiku: Tanoshiku Tsukuri Kukan wo Yomu, Tokyo, Shoukokusha

Nakamura, M. (2002). Chashitsu wo Yomu: Chashou no Kufu to Sozo, Kyoto, Tankosha.

Higashino. A.P (2008). 「スライドによるビジュアル講義の実践」日本建築史講義におけるプリントと予習レジュメを組み合わせる方法と成果, 平成 20 年度独立行政法人国立高等専門学校機構主催教育教員研究集会

Omoete Senke HP
http://www.omotesenke.com/index.html
(accessed July 2019)
Urasenke Home Page
http://www.urasenke.or.jp
(accessed July 2019)

Endnotes:

1) Tai-an (待庵) was designed in 1582 by Sen no Rikyū. It was built inside Miyokian Temple in Yamazaki, Kyoto, and is the oldest tearoom existing and the only remaining tearoom built by Sen no Rikyū.

2) Fushian(不審庵) is the main tearoom of the Omotesenke, which is one of the most famous schools of tea ceremony, and descends directly from Sen no Rikyū. Fushin'an has been inherited by successive generations of Iemoto (head of the family). Fushin'an also refers to the whole organization as well as the Sen family residence, and is one of the names of the Iemoto Sen Sosa.

3) Sen no Rikyū (1522-1591) was from a Sakai city's merchant family. He studied tea under Takeno Jōō (1502–1555) and together with his master were the developers of the wabi aesthetic. Rikyū was the tea master for Oda Nobunaga and Toyotomi Hideyoshi. He designed small rustic tea rooms, which were referred to as sō-an ("grass hermitage").

4) Kon-nichian (今日庵) : Sen Sotan’s (1578-1658) third son, Koshinsosa (1613-1672) inherited Fushian and continue Sen no Rikyū tea ceremony school, which is known as Omotesenke (front Senke). Sen Sontan retired and build a tearoom called Kon-nichian at the back of their residence. His forth son, Sensousoushitsu(1622-1697) inherited Kon-nichian and established the Urasenke (back Senke) school of tea ceremony.

Effectiveness of the PBL Approach in Civil Engineering to Deepen Students' Understanding

Naho TAKEDA[*,a], Vic Marie I. Camacho[b], Melody M. Clerigo[b] and Crist John M. Pastor[c]

[a] Department of Civil Engineering, National Institute of Technology (KOSEN), Akashi College, Akashi, Japan
[b] Faculty of Science, Technology and Mathematics, College of Teacher Development, Philippine Normal University, Manilla, Philippines
[c] College of Graduate Studies and Teacher Education Research, Philippine Normal University, Manilla, Philippines

*takeda@akashi.ac.jp

Abstract

This study reports the effectiveness of the Project-Based Learning (PBL) approach applied in the Construction Materials Course at Akashi-KOSEN. In order to compare the effectiveness of teaching styles, the Construction Materials Course was delivered throughout the year using different styles, including a combination of lectures, group work, fieldwork and PBL. Effectiveness was evaluated by comparing the results of students' self-reflection, peer-evaluation, teacher's evaluation, questionnaire survey conducted at the end of the course, as well as students' academic performance. The results showed that PBL had the largest effect on academic performance among student respondents, particularly in the Construction Materials course.

A quarter of the course was delivered in PBL style. The class was divided into seven groups and each group was given a theme on construct infrastructures, such as bridges, dams, concrete pavements. Each member played the role of a civil engineer and selected the most appropriate material to build the structure depending on site conditions. Students made presentations to explain which and why materials were selected, focusing on the issues of durability and impact of structures on mechanical properties, cost and environmental impacts on construction. Presentations were assessed through peer-evaluation, teacher's evaluation, whereas group work was assessed by peer-evaluation and self-reflection. Half of the course was delivered in lecture style, and the last quarter was delivered in a combined style of lectures and group work, (two to four members), or lectures and fieldwork.

Results of the questionnaire survey showed that students found it most suitable to learn in a combined style of lectures and group work, followed by lectures, fieldwork and lastly, PBL. However, students' academic performance on average was the highest during the term in which the PBL style was implemented and lowest during the term in which the lectures only style was implemented. This trend was particularly noticeable among students who answered that the lecture style was most suitable. This finding implies that some students are less comfortable with the PBL approach, and unaware of its effectiveness in deepening their conceptual understanding.

Keywords: *PBL, Project Based Learning, deepen students' understanding, civil engineering, KOSEN*

Introduction

Project Based Learning (PBL) is a teaching approach that pushes students to explore, an engaging real-world problem to solve, or a challenge to design or create something (Larmer, 2017). It is a preferred strategy for classes in career and technical programs. It is found effective by teachers due to its potential to improve students' motivation to learn, to employ multiple opportunities for technology integration, and for the classroom lesson to be meaningful and connected with real world situations. Studies revealed that employing PBL in the classroom improve students' retention of knowledge over time, improve the use of 21st century success skills that are valuable for their future careers.

PBL can be done individually or in groups. In this pilot study, the respondents were in groups to make the tasks easier and eventually build valuable collaboration skills and also for easy observation and guidance by the teacher. Furthermore, students are given opportunities to communicate with their peers, and teacher in improving their processes and products.

PBL caters to the 4C's of the 21st Century skills which is most popular learning strategies for digital natives in today's environment (Applied Educational Systems, 2019). The first C which is Critical thinking teaches students to question claims and seek truth, Creativity teaches students to think in a way that's unique to them, Collaboration teaches students that groups can create something bigger and better than you can on your own and Communication teaches students how to efficiently convey ideas. The combined development of the four C's empower students to become ready to think rationally and exercise decision-making that is useful in their real lives.

PBL is founded in an Active learning environment which is based on a learning theory constructivism. This theory emphasizes that Learning is a process of making meaning and learners are given opportunities to construct or build their own understanding. Learners replace or adapt their existing knowledge and understanding (based on their prior knowledge) with deeper and more skilled levels of understanding. Teachers then should be skilled in providing learning environments, opportunities, interactions, tasks and instruction that foster deep learning and promote active learning. Social constructivism by Vygotsky described the zone of proximal development (ZPD) and highlights the importance of acquiring learning through social interaction with others in the classroom setting with the teacher and the learner's peers.

This study reports the pilot implementation of the PBL in the Construction Materials Course in NITAC and its effect to performance, utilization of 4Cs and self-reflections of the PBL process.

Methods and pedagogy

The course of Construction materials is offered to second grade students, the age of 17 years old, of the civil engineering department. In the first semester, students learned about the physical and mechanical properties of concrete, steel materials and asphalt from the outline of social infrastructure facilities. Moreover, in the second semester, students studied the deterioration of types of cement, aggregates, and admixtures that is the materials of concrete, furthermore about materials for maintenance and management and environmental considerations. Concrete is one of the structural materials used all over the world, and the items to be considered in the construction environment change, so there are unlimited choice and combination of materials. In addition, the shape of the structure is also made in a so-called custom-made manner, which changes depending on each construction environment and the purpose of use of the structure. For this reason, it is necessary to be able to scrutinize the conditions of the structure from various viewpoints and to be able to select the optimum material and its combination.

In the 1st semester, classes were conducted in the lecture style. The 2nd semester incorporated group work and fieldwork and compared their learning results. One class took 90 minutes and 43 students attended. Handouts were uploaded on the e-learning system before each class and students were allowed to use their laptop, tablet, and smartphone to access the data during a class. In this study, the educational effects of PBL was compared with lecture style, combined lecture and group work, and fieldwork. The details of each pedagogy were as follows:

Pedagogy-1 Lecture style; LS

A lecturer delivered a class. The lecturer, but no discussion between students asked some question to students. However, at the end of the class, exercise and the minute paper (Takeda, 2015) were given.

Pedagogy-2 Group work; GW

Size of groups were pair work and three or four members. The answers were checked between paired students after exercise. A theme was discussed and share ideas with three or four students. Discussion themes were set to connect students' experiences and study content.

Pedagogy-3 PBL (Table.1)

The size of each group was six to seven students. The project theme of PBL was to choose optimal cement, aggregate, and admixtures to construct infrastructures such as bridge, dam, concrete pavement, tunnel, seawall, river wall, and sanitary drainage. Each student had their own roles such as presenter, reporter, civil engineer: design, estimate, assessment, and constructor. Conditions of constructions sites were different depending on the season, area, climate, weather, size of the structure, usage environment, and so on. Each group set the conditions and explained the reason for selecting the most suitable material, including the characteristics of the material, precautions for the construction, and cost. A presenter reported the optimal materials in each by using PPT slides and handouts.

PBL1 to 3 were assessed by peer evaluation of roles within a group, evaluation for presentations and handouts, and self-reflection. The rubric for peer evaluation within the group and self-reflection was including creativity, collaboration, and leadership. The rubric for contents of the presentation was including creativity, clarity, completeness, and collaboration such as explanations about making the process, types, chemical property, physical property, environmental influence, precautions for the construction, cost, and reasons for the decision. The rubric for handouts was including completeness, the correctness of concept, clarity of presentation, and creativity in model making and writing. Furthermore, students made comments for other students and groups.

Pedagogy-4 Fieldwork; FW

Fieldwork-1 was to find out steel, asphalt, and concrete in a town, to take pictures, and to report explain of them and reason for the choice. Fieldwork-2 was to find out the deteriorated structures such as cracked concrete and corrosion of steel, in a college, to take pictures, and to specify causes.

In order to compare the effectiveness of teaching styles, the Construction Materials Course was delivered throughout the year using different styles, including a combination of lectures, group work, fieldwork and PBL (Table-2).

Table-1 Schedule of PBL

Day	Activity
1	PBL-1 (Cement)
2	Presentation (Cement)
3	PBL-2 (Admixture)
4	Presentation (Admixture)
5	PBL-3 (Aggregates)
6	Presentation (Aggregates)
7	Simple experiment of chemical admixtures
8	Midterm

Table-2 Combined schedule of the construction materials course

1st semester	Topics	Pedagogy
1	Introduction of construction materials	Lecture style & Group work
2	Physical properties of materials	Lecture style
3	Quality and standards	Lecture style
4	Concrete structures in a city	Lecture style & Group work
5	Steel	Lecture style
6	Steel	Lecture style
7	Exercise-1	
8	Midterm examination	
9	Asphalt	Lecture style
10	Asphalt	Lecture style
11	Introduction of concrete, fresh concrete	Lecture style
12	Mechanical properties of concrete	Lecture style
13	Physical properties of concrete	Lecture style
14	Mix proportion of concrete	Lecture style
15	Exercise-2	
	Final examination	
	Assignment during summer vacation	Field work
2nd semester		
1	Kinds of cement and production method	PBL-1
2	Chemical properties of cement	PBL-1
3	Roles and kinds of chemical admixtures	PBL-2
4	Roles and kinds of mineral admixtures	PBL-2
5	Roles and kinds of aggregates	PBL-3
6	Physical properties of aggregates	PBL-3
7	Exercise-1	
8	Midterm examination	
9	Various concrete	GW
10	Deterioration and durability of concrete	Lecture
11	Polymer materials	Lecture
12	Maintenance of structures	Field work
13	Maintenance of structures	Presentation
14	Environmental considerations and SDGs in civil engineering field	GW
15	Exercise-2	
	Final examination	

Effectiveness was evaluated by comparing the results of students' self-reflection, peer-evaluation, teacher's evaluation, questionnaire survey conducted at the end of the course, as well as students' academic performance.

Questionnaire Survey

Questionnaire survey items were as follows:

(1) Did you use the course materials in the e-learning system?
- Used all materials and references
- Used only handouts of lecture
- Did not use
- Used all and referred any other website and books by myself
- Others

(2) Did you solve the exercise problem?

1) About exercises at the end of each chapter of the textbook;
- Solved all
- Solved only assignment
- Did not solve at all
- Solved exercises another textbook
- Others

2) About distributed exercises;
- It was helpful to understand construction materials
- It was not enough to understand construction materials
- I would like to solve more exercises
- Others

(3) Which teaching style was suitable to deepen understanding for you? *Multiple selections were possible.
- Lecture style
- PBL
- Group work
- Pair work
- Think by yourself and share ideas with others
- Fieldwork
- Others
(4) Any other comments

Results and Discussion

Teaching materials and reference websites were shared by using the e-learning system in this course. The questionnaire survey was held to 43 students to evaluate the helpfulness of the learning system and the effectiveness of the teaching method for construction materials course. Fig.1 shows the results of how students used the e-learning system. 9% of students used all materials and reffered all references, and 86% of them used only handout of lectures. The e-learning system was helpful to focus on a topic in a class. In addtion, 2% of students tried to understand construction materials while referring not only to the class materials but also other documents. However, 2% of them did not use the materials and the system.

Fig. 2 and 3 shows the rate of the students self-studying. Only 9% of students solved all exercises and another 70% of them solved exercises as an assignment. Unfortunately, 21% of students did not solve any exercise of the textbook. The exercises created based on the past questions were distributed immediately before each examination. 93% of students choose the answer of "It was helpful to understand construction materials", and 7% of them needed more exercises to understand them.

Fig.4 shows suitable teaching/learning style for students. The percentage of students who chose lecture style was the largest at 32%. The percentage of PBL was 9% and GW and pair work was 36%.

Some student commented it was suitable to ask questions after lecture than research by themselves to deepen understanding. On the other hand, some student commented the preparation for a presentation in PBL was helpful to deepen understanding.

For cost calculation, when the information was not available on the Internet, some students called the company dealing with the material and inquired about the price. A construction site visit was held between the 5th and 6th classes. Although it was participation only for desired students, they asked a question based on their experience at PBL. On the other hand, some students felt uneasy about the difference in burden within the group and the difference for knowledge obtained. This means it was not enough to give opportunities to communicate with their peers, and teacher in improving their processes and products.

The simple experiments on the effects of chemical admixtures have also helped to understand the properties of the materials. Since full-scale experiments on construction materials are conducted to third graders, it is impossible to spend time on experiments in this course. However, through experiments, factory and construction site visits will be necessary to incorporate not only theory but also the opportunity to see phenomena.

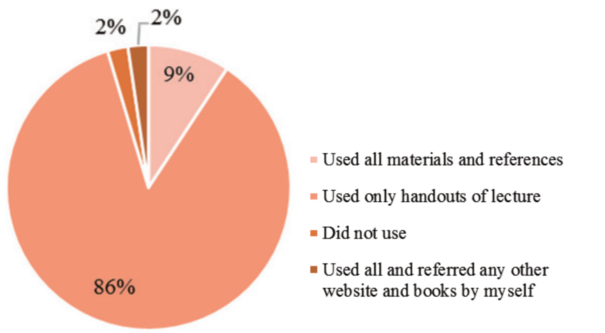


Fig.1 The answered to the question "did you use the course materials in the e-learning system?"

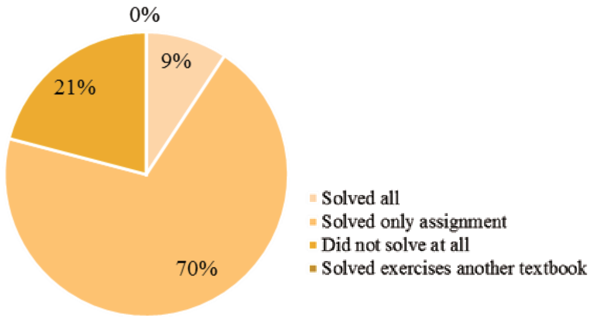


Fig.2 The answered to the question "did you solve the exercise at the end of each chapter of the textbook?"

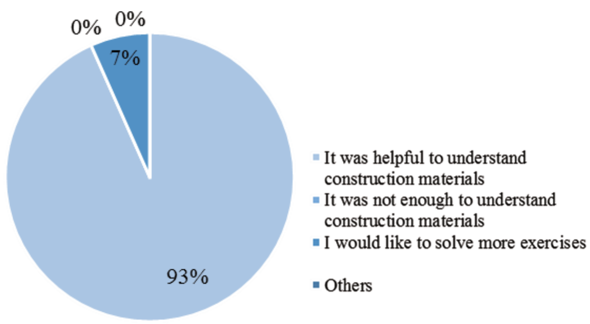


Fig.3 The answered to the question "did you solve the distributed exercise?"

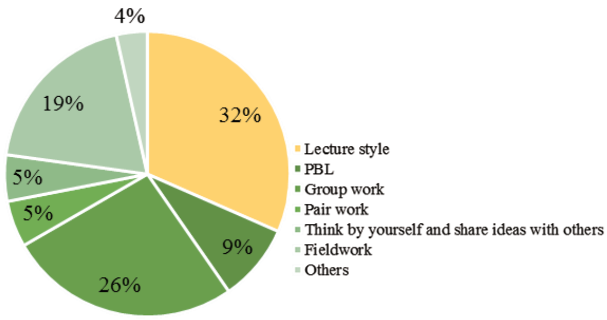


Fig.4 The most suitable learning style to deepen understanding for students

Fig.5 shows an influence of pedagogy to academic score point. In the university, a perfect score of 100 indicates the score, but for convenience, it was converted to a perfect score of 5 points. Three or more points, the red line in Fig. 5, are passing scores in our college. LS-GW means combined lecture style and group work, LS-FW means combined lecture style and fieldwork. The points for which the term was conducted by PBL were the highest, LS-GW, and LS-FW in the order of points were the lowest, and LS was the lowest. The highest score was PBL, but the other terms scored at least 4.5. On the other hand, the lowest points were less than 3.0except for PBL terms.

Results of the questionnaire survey showed that students found it most suitable to learn in a combined style of lectures and group work, followed by lectures, fieldwork and lastly, PBL (Fig.4). However, students' academic performance on average was the highest during the term in which the PBL style was implemented and lowest during the term in which the lectures only style was implemented. This trend was particularly noticeable among students who answered that the lecture style was most suitable. This finding implies that some students are less comfortable with the PBL approach, and unaware of its effectiveness in deepening their conceptual understanding.

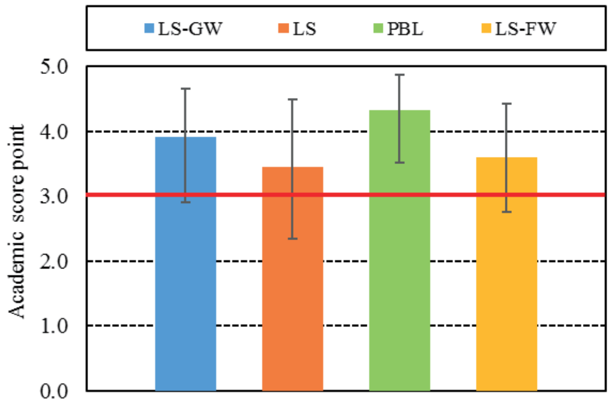


Fig.5 Influence of pedagogy to the academic score point

Conclusions

In order to compare the effectiveness of teaching styles, the Construction Materials Course was delivered throughout the year using different styles, including a combination of lectures, group work, fieldwork and PBL. Effectiveness was evaluated by comparing the results of students' self-reflection, peer-evaluation, teacher's evaluation, questionnaire survey conducted at the end of the course, as well as students' academic performance. The results showed that PBL had the largest effect on academic performance among student respondents, particularly in the Construction Materials course.

However, students found it most suitable to learn in a combined style of lectures and group work, followed by lectures, fieldwork and lastly, PBL. This finding implies that some students are less comfortable with the PBL approach, and unaware of its effectiveness in deepening their conceptual understanding.

It is recommennded to conduct similar studies to further establish PBL improves academic performance

Acknowledgements

The author thanks Prof. Fukahori, S. for her great support and valuable discussions. We also thank professors of Philippine Normal University, International Exchange Office of National Institute of Technology, and all students who learned construction materials together.

References

Larmer, J. PBL Starter Kit. Buck Institute of Education: USA.

What are the 4C's of 21st Century Skills? Applied Educational Systems.https://www.aeseducation.com/careercenter21/what-are-the-4-cs-of-21st-century-skills

Takeda, N. & Ishida, Y. (2015). Practical use of the minute paper to bring out intellectual honesty of students. ISATE2015, 478-482.

ANALYSIS OF THE STUDENT PERFORMANCE IN ENGINEERING MODULES BY APPLYING FLIPPED CLASSROOM CONCEPT

K.C. Ying *[a] and Benson K.H. Hung [b]

[a,b] Lecturer, Department of Construction,
Hong Kong Institute of Vocational Education (IVE), Vocational Training Council (VTC), Hong Kong

*:kc_ying@vtc.edu.hk

Abstract

Flipped classroom is an innovative and proactive learning method that suits the needs of the new generation tertiary education students. A pilot study conducted in two modules of the Higher Diploma in the Civil Engineering programme found this method to be satisfactory. Accordingly, the present study conducts further analysis to discuss the academic performance and feedback of students in two selected Civil Engineering modules that apply the flipped classroom.

The flipped classroom concept has been introduced in vocational training for tertiary education. Meanwhile, online consultations and video tutorials have been introduced in the Higher Diploma of Civil Engineering programme for analysis. Two technical modules, namely, Temporary Work Design and Highway Engineering, applied the concept. A three-year study is performed, and the results indicate an improvement in student academic outcomes of both modules.

Literature review has been conducted to gain knowledge about the concept of flipped classroom. Desktop analysis has been conducted to investigate the academic performance and student satisfaction regarding the two modules. This research provides statistical analysis.

A 10% increase in the average marks and passing rate was observed from academic years 2015–2016 to 2018–2019. Moreover, the number of students who obtained a grade of 'A' increased in the Temporary Works Design module but remained the same in the Highway Engineering module. The passing rate and number of students who obtained an 'A' generally increased as well. The positive result found in student feedback has been recorded.

The concept of flipped classroom has been proven suitable for the new generation. Students exhibited improvements in their general academic results and study performance. Implementing the flipped classroom concept with technical support is therefore recommended in tertiary education, especially among the engineering modules.

Keywords: flipped classroom, online consultation, video tutorial, moodle, engineering module

1.0 Background

Different scholars have introduced the concept of flipped classroom in education with a reasonably satisfactory feedback. However, technical, financial and other reasons prevent the concept from being fully incorporated into today's college or undergraduate education, especially in engineering. This research initially summarises the flipped classroom from the perspective of scholars, presents a case study from a college and finally draws concluding remarks.

Engineering is a challenging subject for college and undergraduate students owing to its considerable amount of mathematical concepts, laboratory sessions, computer applications and technical terminologies. Students require a strong mathematics and science background and the ability to apply computer software to analyse results and remember technical terminologies. This requirement explains why engineering is one of the most difficult programmes in tertiary education.

A pilot study has been conducted in the Institute of Vocational Education (IVE), Vocational Training Council (VTC), Hong Kong. The study investigated the academic performance and satisfaction of Higher Diploma students in the Civil

Engineering programme when the lecturers applied the flipped classroom concept in two of their modules, namely, Highway Engineering and Temporary Work Design.

The two modules applied different flipped classroom concepts. Highway Engineering used online consultation, whereas Temporary Work Design employed online video tutorial to enhance the learning interest of the Civil Engineering students.

Academic performance and student feedback were recorded and analysed in this research. The later section presents the findings and recommendation for further discussion.

2.0 Literature Review

Marks J. et al. (2014) summarised the common positive feedback from Civil and Environmental Engineering students and the improvement of academic results in their study. Traditional lecture may not necessarily be removed because it still has the advantage in message delivery. However, positive feedback and opinions from students found that flipped classroom is beneficial to students' academic results, satisfaction and learning interests. Morin B. et al. (2013) found a good academic result by comparing their inverted and non-inverted classroom student groups. Engineering students who attended the inverted or flipped classroom learning method generally obtained better academic results. However, neutral feedback was drawn because students provided both positive and negative feedback.

Nelson N. (2014) summarised that the traditional learning method encourages surface and strategic learning. Accordingly, the flipped classroom method increases the students' accountability, engages a dynamic learning environment and improves the depth of learning. In the study, engineering students who attended the flipped classroom method obtained better academic results (in both passing rate and better grades). Students were observed to be active, accountable and comfortable to participate in class.

The flipped classroom concept provides a proactive learning opportunity to students. Active study is required by using online facilities, such as videos, online consultations or online question and answer sessions. Freeman S. et al. (2014) summarised that active learning increases student performance in science, engineering and mathematics. In their study, the average examination scores improved by approximately 6% in active learning sections.

Manson G. et al. (2013) investigated the students' academic performance and analysed the feedback from students under flipped classrooms and traditional learning. Better academic results were drawn, and positive feedback were received when they applied the flipped classroom concept in their trial study for software engineering students. The advantages and challenges to apply flipped classroom concepts were also identified. In general, the flipped classroom requires collaboration between instructors and students. Instructors need extra time to prepare materials, such as video tutorials or online systems, and the students must learn proactively to follow the progress of the module.

Lape N.K. et al. (2014) had a similar expectation but did not draw the same results. The academic results of students in two pilot modules (ENG82 and MATH45) were similar for both flipped classroom and traditional method. Worse, student feedback regarding the flipped classroom was not encouraging, showing that students did not always welcome the application of flipped classroom. The study raised the question on how to execute the flipped classroom concept into modules and the need for further discussion.

Karabulut-ilgu A. et al. (2018) reviewed different articles that discussed the students' academic performance and feedback on flipped classroom application. They found an increasing trend of engineering sub-disciplines that apply the concept of flipped classroom in their teaching and obtain good academic results and fair feedback from students. However, a lack of reports or frameworks to guide the development and evaluation of the flipped classroom approach and development was likewise noted.

Ying K.C. (2018) obtained considerable improvement by using video tutorial concept in his teaching of the Civil Engineering course. The average mark and the passing rate increased by 10% from the academic year (AY) 2015/16 to 2017/18. The number of students who attained 'A' grades also increased. A three-year rolling study was performed to investigate whether the academic performance can be sustained as improving and subsequently drew positive preliminary results.

In summary, the flipped classroom method provides an opportunity for students to focus on the process required to analyse, investigate, design, demonstrate and communicate knowledge within a guided environment. Flipped classroom leads both tutors and students to continue working hard, communicate and match students' expectations. Better academic results and a general positive feedback are the encouraging effects on both tutors and students. However, this concept still has a long way ahead to tackle the challenges faced by scholars, instructors and students.

3.0 Methodology

A case study has been conducted to investigate the academic results and feedback from Higher Diploma students in the Civil Engineering programme of IVE, VTC in Hong Kong. The sample is approximately 100 students. Flipped classroom concepts have been applied to year 1 students studying the Highway Engineering module and year 2 students studying the Temporary Works Design module. Different flipped classroom concepts have been applied for the two modules: the Highway Engineering module used the online communication system (Telegram used for online communication), and the Temporary Works design module employed video tutorial (video uploaded to MOODLE, an online system provided by VTC, Hong Kong). The flipped classroom concepts were applied in AY 2017/18 and 2018/19. Academic results and student feedback have been recorded for discussion and further study.

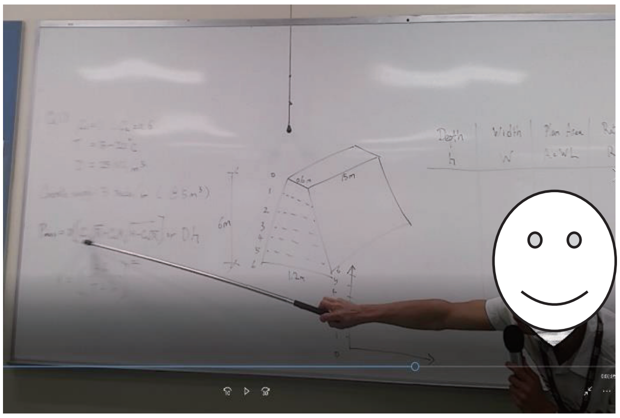


Figure 1: Video tutorial which upload into the Moodle system

Figure 2: Telegram platform for online consultant

AY 16/17			AY 17/18			AY 18/19		
Total No.	Pass rate	Grade A	Total No.	Pass rate	Grade A	Total No.	Pass rate	Grade A
311	79.7%	27.6%	234	68.8%	21.4%	215	85.6%	29.8%

Table 1: Overall Academic results in Highway Engineering

AY 15/16			AY 16/17			AY 17/18			AY 18/19		
Total No.	Pass rate	Grade A	Total No.	Pass rate	Grade A	Total No.	Pass rate	Grade A	Total No.	Pass rate	Grade A
123	79.5%	1%	166	85.9%	1.8%	73	87.3%	8.5%	107	89%	8.4%

Table 2: Overall Academic results in Temporary Works Design (Applied Flipped Classroom concept)

In AY 2016/17, no flipped classroom concept was applied in the Highway Engineering module. The passing rate and percentage of students with ‘A’ grades were 79.7% and 27.6%, respectively (Table 1). In AY 2017/18 and 18/19, the flipped classroom concept (online consultation) was used in the module. The passing rate and percentage of students with ‘A’ grades increased from 68.8% and 21.4% to 85.6% and 29.8%, respectively.

Ying K.C. (2018) recorded the passing rate and percentage of students with ‘A’ grades in the Temporary Works Design module from AY 2015/16 to 2017/18. In Table 2, the author recorded the marks in 2018/19 for further study. The passing rate and percentage of students with ‘A’ grades in AY18/19 were as well as those of the previous year.

The academic results of students studying the two modules maintain a high passing rate percentage. The average passing rates of the Highway Engineering and Temporary Works Design were 78% and 85%, respectively. The percentages of students attaining ‘A’ grades in the Highway Engineering and Temporary Works Design were 26.2% and 5% respectively. Overall student feedback is satisfactory, indicating that students were satisfied of the teaching delivery of these two modules.

The overall passing rate of the Highway Engineering and Temporary Works Design in the Civil Engineering course is high. However, the percentage of students attaining ‘A’ grades in Temporary Work Design module Engineering course is not considerably high.

By comparing a three-year rolling study in the same module recorded by Ying K.C. (2018), the passing rate and percentage of students attaining ‘A’ grades in the Temporary Work Design are found to be consistent (Table 2). No sustainable improvement was found in the fourth-year survey, but a consistent value remained. No information was provided for Highway Engineering because of its two-year data (AY 2017/18 and 2018/19).

4.0 Findings and Analysis

The flipped classroom concept has been applied in two modules of the Higher Diploma course in the Civil Engineering programme of IVE, VTC in Hong Kong. The two modules are Highway Engineering and Temporary Works Design. The former used online consultation method, whereas the latter employed video tutorial method. Academic results and student feedback of these two modules have been recorded. Generally, improvement was found in the academic results by using the flipped classroom concept in this pilot study. Student feedback is neutral regarding the use of the flipped classroom concept.

The overall passing rate of these two pilot modules is high. The teaching method using the flipped classroom concept has a proven advantage. However, concrete conclusions cannot be drawn owing to the similarly high passing rate and percentage of students with ‘A’ grades that use the traditional teaching method. The performance is similar to the findings of Lape N.K. et al. (2014) that different modules have different needs in module delivery. The writers agreed that traditional teaching module has its advantage and matches the need of students in the different modules. By contrast, the flipped classroom concept can fit a particular module but not all modules in the engineering discipline.

The percentage of students with ‘A’ grades in the pilot study (Temporary Works Design) is not significantly high. The writers agreed that using the flipped classroom concept as a teaching method and the test or examination paper differs among modules. Arguing that several examination papers are slightly difficult (may be a new format or style that students have not yet encountered), whereas others are much easier (the question is straight or ones that the students have previously known) is futile. As Manson G. et al. (2013) mentioned, the success of flipped classroom delivery highly depended on the instructor or lecturer instead of the method.

A 15% failing rate was recorded for Temporary Works Design module even when it used the video tutorial method. Thus, the flipped classroom concept can be deemed to provide a proactive platform for instructors and students. Students must also exert efforts to pre-study and re-study the video via an online system to strengthen their knowledge.

Similar to that of the previous AY, the percentage of students who attained ‘A’ grades in the pilot study (Highway Engineering) is high. No significant improvement was found even when it used the flipped classroom. The number of students attaining 'A' grades is high but not in a normal distribution mode. Thus, no significant difference can be drawn between the academic performance of a flipped classroom and the traditional method. Figure 3 shows the mark distribution from AY 2016/17 to 2018/19.

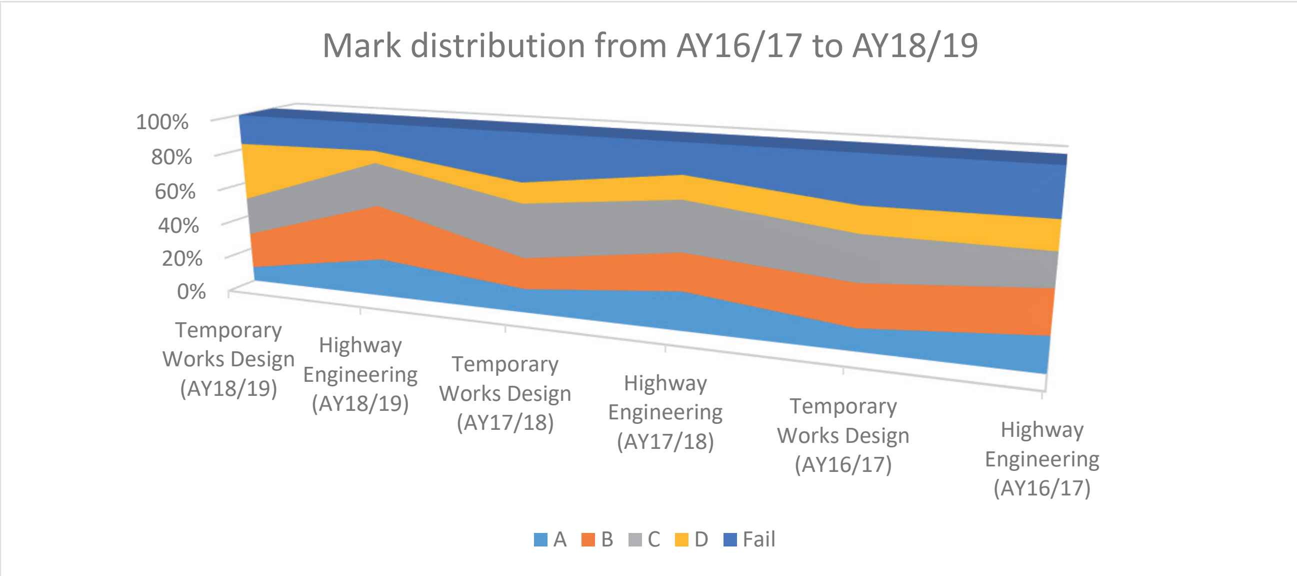


Figure 3: Mark Distribution from AY16/17 to AY18/19

Freeman S. et al. (2014) identified that the flipped classroom provides a platform to encourage a proactive learning environment between instructor/lecturer and the students. The concept is appreciated if the students are willing and active to learn and if the instructor/lecturer correctly adopts the flipped classroom concept. The writers have no information on whether the instructor/lecturer of these two pilot studies correctly adopted the right concept. Furthermore, no solid conclusion has been drawn from the student feedback because no measures were made to ask particular feedback on the application of flipped classroom concept but rather inquired about the general performance of the instructor/lecturer.

A comparison with the results of Ying K.C. (2018) shows no further significant improvement between the percentage of passing rate and attaining 'A' grades in AY 2018/19. Did this finding imply that the flipped classroom concept led the academic performance to reach a peak but which now cannot be sustainably improved? Did the flipped classroom concept help students who are 'poor' in academic performance or background? The answer is questionable. Dynamic factors affecting the percentage of passing rate and A grades include different examination papers and standards of students. The examination papers and student academic background of the four consecutive years differ, and no information is available on whether the flipped classroom concept only led the academic performance to reach a peak but then cannot be sustainably improved. To answer this question, further investigation and discussion are recommended. No information was available in the Highway Engineering module in this course, which only has a two-year data; therefore, only the Temporary Works Design module is solely discussed.

In addition, the instructors are not professional teachers because they obtained Civil Engineering degrees but not Education or teaching lessons. This fact raises the question on whether the teacher would correctly perform the flipped classroom concept. The instructors should be trained in teaching techniques and skills.

• Students appreciated the video tutorial • The video is useful for revision • Students can do pre-study at home • Students can restudy the tutorial through online system even absent from the class

Table 3: Student feedback in Temporary Works Design module

Student feedback is subjective. Neutral feedback was recorded in Table 3 because several students liked the flipped classroom method but others do not, similar to the study of Lape N.K. et al. (2014). Table 3 records a few of the feedback. The findings suggest further investigation and a suitable questionnaire form to particularly ask about the feedback and satisfaction of students after the module using the flipped classroom concept.

5.0 Concluding Remarks

As a pilot study, the flipped classroom concept has been applied in two modules (Highway Engineering and Temporary Works Design) of the Higher Diploma course in the Civil Engineering programme. Consecutive academic performance has been recorded. Online consultation was used in Highway Engineering, and video tutorial was employed in Temporary Works Design.

Tables 1 and 2 record and present the academic results. No significant improvement was found in the Highway Engineering module between applications of the flipped classroom concept and traditional learning. Passing rate and students attaining 'A' grades are high and insignificantly different between using and not using the online consultation method. However, students actively used the online consultation media (Telegram) to ask and answer questions. The media provides a proactive and good communication between students and instructor.

The academic performance retained a consistent and significant result in the Temporary Works Design module by using the video tutorial method. The passing rate and students attaining 'A' grades are significant and similar to those in the last two years (AY 2017/18 and 2018/19). Students are recommended to conduct pre- and re-studying of the online video to strengthen their knowledge and consequently obtain passing or better grades in their study.

Sufficient training is recommended for instructors to effectively perform the concept of flipped classroom. At times, the performance of the flipped concept depends on how, when and where to execute the concept. Training and encouraging instructors to adopt the concept would increase interest in the study.

Traditional teaching method still has the advantage, and the challenges in the flipping classroom concept require solutions. Discussion and further study are necessary on how to execute effectively the flipped classroom concept. Nonetheless, the method is highly recommended in engineering teaching.

Finally, further investigation is necessary to collect the feedback and academic result from the students. This concept still has a long way to develop but appears to be an effective engineering teaching and learning method in the tertiary education.

REFERENCE:

Freeman S, Eddy S.L., McDonough M., Smith M.K., Okoroafor N., Jordt H. and Wenderoth M.P. (2014) "Active learning increases student performance in science, engineering and mathematics", Psychological and cognitive sciences, pp 1-6

Karabulut-ilgu A., Cherrez N.J. and Jahren C.T. (2018) "A systematic review of research on the flipped learning method in engineering education". British Journal of Educational Technology, Vol49, No.3, 2018, pp398-411

Lape N.K., Levy R., Yong D.H., Haushalter K.A., Eddy R. and Hankel N. (2014) "Probing the inverted classroom: A controlled study of teaching and learning outcomes in undergraduate engineering and mathematics", 121st ASEE Annual conference & exposition, Paper ID#9475, June 15-18 2014, Indianapolis, IN

Marks J., Ketchman KJ and Riley II D.R. (2014) "Understanding the benefits of the flipped classroom in the context of sustainable engineering" 121st ASEE Annual Conference & Exposition, Paper ID#9053, June 15-18 2014, Indianapolis, IN

Mason G., Shuman T.R. and Cook K.E. (2013) "Inverting (Flipping) classrooms – Advantages and Challenges", 120th ASEE Annual conference & exposition, paper #7230, June 23-26

Morin B, Kecskemety K.M., Harper K.A. and Clingan P.A. (2013) "The inverted classroom in a first-year engineering course", 120th ASEE Annual conference & exposition, paper #7230, June 23-26

Nelson N. (2014) "Flipping the engineering classroom", proceeding 2014, Canadian engineering education association (CEEA14) conference. Paper #90, June 8-11, 2014. Canmore AB.

Ying K.C. (2018) "Improvement of study performance by applying flipped classroom concept in engineering module", ISATE 2018, Sept 2018, Hong Kong

DESIGN OF THE CONSTRUCTION ENGINEER EDUCATION FOR i-CONSTRUCTION AND ITS APPLICATION FOR THE RECURRENT EDUCATION PROGRAM

M. Ohya[*,a], J. Asada[a], N. Hirose[a], Y. Okazaki[a], S. Arao[a], S. Kawahara[a], M. Takebe[a], M. Suto[a], T.Yamaguchi[a], Y. Matsuzaki[a], S. Omote[b] and S. Ajiki[b]

[a] Department of Civil and Environmental engineering, National Institute of Technology, Matsue College, Matsue, Japan
[b] Center to Support Practical Education, National Institute of Technology, Matsue College, Matsue, Japan

*E-Mail ohya@matsue-ct.jp

Abstract

In recent years, the Japan construction industry has actively introduced ICT to improve productivity at each stage of the construction production process, for example, research, planning, design, construction, maintenance, and so on. The Ministry of Land, Infrastructure and transport is promoting "i-Construction" to improve the productivity of construction sites by utilizing innovative technologies. In order to promote i-Construction in the field of construction, it is necessary to train civil engineers who have expertise in construction and basic skills of BIM/CIM. In addition, the program to solve regional problems by utilizing the basic knowledge and 3D-modeling skills of construction is necessary for the education of the future construction engineers. If students and working people are able to learn together, by using the BIM/CIM virtual space to experience the construction process, it seems possible to help students understand the construction technology early. In consideration of the above, the authors are building a new curriculums of construction engineer education for i-Construction, using 3D-modeling, UAV and simulation, at National Institute of Technology, Matsue College since 2015. This program uses a variety of 2D and 3D software, for example JW-CAD, Sketchup, AutoCAD, Revit, InfraWorks, Civil3D. This program is going to learn the basic usage of each software and also learn how to use it to work with various software. The content built here can be used not only for students, but also for the recurrent education of construction technicians in society. As a feature of this curriculum, we have established a new recurrent education program in which a college and communities cooperate. In this paper, we outlines the technical education program for i-Construction, conducted in 2018. We also report the status of implementation of the recurrent education program. In 2018, ten members of the society participated in the recurrent education program. The results of the questionnaire survey by the participants are reported. From the results, it was confirmed that the program is interesting and effective.

Keywords: *i-Construction, BIM/CIM, construction engineer, recurrent, education*

Introduction

In Japan, a large number of skilled workers and construction engineers will retire due to the aging population. In order to maintain the quality and appropriate functioning of social capital for the future, it is the most important issue to secure young people who will be responsible for the future of the construction industry. In recent years, construction workers have declined nationally. In particular, the decrease in the provinces is remarkable. The construction industry and local governments in Shimane has a majority of engineers over the age of 50. Construction workers are expected to decrease significantly over the next decade in Shimane. It has been pointed out that the same level of productivity and speed of development may lead to a lack of construction administration in Shimane. In recent years, the Japan construction industry has actively introduced ICT to improve productivity at each stage of the construction production process, for example, research, planning, design, construction, maintenance, and so on. The Ministry of Land, Infrastructure and transport is promoting "i-Construction" to improve the productivity of construction sites by utilizing innovative technologies. In order to promote i-Construction in the field of construction, it is necessary to train civil engineers who have expertise in construction and basic skills of BIM/CIM. In addition, it is necessary to develop the construction engineers who have problem-solving ability by utilizing the basic knowledge and 3D-modeling skills for construction. In order to overcome these challenges, it is necessary to innovate way of work and construction education with collaboration of industry, government and academia in construction industry.

We believe that it is necessary to train construction engineers who can utilize information technology that is responsible for this innovation at an early stage. It is tried as a new engineer education in the construction engineer curriculum of National Institute of Technology, Matsue College. In this paper, we will introduce an overview of the curriculum for the development of new construction engineers in our department. As an initiative to foster construction engineers in cooperation with industry, academia, and government, we will use recurrent education the contents of the construction engineer education corresponding to the i-Construction established our department. In addition, we introduce the initiatives that implemented the recurrent education program that students and adults learn together.

Curriculum Overview

From 2016, the curriculum of the Department of Civil and Environmental Engineering, National Institute of Technology, Matsue College, has been added to the curriculum for traditional construction engineers, with the acquisition of skills capable of i-Construction and problem-solving project. We are trying to build a new curriculum. The new curriculum assumes the introduction of CIM, which aims to improve operational efficiency and sophistication of construction production systems. The outline and the concept of the educational curriculum for construction engineer compatible with i-Construction is shown in Figure 1. Within the five-year course, we have organized a curriculum for acquiring basic subjects as construction engineer and 3D-modeling basic skills related to CIM by the third year.

The software used includes 2D JW-CAD, as well as Sketchup, AutoCAD, Revit, Civil3D, and InfraWorks for 3D-modeling. In the curriculum, students learn the basic usage of each software and then learn how to work together with each software. Table 1 and Figure 2 provide an overview of the CIM model. We are developing teaching materials that enable the creation of the required CIM model using various 3D-CAD software. In the current construction production field, design books are mainly delivered with 2D-drawings, and 3D CIM models are treated as reference materials. Also, electronic delivery is drawn in accordance with the CAD drafting standard and must be submitted in electronic media such as DVDs in SXF format (P21 or SFC format). In the electronic delivery procedure corresponding to the currently revised i-Construction, 3DA model (3D annotated model) embedded in the 3D shape attributes such as dimensions and material properties is required. The delivery of intermediate files, LandXML and IFC formats, and 3D original data shown in Table 1 and Figure2 are required as the data to be delivered. Also, 2D drawings are positioned as reference materials. In the future, construction engineers are required to have skills that can easily create various 3D models required to correspond to i-Construction (see Figure 2). In addition, there is a need for skills capable of data collaboration and practical technical capabilities that enable effective use of the 3DA model in each construction stage.

In this program, in order to acquire the skills to create various CIM models (see Table 1 and Figure 2) in 3D-CAD software required by i-Construction, Autodesk's InfraWorks, Civil3D and Revit shown in Figure 3, we have created educational materials that can handle terrain data, create road models, create structural models, create integrated models that work together with three software, and design in detail. InfraWorks is capable of integrating various 3D data into a 3D model of the terrain. It is an important software for the cooperation of each software. Civil3D is a software that can handle 3D coordinate values such as surveys, capturing terrain data, and detailed road design that integrates vertical section, cross section, and road information into road alignment. Civil3D's teaching materials are developed to learn the basic methods of road design, and the materials that can be performed to calculate the amount of material using the corridor surface. Revit developed teaching materials to enable the placement of parts and the creation of original parts in order to learn the basics of creating 3D structure model. We also developed basic teaching materials for the purpose of learning methods for reinforcement of reinforced concrete structures, which are expected to be used more often in practice. In this project, students will learn not only how to use each software, but also how to use it in cooperation. After learning the basics of 3D modeling, the curriculum plans to learn how to apply 3D modeling to case studies and numerical simulations. This material has been developed to be available from WBT(e-Learning platform) of my college.

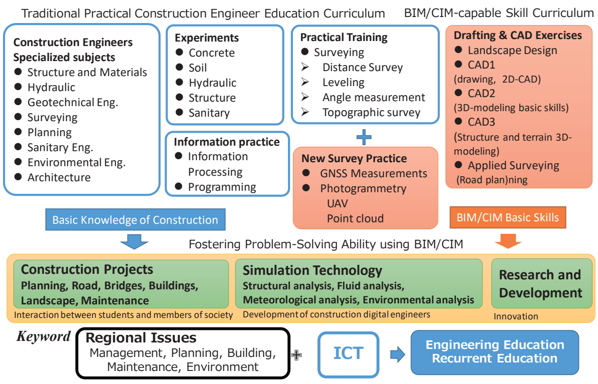


Figure 1 Concept of the Educational Curriculum for Construction Engineer Compatible with i-Construction.

Table 1 List of delivery file formats for each CIM model.

CIM model	Storage file format	Contents of deliverables
Alignment model	LandXML1.2 or Original File	Road alignment, River alignment, Structure alignment
Alignment-geometry model	LandXML1.2 or Original File	3D-model connecting road cross section design
Surface model	LandXML1.2 or Original File	3D surface model of survey results
Structural model	IFC2X3 or Original model	3D-model of target structure for design or construction
Geological model	Original model	Boring model, 3D ground models such as quasi-3D cross-section and surface model.
Landscaping	LandXML1.2 or Original File	Numerical map data
Integrated model	Original File	The 3D model created by various tools is integrated. It can be worked lightly.

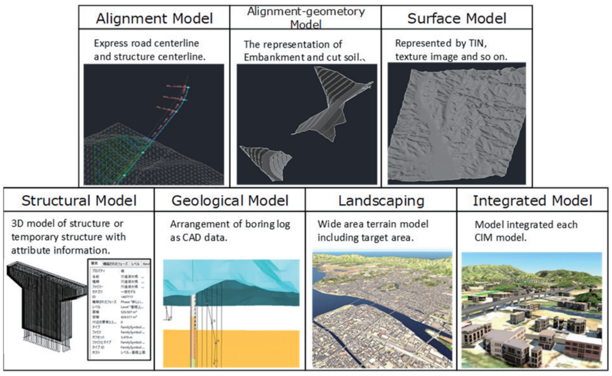


Figure 2 An overview of CIM model.

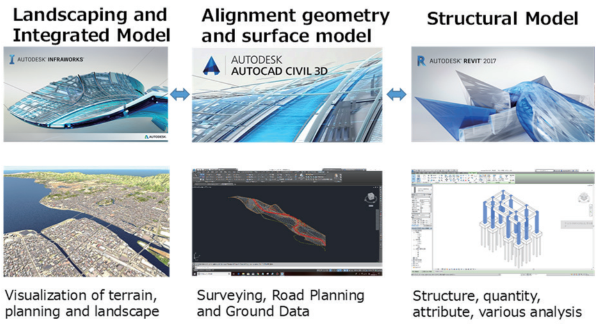


Figure 3 3D-CAD Overview

Recurrent Educational Program

If students and working people are able to learn together, by using the BIM/CIM virtual space to experience the construction process, it seems possible to help students understand the construction technology early. The feature of this project's recurrent education program is that working peoples take the usual courses of our college. Figure 4 shows the brochure at the time of recruitment. The lectures are eight times and final lectures present the results of group assignments. This time, there were 13 applicants. In the end, 10 members of the eight companies and one government participated in the recurrent education program. Photo 1 shows the status of the recurrent education program. In 2018, the final presentation was widely open to members of the regional council, the governments, industries in Shimane, and other NIT colleges. Photo 2 shows the status of the final presentation.

Regional Council for Supporting the Human Resource Development for the Construction Engineers of the Next Generation in Shimane

The Regional Council, for supporting the human resource development for construction engineers of the next generation, was established to promote recurrent education for construction engineers compatible with i-Construction through industry-academia-government collaboration. The purpose of this council is to promote the introduction of ICT technology in the construction field in Shimane and to promote the use of new technologies for the next generation.

Figure 4 Recurrent Program Brochure.

Photo 1 The Status of the Recurrent Education Program.

Photo 2 The Status of the Final Presentation.

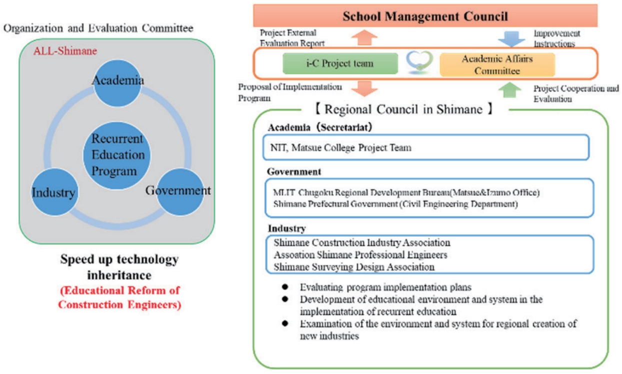


Figure 5 Regional Council for Supporting the Human Resource Development for the Construction Engineers of the Next Generation in Shimane.

Conclusions

In this paper, we report a case study of the constructing the curriculum of effective for the development of construction engineers compatible with i-Construction and the use of the contents developed for recurrent education for working people. The purpose of this recurrent education is to accelerate the speed of early understanding of construction technology and the development of construction engineers by learning PBL type group lectures using 3D modeling and students and working peoples together. The established regional council was able to discuss the verification of issues, evaluate projects, and establish a system for support, and to provide cooperation and environment improvement for construction engineer training projects.

Many students and working peoples who took the recurrent education program said that the project was effective. In addition, they were told to continue the recurrent educational projects while improving the content of this project. At this year's council, we received high praise for our recurrent education program. In the following year, we will improve and implement the contents of the educational materials and implementation programs. We would like to further develop this recurrent education program into practical regional issues, where students work on the technical aspects of 3D modeling to solve problems, and, working peoples work on the problem solving in the aspect of construction knowledge.

Acknowledgements

This work supported by JACIC received research grants (from 2015 to 2016) and a grant "KOSEN 4.0 Initiative" by the Ministry of Education, Culture, Sports, Science and Technology to implement the recurrent education program. We gratefully acknowledge the work of past and present members of our department.

INTRODUCTION OF TRINITY OF SCINCE: PHYSICS, EXPERIMENT AND MATHEMATICS FOR INTERNATIONAL STUDENTS

S.Fujii[*,a] and H. Ohno[a]

[a]National Institute of Technology, Tokyo College/Department of Liberal Arts,1220-2 Kununugida, Hachiohji, Tokyo, Japan

*fujii@tokyo-ct.ac.jp

Abstract

In the class of physics and engineering, instructors often face students who feel difficulty in basic concepts on physics and mathematical expression of physical quantities. Especially for international students there exist more gaps between high school education in their originated country and education at the third grade students in Tokyo College, in terms of experimental experience and the differences in curriculum. To make up of these gaps, experimental experiences and 'discovery' of the connection between experiments, physics and mathematics is necessary. To promote these connections, we will propose experiment class of physics with data analysis by introducing some primitive experiences.

To make international students experience the distinction between linear graph and semi-log graph, radioactive experiment is one of the most appropriate choices. We prepared radioactive experiment, which is β-ray (^{90}Sr-^{90}Y) absorption experiment using Geiger-Müller counter. To simplify the experimental procedure, we previously checked and picked up the linear region in semi-log graph vs. the thickness.

As the first step, international students measured β-ray intensity [cpm] vs. the thickness of aluminium plates [mm]. As the second step, they plotted linear graph (10 m×1m). They found sharply decreasing curve in the plot. The differences of the linear plots are ambiguous. They just see their plots are similar in shape and sharply decreasing. As the third step, they plotted semi-log graph (A4 size). And the intensity in semi-log scale vs. the thickness is plotted. Students discussed why the same tangent appears in semi-log scale intensity vs. the thickness. Compare to Japanese students in our college, they could join the experiments more actively. Especially actual comparison between plots in linear and semi-log scale is extremely helpful for understanding the property of exponential decrease of intensity read from the plot.

We conclude that this separation into step by step procedures (we call this modified "small steps method") is useful as an introduction, so that more intuitive and unified understanding of experiment, physics and mathematics, that is "Trinity of science" can be realized.

Keywords: *physics education, experiment, international students, small step method, linking mathematical concept*

1.Introduction

In National Institute of Technology, Tokyo College (NITTC), wider variety of students learn Physics, and sometimes feel difficulty in understanding basic concept in physics as well as mathematics. On the other hand, a few international students enter the third grade in NITTC, and some students feel difficulty in learning physics. The reason of the difficulty may stems from gaps between the education in their originated country and the physics education in NITTC in terms of the differences in experiences in experiment and curriculum in originated country.

Based on our daily trial and error experiences, we found that teaching aids in physics make introduction to basic physical concept easier, such as sharing situation, giving students concrete imagination, and definitions of the technical terms involved with physical situation. We have kept making students shift their way of understanding depart from just memorizing results or facts for essential understanding physical laws with simple logical structure, so that students can apply them to understand various phenomena in principle. Some courses of lectures (Azabu, 2009) gave us an idea of employing small teaching aids in physics class. These small teaching aids can make students to share and understand basic physical concepts by themselves. And (Ushio et.al, 2000) shows that it is possible to have experimental physics class even before students learn the theme of physics. Direct measurement and closer examinations of the data taken in physics experiment, can even lead students to 'discovery' of basic concepts and physical laws hidden in the phenomena. We are especially inspired by "the instructional design"

(Shimamune, 2008), which introduce some instructional key-points, such as “committing what they learn”, “distinction between composite skills and component skills” and “small steps: increasing their successful learning experiences by partly mixing the contents with what they have already learned“.

In order to improve our physics education of international students, it is convenient to start from the gap problems in less experimental experiences of international students. It is important not only to have more experimental experiences but also to unite physical law (principle), phenomena (experiment) and mathematics (knowledge) in any experimental analyses.

We will propose an example of the introductory class design for international students to give them a good opportunity to unite experiment, physical law and mathematics as intuitive as possible. We will report β-ray absorption experiment class in this paper. This theme requires understanding of logarithm in the experimental and mathematical analysis. To reinforce understanding of semi-log analysis, we separate this (composite) skills required to analyze semi-log graph into two pieces, such as a skill required to plot in linear scale and a skill required to plot in semi-log scale. In the words of Shimamune (2008), “distinction between composite skills and component skills”, can be realized in our proposal.

The realization of separation of composite skills can be achieved in the plotting stage of this experiment. When plotting data ranging from 1 to 8000 cpm in linear scale, large plotting area (8m×1m) is needed and experiences to plot such large area help students to understand intuitively how sharply exponential decrease occurs. And experiences plotting in linear scale can give the imagination, what it is like to be exponential change. Thus students can overcome mental barrier to accept new phenomena. And Plotting in linear scale will also give educationally good effects for international students because such uncommon procedure can be of recreation and the recreation elements in experiment can stimulate students’ interest.

The realization of “small steps: mixing already learned contents” can be achieved in the stage of summary of experiments introducing mathematical background after series of plotting in linear and semi-log scale.

By separating composite skills into component skills and mixing already learned contents, each experimental procedure can be made more understandable and intuitive. We call this way of realization modified “small step method”. With our method we will challenge to give students the unified understanding of physics, experiments, mathematics starting from primitive experiences, namely understanding as “Trinity of science”.

In our lecture experience in applied mathematics (Vector analysis and complex analysis) and freshman level mechanics class, our modified small step method works well. This small step method will encourage students to distinct and recognize more clearly on what they understand and what they cannot.

The β-ray absorption experimental class is designed to connect mathematical concept “logarithm” and radioactivity experiment by comparison of linear graph and semi-log graph.

The rest of this paper consists of Materials and Methods where details of our class design are reported in section 2, Results and Discussion where the reaction of students and evaluation of our step by step method are shown in section 3 and conclusion will be remarked in section 4.

2.Materials and Methods

2.1. Illustration of β-ray absorption instruments

At first, we will illustrate the usual procedures and purpose of β-ray absorption experiment. When β-ray emitted from the source encounters some obstacles such as metal plates, part of the β-ray is absorbed and its intensity decreases. The usual purpose of the β-ray absorption experiment is to evaluate the change of intensity qualitatively, that is to measure absorption coefficients μ [cm²/g]. However, our purpose in this paper is not to evaluate absorption coefficients μ [cm²/g] . To promote intuitive understanding of β-ray absorption phenomena, we simply set equivalent distance as [mm] rather than [g/cm²]. The details of the experimental simplification will be discussed in section 2.2.2.

Secondly, we will illustrate our instruments for β-ray absorption experiment. Figure1 Illustration A and 1B shows the whole configuration of experiment (Geiger-Müller tube (GM-tube) and counting instrument) produced by Shimadzu Rika Corporation. In Figure1 Illustration B, it is shown that the source board where β-ray source are fixed, β-ray absorption board, and β-ray absorption instruments where both boards are set inside. The thickness of aluminium plates can be adjusted by combination of plates with thickness 0.1mm, 0.2mm, 0.3mm, 0.5mm, 1.0mm, 2.0mm, 3.0mm, 5.0mm

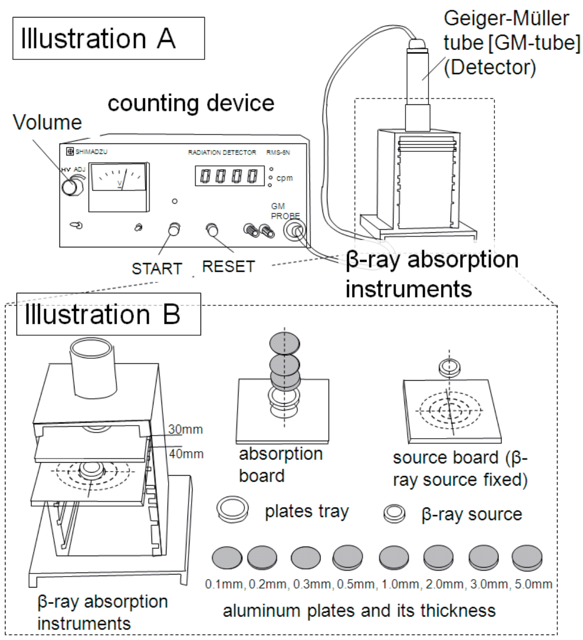


Figure 1. β-ray detector (GM tube) and counter

respectively from the left in the Figure1 Illustration B. The absorption board and the source board are set in the absorption instruments at 30mm and 40mm distances from the GM-tube, respectively.

Thirdly, we will describe the usage of the instruments. In Figure1 Illustration A, the volume adjusts voltage applied on the GM tube, the start switch counting up the pulse signal from the GM tube and the reset switch resets counting rate shown in the window in the counting instrument. In this experiment we choose 1 minute timer (cpm mode) and setting applied voltage as 450 volts. We used two old instruments (450 Volts) and one new instrument (400 Volts).

$$^{90}\mathrm{Sr} \underset{27.7\,\mathrm{yr}}{\overset{\beta^- \, 0.546\,\mathrm{MeV}}{\longrightarrow}} {}^{90}\mathrm{Y} \underset{64.0\,\mathrm{hr}}{\overset{\beta^- \, 2.27\,\mathrm{MeV}}{\longrightarrow}} {}^{90}\mathrm{Zr}$$

Figure 2. Nuclear reaction in β-ray source

Figure 2 shows nuclear reactions in the β-ray source. Main β-ray signal contribution from the source to the GM tube comes from the second reaction such as $^{90}Y \rightarrow {}^{90}Zr$, which has shorter half-life in nuclear decay compare to the first reaction starting from ^{90}Sr. We prepared β-ray sources with different intensities, such as 8231.8cpm (A), 6352.3cpm (B) and 5370cpm (C).

2.2. Class design

2.2.1 Class scheduling

Experimental class is 120 minutes class in total. International students are divided into 3 groups and each group measured different β-ray sources, respectively source (A),(B) and (C). And the class schedule is classified as the following 3 parts.

Beta-ray absorption experiment

Experiment 2-1

background radiation			
the 1st time	the 2nd time	the 3rd time	avrage $\overline{N}_0$ [cpm]

Attention : Average value should be rounded to the first decimal place example : 14.32≒14.3

Experiment 2-2

beta ray source B

intensity of β -ray source [cpm]	Net intensity (only one time) [cpm]
$\overline{N}_\beta$	$\overline{N}_\beta - \overline{N}_0$

thickness	intensity [cpm]			average [cpm]	Net intensity [cpm]
d[cm]	the 1st time	the 2nd time	the 3rd time	$\overline{N}_\beta$	$\overline{N}_\beta - \overline{N}_0$
0.10					
0.15					
0.20					
0.25					
0.30					

Attention : Average value should be rounded to the first decimal place

example: 220.45 ≒220.5

Attention : plot linear graph on the corridor of experiment room with approximated curve (show it by thick color curves).

Experiment 2-3

After the removal of all aluminum plates

only if you have time

Thckness of air	intensity [cpm]
ℓ[cm]	(Only one time)
4.0	
5.0	
6.0	
8.0	
12.0	

Attention : plot linear graph on the corridor of experiment room with approximated curve (show it by thick black curves).

Figure 3. Worksheet for beta-ray source B

Part1: Introduction (30 minutes)

elementary knowledge of radioactivity, background radiation, cause of radioactivity due to nuclear reaction, annual average dose equivalence [mSv/yr], property and difference of α,β,γ-ray, usage of β-ray absorption system (See Figure1 Illustration A)

Part2: experiment (45 minutes)

Background intensity, β-ray absorption measurement using thin aluminium plates, data plots both in linear and semi-log scale based on worksheets (See Figure 3)

Part3: Discussion between linear and semi-log graph

Comparison, physical Interpretation and mathematical relation

We will describe the reaction of students in each part later in section 3.

2.2.2. Simplification of experimental procedures

As emphasized in the beginning of section 2.1., some experimental procedures are simplified. The units of horizontal axis is set to [mm] rather than [g/cm^2], although the equivalence distance [g/cm^2] gives more universal value than [mm] in the sense that the equivalent distance doesn't depend on materials used in the experiment. And in order to assist students who are not get used to evaluating numerical data taken in experiment, attentions are included in the worksheet (See Figure 3), saying present significant digit is up to the first decimal place with concrete example of rounding numerical values.

One of simplifications is limiting times of repeating the same experiment. Due to randomness of β-ray emitting timing from the source arisen from quantum mechanical origin, experiments with the same aluminium thickness generally needs to be taken many times to calculate average value. For the lack of time, the number of repeating the same experiment is limited to only 3 times. And the net intensity N [cpm] is calculated by $N = \overline{N}_\beta - \overline{N}_0$ where $\overline{N}_\beta$ is the average intensity [cpm] and $\overline{N}_0$ is the averaged background intensity [cpm]. (See Figure 3).

As in the worksheet of Figure 3 (gray shaded region), one of such simplifications is to specify measuring range of thickness of aluminium plates. Each range are determined by pre-experiment so that plotting results in semi-log scale appears as line, and other range of region are removed because the data away from the line in semi-log scale will include many implications for international students. By this removal of non-exponentially decaying region from worksheets based on the pre-experiment data (see next section 2.2.3.), clearer interpretation of data is possible, which is appropriate for the present purpose. Then even international student can find the exponential decay of the β-ray intensity from the experiment.

2.2.3. Pre-experiment by instructors

Pre-experiments by instructors are necessary especially for international students who have less experience in physics experiment and no knowledge of radioactivity, because they are beginners of radioactive experiment and soon will be loss at where they are. For example, we simplified and limited experimental conditions, which are the range of the thickness.

We searched linear area in β-ray absorption by measuring three kinds of β-ray sources (A,B and C) in advance. Table 1A and table 1B are the examples of the background and the β-ray absorption experiment both for the source B, which shows the intensity [cpm] vs. whole range of the thickness of aluminium plates. The range of the thickness is listed in the beginning of this section 2. In pre-experiment intensity [cpm] is measured by six times for each aluminium thickness as in Table 1B.

Table 1A. Pre-experiment data for source B

background			
1st time	2nd time	3rd time	average
16	12	16	14.7

Table 1B. Pre-experiment data for source B

beta ray source	Aluminium thickness [mm]	1st time	2nd time	3rd time	4th time	5th time	6th time	avarage	Net intensity (cpm)
B	0.0	6480	6392	6284	6474	6319	6253	6367.0	6352.3
	0.1	5341	5372	5257	5295	5429	5358	5342.0	5327.3
	0.5	3288	3376	3343	3292	3340	3265	3317.3	3302.7
	1.0	1905	1908	1978	1925	1882	1936	1922.3	1907.7
	2.0	398	451	444	422	428	425	428.0	413.3
	3.0	60	49	57	63	61	55	57.5	42.8
	3.5	27	24	27	25	28	35	27.7	13.0
	4.0	18	22	9	28	14	12	17.2	2.5
	4.5	32	17	14	18	17	29	21.2	6.5
	5.0	24	19	21	16	16	26	20.3	5.7

Using the net intensity [cpm] in Table 1B, we can plot intensity vs. whole region of the thickness graph in semi-log scale as in Figure 4. then we limit the plotting data based on the gray region in Table 2, and we can find the approximately linear region of the data in semi-log scale. Whole data in Figure 4, include some effects in electron scattering. For the increasing thickness, the reason why intensity is increased again is due to back scattering of electron. In the educational point of view for international students to grab rough sketch of β-ray absorption experiment, removing electron back scattering and other effects make experiment easier and their discussion can be simplified, although real electron scattering phenomena is partially screened. Especially for the purpose of data fitting this simplification can be justified at least educational purpose. The screened data can be fitted to the following simple relation,

Table 2. Finding the exponential region

data summary	
Thickness [mm]	Intensity [cpm]
0.0	6352.3
0.1	5327.3
0.5	3302.7
1.0	1907.7
2.0	413.3
3.0	42.8
3.5	13.0
4.0	2.5
4.5	6.5
5.0	5.7

$$N = N_0 \, e^{-\mu x}, \quad \cdot \cdot \cdot \cdot \cdot \cdot (1)$$

where x is the thickness of absorbing plates and μ is the β-ray absorption coefficient.

We also searched the exponential part of the intensity data for other β-ray sources (A and C) and found and reflected as the range of thickness in worksheets (the sample is only shown in the case of source B as in Figure 3).

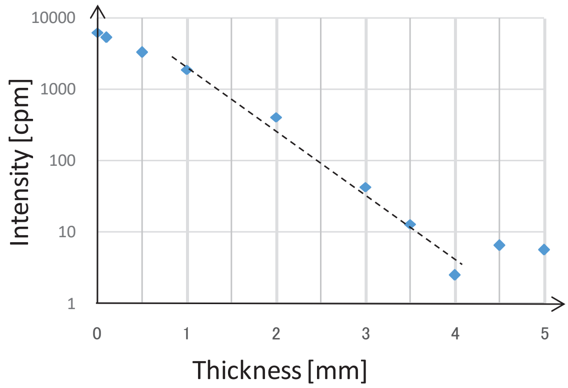


Figure 4. Pre-experiment: whole data

2.2.4 Students activity

Based on each worksheet, international students are plotting the data, intensity [cpm] vs. thickness with unit

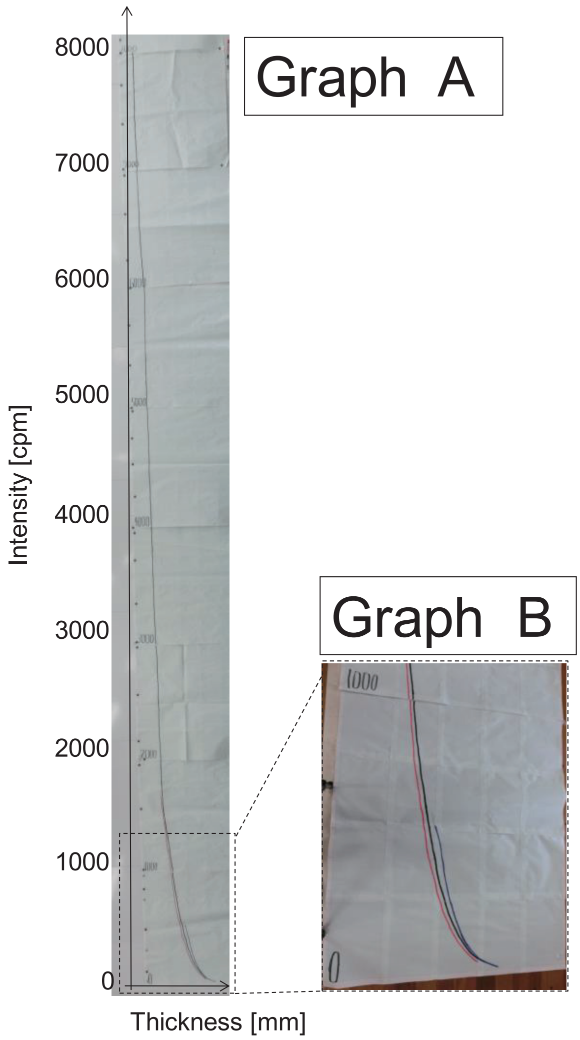


Figure 5. Linear graph and exponential decaying region

[mm] on large linear graph (8m×1m in length and width, 160 sheets of A4 1mm linear paper are pasted altogether). Due to the lack of time, data within intensity from 2000 cpm to 8000 cpm, are plotted by

only member of 1 group (See Figure 5 Graph A). And data within intensity 0-2000 cpm is plotted in 2m×1m region (Figure 5 Graph B).

After this linear plotting, we took standard analyzing method using graph in semi-log scale. As designed, the region chosen by pre-experiment (See Figure 6), shows

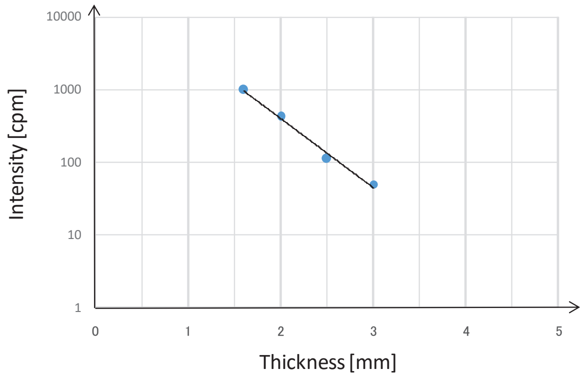


Figure 6. Exponentially decaying region

good linearity in semi-log graph. The lines have the same tangent in intensity vs. the thickness of aluminium plates.

3.Results and Discussion

We will evaluate our experimental class through students' activity.

For the part 1, introduction of basic knowledge of radioactivity and radiation, international students could understand our short introduction. And they could do experiment smoothly.

For the part 2, with this simplified experimental settings based on the pre-experiment, international students can roughly understand the characteristics of β-ray absorption phenomena for sources (A), (B) and (C) with different intensities. When they start experiment of background radiation, they wonder why experimental instruments start counting intensity [cpm] without any sources but they soon realized that it is because of the background radiation, which shows that we can successfully make each international student connect temporal knowledge of physics and experimental result. Next international students plot the data on linear graph. They enjoyed plotting on large graph (8m×1m) sheets, and experienced the sharply changing intensity, so that they could have primitive experiences on what it is like to exponential decrease of intensity by plotting the data in the linear scale. Successively by re-plotting the same data in semi-log scale, they learned how to plot semi-log graph and got to know its convenience: the data is compactly mapped from 160 sheets of A4 paper to one sheet of A4 paper.

For the part 3, we discuss the relation and implication from the plots. After plotting in semi-log scale, international students began to compare the semi-log graph to each other. In spite of using different intensities, the semi-log graph appears to be the same tangent line to one another as designed in section 2.2.3. They began to look curious about this result. Then it is the right time to interpret results and unify every concept. We explained that the reason of same tangent is due to the material feature for β-ray absorption under the unit thickness [mm]. And there still remains question: what is the meaning of line in semi-log scale mathematically. For such mathematical interpretation of semi-log scale graph, we referred to relation between exponential and logarithm using the known relation on intensity, eq.(1). And show that eq.(1) become line when you take logarithm. They looks convinced because they have already experienced and compared linear graph and semi-log graph using the same data as well as their understanding our mathematical explanation. Primitive experiences make them discover relation between tangent line in semi-log graph and physics, and make them discover mathematical relation between logarithm and exponential function. Thus, using large linear graph (See Figure 5 Graph A), we have succeeded in leading international students to the unified understanding of physics, experiment and mathematics, that is understanding as "Trinity of science". That is to say, by our step by step method, experimental facts, physics and mathematics can be more effectively unified in our class.

With this β-ray experiment, some experimental procedures are separated from one composite procedure: 'well-known' semi-log plotting into two component procedures: plotting in linear scale and plotting in semi-log scale. Although logarithm is known mathematical knowledge for international students, we intentionally include re-discovery procedures such as plot in large linear graph, which also works as recreation and refreshment.

4.Conclusions

To make experimental interpretation based on principle in physics and knowledge in mathematics clearer, we simplified experiment. When international students feel difficulty in understanding the concept or experimental procedures in daily trial and error physics education, there is a possibility that we can separate concepts or procedures into smaller pieces of component concepts or procedures. Difficult concept can be separated into smaller and more intuitive components. Such separation, for example, can be realized through primitive experiment and reinforcing mathematical knowledge. We have conviction that such separation can be applicable to other field of education. Besides introduction of such primitive experiences stimulates students' interest and give them energy to consider furthermore. Combination of our small step method with intuition and knowledge aids lead international students to logical and unified view of science, namely understanding as Trinity of science. We will end this report with phrase, "Thinks things into smaller steps, and end (difficulty) becomes starting point of our education. "

Acknowledgements

S.F. and H.O acknowledge to physics department stuff of NITTC to share their long standing experimental educational experience, and S.F.

acknowledge all the high school teacher in Iwate prefecture and Tokyo, who gave S.F. chances to discuss how to make students construct basic concept of physics by themselves.

References

Association for physics education of Japan (APEJ), Lecture course of basic experiment for physics class in high school, July (2019) held at Azabu high school

S.Shimamune, *Instructional Design –rule book for teachers*-, Dec.(2008) Sangyo Publisher inc.

U.Hideki, S.Maedan, H.Ohno, *Feature of physics education program in NITTC*, Applied physics education, Vol.24 No.1 (2000) p57-62

On the Support System KeTCindy for Creating Mathematics Teaching Materials Using TeX

S. Yamashita*,a

[a] National Institute of Technology, Kisarazu College / Division of Natural Science, Kisarazu, Japan

*yamasita@kisarazu.ac.jp

Abstract

Most mathematics teachers often use TeX for creating teaching materials. TeX is a typesetting system that can automatically adjust sentences that contain mathematical expressions. However, it is difficult for drawing figures and writing programs using TeX, and users require considerable techniques to realize them. In order to improve these, from 2006, I and my colleagues had developed KeTpic as a plugin for several mathematics softwares. Because KeTpic had no graphical user interface, users faced difficulty to grasp the whole picture of a complicated figure. Therefore, since 2014, we have been developing KeTCindy that collaborates both KeTpic and the interactive geometry software Cinderella. KeTCindy can create various types of mathematics teaching materials such as slides for presentation and interactive presentation materials. In this paper, I introduce that KeTCindy is total support system for creating mathematics teaching materials using TeX.

Keywords: *TeX, mathematical software, interactive geometry software, Cinderella, R, Maxima, KeTCindy*

Introduction

Collegiate mathematics teachers often use TeX for creating teaching materials that are prints, reports, tests, and so on. TeX is a typesetting system that can automatically adjust sentences that contain mathematical expressions. However, it is difficult for almost teachers to draw figures and write programs in a TeX document. In order to draw accurate and beautiful figures in a TeX document, since 2006, the author and his colleagues (called KeTpic/KeTCindy Developing Group, in short, KDG) had been developing KeTpic as a plugin for several mathematics softwares that are Maple, Mathematica, Maxima, Scilab and R, and almost completed it as a plugin for Scilab in 2011.

Since KeTpic had no graphical user interface, users faced difficulty to grasp the whole picture of a complicated figure. Therefore, since 2014, KDG have been developing KeTCindy that collaborates both KeTpic and the interactive geometry software Cinderella. Cinderella has two screens: one is the interactive geometric screen (called main screen) and the other the script editorial screen (called Script Editor). Users write KeTCindy programs on Script Editor and grasp the whole picture of a figure on the main screen. KeTCindy enables users to create the followings:

- 2D drawings with several accessories: line types and width, inserting expressions and letters, and so on.
- 3D drawings as a projection with two spatial representations: one is the skeleton method at a crossing point that distinguishes the over-line with the under-line by creating a break in the line going underneath, and the other is the ridge-line method of a surface.
- Slides with animation and audio for presentation: animation has two types, one is movie and the other flip-book.
- Call and execution of mathematics softwares and C programing.
- HTML files written in JavaScript and KaTeX: the html file as a teaching material can be distributed to students' smartphones and tablets, and students can operate it freely and observe the change of mathematical phenomena.

KeTCindy has two TeX style files ketpic.sty and ketlayer.sty. The file ketpic.sty defines three distance variables for drawing figures. The file ketlayer.sty can set the position to insert a drawing.

From the above, in addition to printed materials, KeTCindy can create various types of mathematics teaching materials such as slides for presentation and interactive presentation materials. KeTCindy is total support system for creating mathematics teaching materials using TeX.

In this paper, the author introduces how to create three types of mathematics teaching materials that is prints, slides and HTML files using KeTCindy.

Preliminaries for Using KeTCindy

In this chapter, the author introduces how to install KeTCindy. KeTCindy has been registered with CTAN (Comprehensive TeX Archive Network) since 2016. You can go to the following website

https://ctan.org/pkg/ketcindy

by searching on "ctan ketcindy" (See Figure 1). You can download the folder named "ketcindy-master" by pressing the "Download" button. You open the folder named "forLinux"/"forMac"/"forWindows" according to the operating system for your computer. If you open the

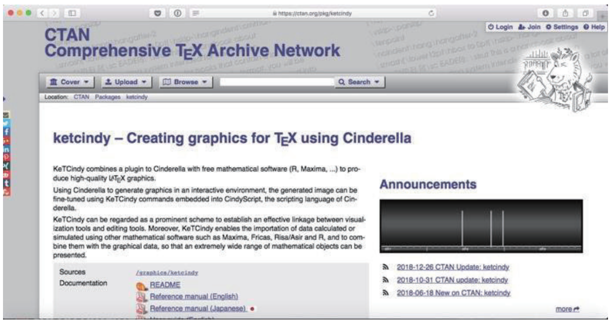


Figure 1. CTAN for KeTCindy

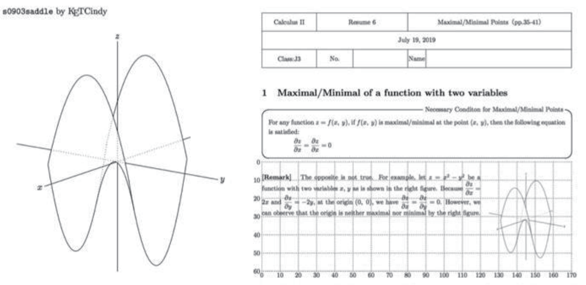


Figure 2. 3D figure (right) and TeX document (left)

pdf file "Readme…" and work as it is, the installation for KeTCindy is complete, and you can find the folder named "ketcindy".

The "ketcindy" folder has the folder named "samples" that contains many sample Cinderella files. If you rewrite these files and use them, you can create teaching materials as you want.

Printed Materials Using KeTCindy

In this chapter, the author introduces how to create a printed material for maximal/minimal values of functions with two variables. For any function $z = f(x, y)$ with two variables x, y, a maximal/minimal point (x, y) satisfies that $\frac{\partial z}{\partial x} = \frac{\partial z}{\partial y} = 0$, but the opposite is not true. For example, the origin (0,0) satisfies that $\frac{\partial z}{\partial x} = \frac{\partial z}{\partial y} = 0$ for the function $z = x^2 - y^2$, but the origin is neither a maximal point nor a minimal point. The origin is called a "saddle point". We will create a figure of the "saddle point" of the surface $z = x^2 - y^2$.

We open the folder named "S09surfaceC" in the "samples" folder, and copy the Cinderella file named "s0903saddle.cdy" on the desktop. We open this Cinderella file and move the two sliders named "TH" and "FI" to determine the viewpoint. For example, we set $TH = 75.80$ and $FI = 35.98$, and press the "Figure" button. You can automatically generate the folder named "fig" and open the pdf file as is shown in the left side of Figure 2.

We prepare a TeX document to insert a 3D figure for the saddle point of $z = x^2 - y^2$. A TeX document has two parts; the first part is the preamble and the second part the document. The preamble part is the following:

```
1 \documentclass{article}
2 \usepackage{amsmath,amssymb}
3 \usepackage{graphic,color}
4 \usepackage{ketpic,ketlayer}
  …
6 \usepackage{wrapfig}
  …
9 \setmargin{20}{20}{20}{20}
```

In line 4, two TeX style files for KeTCindy are available. The document part is the following:

```
11 \begin{document}
   …
30 \begin{layer}{170}{60}
31 \putnotesw{170}{5}{
   \scalebox{0.5}{\input{fig/s0903saddle}}}
32 \end{layer}
33
34 \begin{wrapfigure}{l}{120mm}
35 \noindent{\bf [Remark]}\hspace{1zw}
36 The opposite is not true.
   …
40 \end{wrapfigure}
41
42 \end{document}
```

From line 30 to line 32, we put the figure using the layer environment defined by the style file "ketlayer.sty". In line 30, if we change the second argument into "0", then the ruled lines in the left side of Figure 2 disappeared. From line 34 to line 40, using the wrapigure environment, we can write sentences while making a 50mm space in the right.

Slides Using KeTCindy

In this chapter, the author introduce how to create slides for the lecture of maximal/minimal values of functions with two variables. We open the folder named "S07slides" in the "samples" folder, and copy the Cinderella file named "s0702graphE.cdy" and the text file named "s0702graphE.txt" on the desktop. We write the manuscript of slides in the text file, and get PDF slides if we execute the Script Editor of the Cinderella file.

We open the Script Editor of the Cinderella file and write the following:

```
Settitle([
"s{60}{20}{Maximal/Minimal Points}",
"s{60}{50}{Satoshi Yamashita}",
"s{60}{60}{NIT, Kisarazu College}",
"s{60}{70}{July 19, 2019}"
],["Color=[1,1,0,0]"]);
```

When we execute the Script Editor and press the "Title" button in the main screen, we get a PDF slide for the title. We open the text file and write the following:

```
title::slide0::%wallpaper

%%%%%%%%%%%%%%%
main::Maximal/Minimal Points
```

```
5 \slidepage[m]
6
7 %%%%%%%%%%%%%%%%%%
8 new::Necessary Condition
9 %repeat=2
```

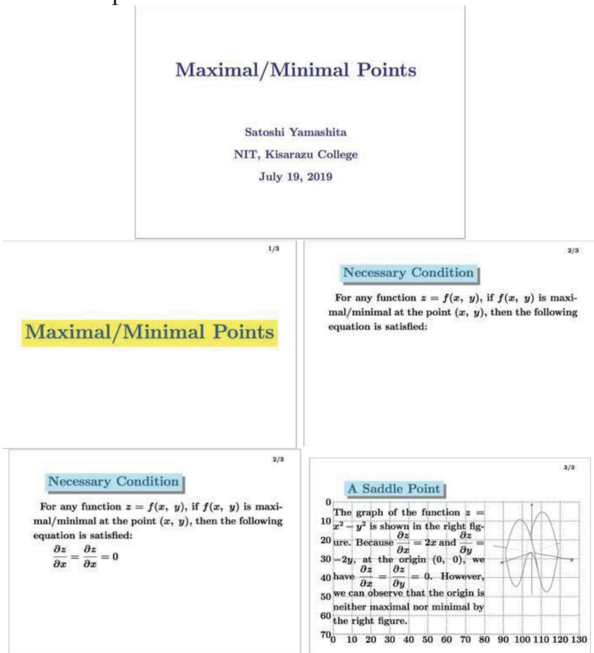


Figure 3. Slides using KeTCindy

```
10 \slidepage
11
12 For any function $z=f(x,\ y)$,
   if $f(x,\ y)$ is maximal/minimal at the point
   $(x,\ y)$, then the following equation is satisfied:
   \vspace{2mm}\\
13 %[2]::\hspace*{2zw}$\displaystyle
   \frac{\partial z}{\partial x}=
   \frac{\partial z}{\partial x}=0$
14
15 %%%%%%%%%%%%%%%%%%
16 new::A Saddle Point
17 \slidepage
18
19 layer::{130}{70}
20 putnote::sw{130}{0}::s0903saddle,0.5
21 end
22
23 \vspace{-5mm}
24 \begin{wrapfigure}[6]{l}{80mm}
25 \noindent
26 The graph of the function $z=x^2-y^2$ is shown
   in the right figure.
27 Because $\displaystyle
   \frac{\partial z}{\partial x}=2x$ and
   $\displaystyle \frac{\partial z}{\partial y}=-2y$,
   at the origin $(0,\ 0)$, we have
   $\displaystyle \frac{\partial z}{\partial x}=
   \frac{\partial z}{\partial y}=0$.
28 However, we can observe that the origin is neither
   maximal nor minimal by the right figure.
29 \end{wrapfigure}
```

From line 1 to line 2, we can create the title slide. From line 4 to line 5, we can create the slide for the main title. By line 9, we can create two slides; the first slide has line 12 and the second slide has both line 12 and line 13. From line 19 to line 21, we can put the figure in the right side of the slide.

HTML files Using KeTCindy

In this chapter, the author introduce how to create HTML files (called CindyJS files) using KeTCindy. Cinderella can be exported to HTML files using the macro CindyJS. Since 2018, KDG has been developing the macro KeTCindyJS in order to add the data generated by KeTCindy to CindyJS files. We open the folder named "S16KeTCindyJS" in the "samples" folder, and copy the Cinderella file named "s1501basic.cdy" on the desktop. We open the Script Editor of this Cinderella file and write the following:

```
Setketcindyjs(["Nolabel=all","Local=y"]);
//no ketjs

Setwindow([-2,2],[-1,4]);
hL=remove((-2)..2,[0]);
vL=remove((-1)..4,[0]);
forall(hL,
 Listplot("xdo"+text(#+3),
 [[#,YMIN],[#,YMAX]],["do"]);
);
forall(vL,
 Listplot("ydo"+text(#+3),
 [[XMIN,#],[XMAX,#]],["do"]);
);
tmp1=apply(hL,[#,text(#)]);
tmp2=flatten(tmp1);
Htickmark(tmp2);
tmp1=apply(vL,[#,text(#)]);
tmp2=flatten(tmp1);
Vtickmark(tmp2);

mf(s):=(
  regional(tmp,m);
  tmp=Assign("s^x",["s",s]);
  Plotdata("1",tmp,"x");
  Expr([log(4)/log(s),4],"n","y=a^x");
  Expr([2.5,1.5],"ne","a="+text(format(s,3)));
  m=Derivative("gr1","x=0");
  tmp=Assign("m*x+1",["m",m]);
  Plotdata("2",tmp,"x",["Num=1","Color=blue"]);
 Expr([2,m*2+1],"n","y="+text(m)+"x+1");
);

str="0.1";
//str=Textedit(0); //only ketjs
tmp=Strsplit(str,"=");
if(length(tmp)>1,
  vstr=tmp_2;
,
  vstr=str;
);
ss=Animationparam(2,parse(vstr),[2,3]);
```

39 mf(ss);

From line 2 to line 16, we can write the ruled dotted lines. From line 18 to line 28, we can the s-th frame of the animation. By line 38 and line 39, we define the animation using the definition of the s-th frame. We

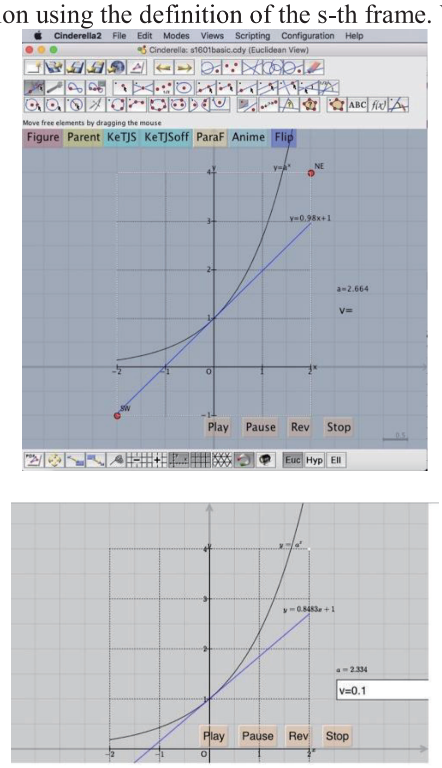


Figure 4. Main screen (upper) and a HTML file (lower)

return to the main screen, we generate a Text box "$v =$" with calculation by pressing the "$f(x)$" button and the "evaluate" button. When we push the "play" button, we can check this animation (See the upper of Figure 4). When we select "export to CindyJS.." from the pulldown menu "File" in the upper bar, we can generate a HTML file "s1601basic.html" using the macro in the desktop. We return to the main screen as is shown in the upper of Figure 4, and we can get a HTML file (as is shown in the lower of Figure 4) using KeTCindy with the online/offline version by pressing the "KeTJS"/"KeTJSoff" button, respectively.

Conclusion and Future works

In the above chapters, the autor introduced how to create the various teaching materials that are printed materials, slides and HTML files using KeTCindy or KeTCindyJS. In order to create printed materials using KeTCindy, we can not only create drawings by modifying some sample files selected from the "samples" folder, but you can also place the drawings in precise positions using the two style files "ketpic.sty" and "ketlayer.sty". In order to create slides using KeTCindy, we can create slides by modifying one Cinderella file and the text file associated with the Cinderella file in the "s07slides" folder. In order to create HTML files using KeTCindyJS, we can exchange HTML files using CindyJS to HTML files using KeTCindy by only pressing the "KeTJS"/"KeTJSoff" button.

Finally, the author propose some future works.

- KDG will improve KeTCindy and KeTCindyJS in order to create the various teaching materials more easily.
- KDG will investigate more effective teaching materials by taking a questionnaire to students in the class.
- KDG will publish effective teaching materials on the website in order to provide an environment accessible to many teachers.

References

Yamashita, S. (2016). Active Learning of Kosen Mathematics Using KeTCindy. *2016 IEEE/SICE International Symposium on System Integration*, pp.844-849.

Yamashita, S. & Kobayashi, S. & Makishita, H. & Takato, S. (2017). PDF Slide Teaching Materials Created Using KeTCindy. *The 17th International Conference on Computational Science and Its Applications, Proceedings, Part IV,* pp.285-300.

Yamashita, S. & Kitahara, K. & Takato, S. (2018). Active Learning Class Using PDF-Based Video Materials Generated Using KeTCindy. *2018 CDGAME Computer Algebra and Dynamical System in Mathematics Education*.

Yamashita, S. & Vallejo, J.A. & Takato, S. (2019). Calculation and Visualization of Fourier Series with KeTCindy and KeTCindyJS . *2019 ACA Applications of Computer Algebra*.

AUGMENTED REALITY IN CHEMISTRY: EFFECT ON LEARNERS' ACADEMIC ACHIEVEMENT AND LEARNING EXPERIENCE

Jayden W. J. Ang[*,a], S. Shi[b] and W. M. Kong[b]

[a] Nanyang Polytechnic, School of Chemical & Life Sciences, Singapore
[b] Nanyang Polytechnic, School of Engineering, Singapore

*jayden_ang@nyp.edu.sg

Abstract

The ability to visualize microstructures of molecules is vital yet challenging for chemistry learners resulting in learners being unable to assimilate important concepts. The absence of visuospatial skills leads to challenges in understanding, interpreting and translating molecular structures. To address this problem, educators introduced teaching aids, such as molecular modelling kit (MMK), to help learners visualise molecules. However, limitations of MMK such as cost, and availability led to the search of alternatives. With the advancement of technology, augmented reality (AR) has been employed in education and has been proven effective in making concepts visible. AR can extend learning to learners as it provides a ubiquitous experience, easily accessible by all through a smart device and app. Reported studies involved the use of AR in laboratory experiments and the periodic table. To the best of our knowledge, there are no AR apps developed for isomerism in inorganic chemistry. In this pilot study, the effectiveness of an AR app, as a teaching aid, in academic achievement and learning experience was determined. This study was conducted with second-year students (*N*=44) from the Diploma in Medicinal Chemistry at Nanyang Polytechnic. The AR app was developed using Blender and Vuforia. Quasi-experiment was employed: the experimental group (*N*=23) used AR while the control group (*N*=21) used MMK. Both groups with similar grade point average (GPA) profile, took individual pre- and post-tests. A survey was administered to the experimental group to understand their learning experience with AR. Greater increment in academic achievement was observed with AR (51% increment) compared to MMK (33% increment). The effectiveness of AR was especially noticeable with low-achieving learners. Learners also found the AR app interesting, enjoyable and useful. AR could be the reason for the increase in scores due to enhanced understanding of spatial molecular structures. These significant findings showed that AR is a promising educational technology in developing visuospatial skills which are important in chemistry and across STEM education.

Keywords: *Augmented Reality, Chemistry, Isomerism, Technology-enhanced Learning, Educational Technologies, Learning and Teaching Tools Effectiveness*

Introduction

Some topics in chemistry can be challenging as the naked eye is unable to visualise molecules. To illustrate these molecules, topics are traditionally taught using pen-and-paper by drawing the molecules. Yet, it is ineffective because molecules are three-dimensional (3D), not two-dimensional (2D). Some learners find it difficult to grasp important concepts, such as stereochemistry, as it requires learners to visualise and rotate 3D molecules which are presented in 2D. Although the ability to visualize microstructures of molecules is imperative, it was reported that visuospatial skills are absent even for university students (Harle & Towns, 2011). The absence of this skill leads to challenges in understanding, interpreting and translating molecular structures, resulting in learners memorizing structures (Quiros *et al.*, 2008).

Chemistry educators have used various teaching aids to help learners visualize these microstructures. The most commonly used teaching aid is the molecular modelling kit (MMK) which consist of "balls and sticks". Despite the benefits, there are some limitations:

- MMK is not cheap and more than one set of MMK is required to construct larger molecules. In addition, it is uneconomical for non-chemistry majors to invest in a set of MMK.
- It is impossible for schools to provide MMK to all students in a large group setting (lecture).
- Learners must comprehend molecules in 2D prior to building the correct 3D model.
- It could be cumbersome to carry a box of "balls and sticks" around.

Virtual reality (VR) and augmented reality (AR) has gained increasing attention in education with the advancement of technology. Reports showed that 3D environments can promote learning of chemistry with better efficiency and allows for distant learning (Dalgarno *et al.*, 2009; Merchant *et al.*, 2012; Stull *et al.*, 2013). Despite the benefits which VR brings, VR is still limited and unnatural. AR, on the other hand, is more natural as compared to VR as it has the added benefit of incorporating graphics onto the real world which can better illustrate ideas and concepts.

Reports utilizing AR in chemical education focuses on the periodic table and experiments in an AR laboratory (Singhal *et al.*, 2012; Cai *et al.*, 2014; Tuli & Mantri, 2015; Tacgin *et al.,* 2016). To the best of our knowledge, there are no AR mobile applications developed for the teaching of isomerism in inorganic chemistry. This research aims to evaluate the effectiveness of the AR application on learners' academic achievement and to gather information on the user experience of the AR application.

Materials and Methods

AR Application Development and Implementation

The AR application was developed using Blender (to create 3D molecules), Vuforia (software development kit to create the mobile application) and Unity (platform to develop the AR application). Students from the experimental group were provided with a QR code to download the AR application (Figure 1).

Figure 1. QR to download AR application (limited to Android).

(a)

(b)

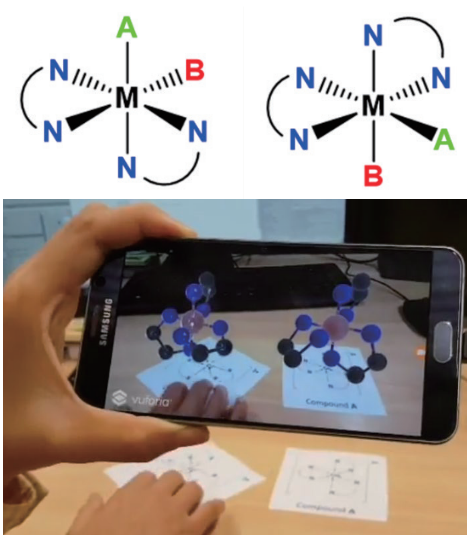


Figure 2. (a) An example of a pair of molecular image target, (b) rotating image target results in concurrent rotation of 3D molecule on screen.

After launching the AR application, learners will align their mobile device's camera to the image target (Figure 2a). The pre-loaded 3D image of the molecule will appear on the device's screen, right above the image target. Rotation/movement of the image target or the mobile device will result in the rotation/movement of the 3D molecule (Figure 2b). The application was developed in a way where two molecules can be rotated concurrently. This allows learners to determine whether the pair of molecules are stereoisomers. The image target could be embedded into handouts or displayed on screens and doesn't require a flat surface, like a table, for the application to work. However, the quality of the image target does affect the response time the application takes to generate the 3D molecule.

Research Design

The primary purposes of the research were (a) to evaluate the effect of the AR application on academic achievement and (b) to understand students' learning experience in using the AR application.

Participants were second-year students (N=44) from the Diploma in Medicinal Chemistry at Nanyang Polytechnic. Quasi-experiment was employed since students were pre-assigned to two tutorial classes. The experimental group (N=23) experienced the intervention (AR application) while the control group (N=21) used traditional teaching aid (MMK). Both groups took the same individual pre- and post-tests (maximum 10 points). A survey was administered to the experimental group to understand their learning experience with the AR application (Figure 3).

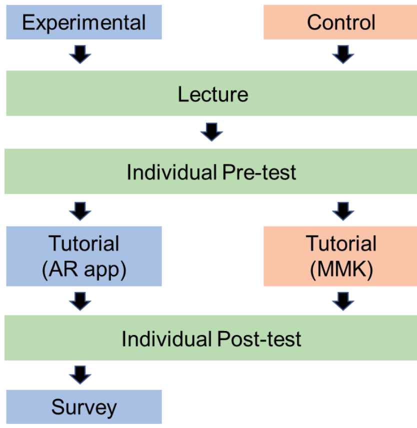


Figure 3. Research design to compare the effectiveness of the AR application with traditional MMK.

The topic (Isomerism in Metal Complexes) was taught in a combined lecture to both groups. At the start of the tutorial session, students from both groups took an individual pen-and-paper pre-test. Subsequently, students were provided the teaching aid, dependent on the group they are in, and completed a tutorial worksheet related to isomerism. After the worksheet, an individual post-test was administered. The results from both tests were compared to determine the effectiveness of the teaching aids. Students from the experimental group completed an individual survey to provide insights to user experience, perception and learning motivation while using the AR application.

Results and Discussion

Students' academic achievement was measured by comparing their pre- and post-test results (Table 1). For the control group, there was a significant difference in the mean score for post-test (M = 5.05, SD = 2.25) and pre-test (M = 2.57, SD = 2.01); t(20) = 4.65, $p<0.001$. Likewise, For the experimental group, there was a significant difference in the mean score for post-test (M = 6.87, SD = 2.40) and pre-test (M = 3.65, SD = 2.99); t(22) = 6.66, $p<0.001$. As expected, there is strong evidence that both AR and MMK improved learners' scores. There was a mean increase of 2.48 (2.57 to 5.05 marks, 33% increment) and 3.22 marks (3.65 to 6.87 marks, 51% increment) for the control and experimental group respectively in terms of learning gains [(post-test scores – pretest scores) / (10 – pre-test scores)]. Comparing AR and MMK, it was observed that the improvement of scores was greater when AR was used (mean difference = 0.74 marks). This observation was in line with the previous report (Abraham *et al.*, 2010).

Table 1. Mean scores and standard deviations (SD) of the test results for both groups (Base mark: 10).

Group	N		Mean	SD
Control	21	Pre-test	2.57	2.01
		Post-test	5.05	2.25
Experimental	23	Pre-test	3.65	2.99
		Post-test	6.87	2.40

According to Johnstone's Triangle, the study of chemistry requires learners to move between multiple levels (macro, symbolic and sub-micro) seamlessly (Johnstone, 1982), which is made possible with AR technology. AR potentially enhanced learners' understanding of the spatial structure of molecules (Maier & Klinker, 2013) and could be attributed to the increase in scores.

Results from the pre- and post-tests were further analyzed to determine improvement in test scores between low and high achieving students. Based on students' pre-test scores, low and high achieving students were categorized based on the bottom and top 33% respectively.

Table 2. Mean learning gains in pre- and post-tests scores and standard deviation (SD) for low achieving (low) and high achieving (high) students.

Group		N	Mean learning gains	SD
Control	Low	7	3.71	2.43
	High	7	0.86	1.57
Experimental	Low	8	4.25	2.25
	High	8	1.25	1.83

Mean learning gains (mean post-test scores – mean pre-test scores) for low and high achieving students is shown in Table 2. For the control group, there was a significant difference in the score for low achieving (M = 3.71, SD = 2.43) and high achieving (M = 0.86, SD = 1.57) students; t(12) = 2.61, p = 0.023. For the experimental group, there was a significant difference in the score for low achieving (M = 4.25, SD = 2.25) and high achieving (M = 1.25, SD = 1.83) students; t(14) = 2.92, p = 0.011.

Generally, the mean learning gains for low achieving students were approximately 3 points higher than high achieving students. In both groups, an increased in scores was observed with greater increment in low achieving students' scores than high achieving students' scores. This shows that both teaching aids benefited low achieving students more. Comparing learning gains, the experimental group utilizing the AR application has 0.54 marks more than the control group for the low achieving students and 0.39 marks more for the high achieving students. With these results, it can be concluded that low achieving students benefitted more from the AR application. However, the greater increase in scores for low achieving students could also be due to two reasons: (1) High achieving students were able to visualize the molecules even without teaching aids and (2) there was little room for improvement for high achieving students as their pre-test scores were higher.

Next, students' learning experience towards learning chemistry (isomerism) with the use of AR as an alternative teaching aid was studied. Students from the experimental group (N=23) responded to all survey items using a 5-point Likert scale (from 1= strongly disagree to 5=strongly agree) (Table 3).

Table 3. Mean scores and standard deviation (SD) of students' learning experience using the AR application.

	Mean	SD
Learning attitude		
How motivated do you feel about learning using the AR application?	3.43	0.84
Cognitive validity		
How helpful is the AR application in helping you to differentiate isomers correctly?	3.43	0.95
Does the AR application help you better visualize the molecules?	3.43	1.20
Satisfaction		
How interesting do you think is the AR application?	4.30	0.63
How enjoyable is the AR application?	3.96	0.71
Do you prefer to use the AR application in learning?	3.61	1.27
How satisfied are you with your overall experience with the AR application?	3.70	0.56

From Table 3, the question "How interesting do you think is the AR application?" has the highest mean value (M = 4.30), which is very close to the maximum of 5. This suggests that most students found the AR application interesting. The question on "usefulness of AR, learning motivation using AR and usefulness in the visualization of molecules" had the lowest mean value (M = 3.43). This suggests that although students found the application interesting, the application motivated their learning slightly and they found the application useful to a smaller extent. Generally, students gave positive evaluations of the AR application.

The relationship between learning attitude with cognitive validity and satisfaction was determined. In all cases (N=23), there was a strong, positive correlation ($r>0.5$) and were statistically significant ($p<0.001$). This suggests that learning attitude has a positive and significant correlation with learners' satisfaction and cognitive validity of the AR application. Students who are motivated will also be satisfied with the application and found the application useful. Hence, this shows that there is a significant improvement in learning experience after using the AR application. Survey results were consistent with those reported in the literature, stating that AR helped students understand 3D structures (Nunez *et al*., 2008) and improved their learning experience (Lordache *et al*., 2012).

The usability of the AR application would affect the user experience. During the tutorial session, some students from the experimental group commented that the AR application is "difficult to use". Being frustrated with the technology, students' motivation and perception on the usefulness of the AR application would decrease. Thus, this could have affected the survey findings. In addition, the small sample size involved could have affected the statistical significance of the research. In further studies, the research should include more students which will allow better generalization of the results.

Conclusions

An AR mobile application was developed as a teaching aid to teach isomerism in inorganic chemistry. This AR application could be modified and implemented for other levels and areas of chemistry (i.e. organic chemistry). The effectiveness of the AR application was evaluated by studying learners' academic achievement in comparison with the traditional MMK. Findings from the study showed that the increment in academic achievement was greater with the experimental group. The benefits of the AR application was also evident for low achieving students. Students who used the AR application found it interesting and gave positive feedback on their learning experience. These results were encouraging as the AR application was developed for learners in this digital age. With the ubiquity of mobile devices, learners are spending more time on their mobile devices. The AR application allowed learners to approach a challenging yet important chemistry concept anytime, anywhere.

Acknowledgements

The authors would like to gratefully acknowledge the support and guidance provided by Nanyang Polytechnic's School of Chemical & Life Sciences and School of Engineering.

References

Abraham, M., Varghese, V., & Tang, H. (2010). Using Molecular Representations to Aid Student Understanding of Stereochemical Concepts. *Journal of Chemical Education, 87*(12), 1425.

Cai, S., Wang, X., & Chiang, F.-K. (2014). A case study of augmented reality simulation system application in a chemistry course. *Computers in Human Behavior, 37*, 31-40.

Dalgarno, B., Bishop, A., & Adlong, W. (2009). Effectiveness of a virtual laboratory as a preparatory resource for distance education chemistry students. *Computers & Education, 53*, 853-865

Harle, M., & Towns, M. (2011). A review of spatial ability literature, its connection to chemistry and implications for instruction. *Journal of Chemical Education*, *88*(3), 351-360.

Johnstone, A. (1982). Macro- and Micro-Chemistry. *School Science Review, 64*, 377.

Lordache, D., Pribeanu, C., & Balog, A. (2012). Influence of specific AR capabilities on learning effectiveness and efficiency. *Studies in Informatics and Control, 21*(3), 233.

Maier, P., & Klinker, G. (2013). Evaluation of an Augmented-Reality-based 3D User Interface to Enhance the 3D-Understanding of Molecular Chemistry. *Proceedings of the 5th International Conference on Computer Supported Education*, (p. 294).

Merchant, Z., Goetz, E., Keeney-Kennicutt, W., Kwok, O., Cifuentes, L., & Davis, T. (2012). The learner characteristic, features of desktop 3D virtual reality environments, and college chemistry instruction: A structural equation modeling. *Computers & Education, 59*, 551-568.

Nunez, M., Quiros, R., Nunez, I., Carda, J., & Camahort, E. (2008). Collaborative augmented reality for inorganic chemistry education. *New Aspects of Engineering Education*, 271.

Quiros, M., Carda, I., & Camahort, E. (2008). Collaborative Augmented Reality for Inorganic Chemistry Education. *International Conference on ENGINEERING EDUCATION* (pp. 271-277). Greece: WSEAS / IASME.

Singhal, S., Bagga, S., Goyal, P., & Saxena, V. (2012). Augmented Chemistry: Interactive Education System. *International Journal of Computer Applications, 49*(15), 1-5.

Stull, A., Barrett, T., & Hegarty, M. (2013). Usability of concrete and virtual models in chemistry instruction. *Computers in Human Behavior, 29*(6), 2546-2556.

Tacgin, Z., Ulucay, N., & Ozuag, E. (2016). Designing and developing an augmented reality application: A sample of chemistry education. *Journal of the Turkish Chemical Society Chemical Education*, 147-164.

Tuli, N., & Mantri, A. (2015). Augmented reality as teaching aid: Making chemistry interactive. *Journal of Engineering Education Transformations*, 188-191

PRACTICAL COMMUNICATION CLASS WITH A "USA" THAT IS LOCATED TEN MINUTES FROM KOSEN

H. Nishiguchi*, Y. Yagyu*, T. Fukuda*, K. Haraguchi*, H. Matsuo*, K. Morishita*, H. Osato*, M. Ueda* and K. Higashida*

National Institute of Technology, Sasebo College/ Department of Mechanical Engineering, Okishin 1-1, Sasebo, Japan

*hiroshin@sasebo.ac.jp

Abstract

To increase Japanese students' practical English communication skills, we conducted exchange meetings with foreign students. In addition to previously established meetings, from 2013, we introduced four additional events with high schools and elementary schools located in the U.S. Navy base in Sasebo. These included a science fair, tour, expos and a STEM presentation. In the first three events, students from Sasebo-Kosen discussed scientific topics such as a liquid nitrogen experiment and an air bazooka. Through these simple science experiments, the students could learn how to use common English scientific language. In the fourth, King High School students introduced the research that they are conducting with Tsukuba University to Sasebo-Kosen students, for example, evaluating the impact of light frequency on the photosynthetic rate of plants.

In order to maximize communication opportunities, we employed "poster sessions", where students presented to each other about a poster. However, during these events, we found that designing exchange programs to include Q&A sessions was critical to allow students to engage in English. From their questions and exchanges of science information with native English speakers, the students noticed that although they needed to improve their English communication skills, they were able to engage in conversation with native speakers better than they had expected. Furthermore, one Sasebo-Kosen student suggested to us that this kind of education should begin in first grade.

Such experiences and knowledge can help students to break down their mental barriers to English communication and gain the confidence needed to speak with native speakers. Therefore, practical scientific English communication classes should be introduced in Kosen education as much as possible, in addition to typical English classes and communication training classes. Such a situation is not unique to Sasebo City, as there are many International Schools in every Japanese prefecture. Therefore, the education developed in this study can be extended universally.

Keywords: *STEM night, Sasebo Expo, STEM presentation, Navy, Scientific language*

Introduction

Since 2009, Sasebo-Kosen, Sasebo City, Japan, has had a strongly established English educational system based on small communication classes and exchange meetings.

In previous research (Nishiguchi et. al. 2013), we determined an improvement model for practical English communication skills involving three key elements (Figure 1). In order to improve students' English communication abilities according to this model, we must expand not only in-class learning, in which the students learn English grammar and writing skills, but also practice environments and opportunities for practical application. In our opinion, presently, Japanese language education in English focuses on classroom lecture considering with less opportunity of communicating in Enlgish, so students are often unable to communicate effectively in English in real situations.

Sasebo-Kosen has an exchange program with both Singapore and Xiamen. Furthermore, as Sasebo is welcoming to US military bases, Sasebo-Kosen has offered exchanges with elementary schools and high school students from these bases since 2014. These

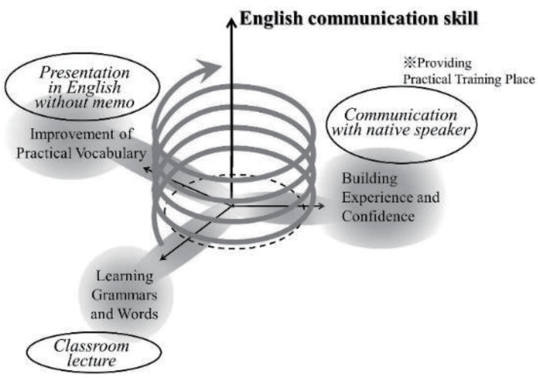


Figure 1. Model for the improvement of practical English communication skills, constituting of three key elements (Nishiguchi et. al. 2013).

exchanges involve fun science experiments for elementary school students (Science Fair) and introductions to engineering and research devices for high school students (Science Tour).

The current report examines some examples of these exchanges, both at Sasebo-Kosen and out in the field. Additionally, we will discuss the importance of conducting time-limited "poster sessions". Organizing exchange meetings allows students repeated practice, which in turn enables them to learn conversational English skills effectively. In this type of exchange, students practice not only every day and cultural conversation but also science-related English vocabulary and grammar.

Exchange meetings with students from Singapore and Xiamen

As we reported in previous research (Nishiguchi et. al. 2013), we had previously undertaken many foreign exchange meetings, although these were conducted only for 4th-grade students who had chosen the International English Communication Course from the course list and not with native English-speaking students. During this research, the presentation style for the exchange meetings was modified from oral session (Nishiguchi et. al. 2013) to poster session (Figures 2a, 2b, and 2c). In the oral presentation sessions, students could only speak for 30 seconds at a time, while the majority of the other students listened to the presentation without speaking. In contrast, in the poster presentation system, each student spoke for 35 ～ 45 seconds several. Figure 2d illustrates the rotation system in these poster sessions. Each presentation lasted three minutes, followed by two minutes of Q&A time. This process was repeated three times in total. The theme of each poster was Japanese culture, Sasebo, or Japanese idioms. About 50 students were divided into groups of four or five. There were 12 groups, out of which 6 groups gave presentations on the posters, while the others posed funny questions. In each three-minute presentation, one student talked for about 35 ～ 45 seconds. As the process was repeated three times, students were exposed to the same English-language sentences repeatedly.

Taking into consideration the rehearsal held one week before the exchange day, students took part in the poster sessions six times in total using the same explanatory sentences. Before the rehearsal native speaking teachers revised the sentences and posters, and the students were instructed to be able to use correct English grammar and pronunciation. Thus, the repetitive English speaking practice and support from native teachers allowed the students to accumulate familiarity with English sentences and confidence at the same time.

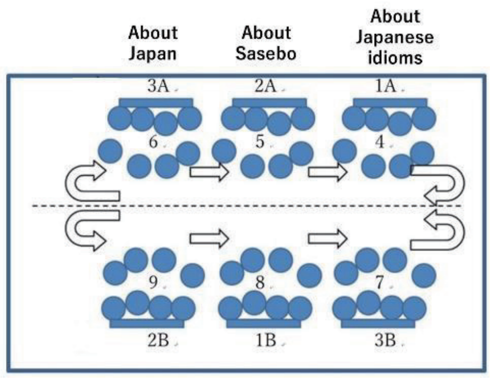
Practical Communication Class with a "USA" located 10 minutes from KOSEN

(I)Science Fair with Sasebo Elementary School and Science Tour with King High School

Figure 2a. Overview of a poster session.

Figure 2b. Example of a poster presentation.

Figure 2c. Comment time from native teachers after exchange meeting.



1.Presentation (3 min)→ 2. Q&A (2 min)→3. Move to next poster (1 min) After that 1,2,3 was repeated 3 times, the panel was rotated from back to front, and 1,2,3 will be started again.

Figure 2d. Rotation direction and time schedule during a poster session.

Figure 3. Science Fair with Sasebo Elementary school students.

Number shows devices. The guest went from device to device, located in various places in Sasebo-Kosen campus.

Figure 4. Science Tour with King High School students, including rotation map.

For this report, we have been conducting exchanges with U.S. Navy schools: a Science Fair for Sasebo Elementary school students and a Science Tour for King High School (Sasebo, Japan) students since 2014. The staff was 4th-grade students in the International English Communication Course. Figures 3 and 4 depict the Science Fair and the Science Tour, respectively. Although we conducted two different kinds of science events, the basic implementation method was the same as the cultural exchanges detailed above; the science exchanges were also conducted in the form of poster sessions. First, guests were assigned to each poster, and after a few minutes of explanation, a demonstration of the experiment was given. After each experiment, the students were rotated.

The themes of Science Fair (elementary students) were fun experiments, as below. The event was held at a kendo and judo center.

1. Liquide nitrogen experiment
2. Riding a Segway
3. Making music with pipes and a glass harp
4. Making a bamboo-copter
5. Shooting an air bazooka
6. Flying a X-zyro
7. Riding a hovercraft
8. Making artificial salmon roe

The Science Tour (high school students) experiments featured more technical scientific explanations and experimental devices, as below. It was also conducted in the poster-session style. The venue was the Kosen campus.

1. Tensile test
2. Charpy impact test
3. Spiral handrail
4. Underwater search robot and contactless electricity supply system
5. Casting
6. Laser cutter
7. Scanning Electron Microscope (SEM)
8. Artificial lightning generator
9. Drone

In addition to these exchange meetings, we conducted other exchanges like the below (II), (III), (IV) to increase opportunities to use scientific English for not only for 4th-grade students from the International Communication Course, but students from every grade.

At the same time, we established small after-school communication groups, named CAT (Chat-Act Time). Students who joined CAT were then able to go to events (II) and (III) described below.

(II) STEM (Science Technology Engineering Mathematics) Night at the Navy,

Figure 5 depicts the STEM night event. We conducted the exchange with Darbey Elementary School students in the U.S. Navy's Hario residential community on June 1st, 2018. The number of American students was about 300. Over 42 Sasebo-Kosen students and 4 teachers attended the exchange. Before going to the school, we prepared for the experiments and trained students on how to communicate about them in English in the CAT sessions. We prepared several experiments, including a pipe inspection robot, making a paper helicopter, making a flying gyrocopter, an air cannon, gleaming slime, and a plasma ball. During their time with the Navy, students were exposed to an American atmosphere. It was beneficial for them to feel something different from the

Figure 5. STEM night with Darbey Elementary School students.

usual Japanese atmosphere; we observed that most of them gained confidence in communicating with native speakers and thinking about traveling overseas, even if they had been initially hesitant and anxious about visiting the Navy community. In Sasebo, we can visit "America" with little cost and in a short time. By exchanging these simple science experiments with native speakers, the students learned how to use scientific language that is often used in English.

(III) The Sasebo Expo in Collaboration with Sasebo City

Sasebo City launched a new project in May 2017 named the "Sasebo Intercultural Project" and lead by city mayor Norio Tomonaga. This project focuses on promoting English communication within Sasebo City in the hopes of making Sasebo a bilingual town. As shown in Figure 6, Sasebo Expo was launched as one of the main approaches to these project goals.

1st Sasebo Expo (February 2018)

15 students from Sasebo-Kosen volunteered to take part in this event as "support staff". We prepared two experiments: "making a replica of your own finger" and "making a pon-pon ship", both of which take about 20 minutes each. However, the experiments had to be conducted in a noisy, narrow space, surrounded by 200 attendees, and the staff was so busy they did not have much discussion time. As a result, the experiments were demonstrated without many opportunities for communication.

2nd Sasebo Expo (May 2018)

We conducted the same experiments in a tent outside of the hall. This space, and the removal of the pon-pon ship experiment, increased opportunities for our staff to communicate calmly and clearly in English. However, even though the communication time itself was increased, students still just conducted the experiments without much discussion, even distributing handouts describing the experiments to the other students. This was one of the main problems to be solved and required a new mechanism to encourage them to communicate more in English.

3rd Sasebo Expo (November 2018)

The 3rd Expo took place in the Kyomachi arcade. This venue is a shopping street, which meant that many members of the public could visit the experiment booth. This time, we conducted 4 experiments: (1) a toy replica of a fuel-cell vehicle, (2) liquid nitrogen experiments, (3) a drone game and (4) making a replica of your own finger. By increasing the number of experiments, the volume of scientific languages used to explain the experiments was also increased. In addition, we introduced a new conversation system during the experiments; we included time for Q&A in the experiment and asked guests about the reactions caused by adding liquid nitrogen to a balloon, grass, a bouncy ball, and a banana. In this way, we could carry out experiments with much mutual conversation, which may have improved the student stuffs English skills.

4th Sasebo Expo (May 2019)

This time, we prepared just two experiments: the drone game and the liquid nitrogen experiments. The time taken to make the finger statue was difficult for each individual which made us too busy to communicate with guests in English, therefore this experiment was omitted in the 4th Expo. In contrast, the liquid nitrogen experiments enabled us to answer questions and to increase the English dialog between guests and staff. In the drone game experiment, the staff needed to explain how to use the remote controller. However, sometimes a visual demonstration was used instead of verbal description in English.

Figure 6. Sasebo Expo held by Sasebo City. Sasebo-Kosen and the other high school students demonstrated science experiments and flower arranging to children living in the nearby U.S. Navy base.

(IV) A STEM Presentation in Sasebo-Kosen

Figure 7 depicts the STEM presentation King High School students introduced at Sasebo-Kosen to explain the research they are conducting with Tsukuba University, such as evaluating the impact of light frequency on the photosynthetic rate of plants, the effects of temperature on the cellular respiration of macroinvertebrates, and measuring the “quality” of rice (palatability vs. nutrient content of rice strands). Although the English used by the King High School students at this event was of a high level, the Sasebo-Kosen students were able to meet the challenge and communicate with the King High school students during eight minutes of presentation time and four minutes of Q&A time. The staff present taught 4th-grade students in the International English Communication Course.

From the Sasebo-Kosen students’ questions following these exchanges, as well as exchanging science information with native speakers, they noticed that they needed to improve their English communication skills, although they were able to engage in conversation with native speakers better than they expected. Furthermore, one Sasebo-Kosen student suggested that this kind of education should begin in first grade in Kosen.

Discussion

In order to increase communication time during this type of science and language exchange, the experiments need to contain communicative Q&As and some visualization, as well as be impactful and pique curiosity.

Science exchange meetings like these create a “win-win” situation for both Japanese and American students. Japanese students can improve their use of scientific language in English, while American students can gain familiarity with new scientific knowledge. The Navy school suffers from the fact that there is no university to provide younger students with science experiences or prevent them from leaving science education. In place of a university, Kosen makes a valuable contribution to the Navy schools with these exchange meetings. This "win-win” relationship is important for the sustainability of such ventures.

As we previously suggested (Nishiguchi et. al. 2013), it is critical for English language learning to expand not only in-class English (in which the students learn grammar and writing skills), but also practice environments and practical situations. Through the exchanges described in this report, we found poster sessions to be more effective than oral presentations because the poster sessions allow for many more chances to practice the use of English.

Sasebo is a city with a good relationship between the Americans and the Japanese, however, it is not unique in this. There are 125 International Schools in Japan, therefore, the pedagogy developed in this study can be extended any school with a relationship with a foreign school should hold exchange events, which give students practical opportunities to introduce foreign students to their traditional events and practice their English. For example, Sasebo-Kosen has already introduced foreign students from the U.S. Navy, students from other junior high schools, and ALT teachers to local cultural festivals in our school. Figure 8 shows the example of invitation from King High school to the annual events in Kosen. Furthermore, we found that introducing CAT sessions, in which the students can communicate with native teachers for 40 minutes per week, was universally beneficial.

The number of students who could experience English communication opportunities was limited in the exchanges discussed in this paper. In other words, most students don’t have the opportunity to experience practical English communication. However, in thinking about a future sustainable model for English language education, Sasebo-Kosen will start a global educational project in this year and introduce exchange meetings with Sasebo Elementary school students to all 1st-grade

Figure 7. STEM presentation from King High school students at Sasebo-Kosen.

students. In this plan, we will also introduce time for making posters and preparing experiments, as we previously did for the 4th-grade students in the International English Communication Course.

Implementing this exchange system for a whole first grade is a challenge because although some students are interested in learning English, those who are not have difficulty maintaining the motivation to improve their English skills. Nevertheless, we believe that providing practical situations for students to practice real English conversation induces interest and curiosity in English, even for those who are not interested at first. In the future, our target will be expanded from 1st grade to 1st and 2nd grades in 2020, and in 2021 to 1st, 2nd and 3rd grades, when we believe that the 4th-grade International Communication Course students grade will be able to undertake more advanced education.

Figure 8. Invitation from King High School to attend annual school events.

Conclusion

In today's global society, it is necessary for practical scientific English classes and practice situations to be introduced into science education as much as possible, in addition to typical English classes and communication training classes. In this report, we described several exchange meetings with American students in a U.S. Navy community in Japan. Such experiences and knowledge will help Japanese students break down their mental barriers to English communication and gain the confidence needed to speak with native speakers.

References

Nishiguchi, H., Yagyu, Y., Matsuo, H., Morishita, K., Osato, H., Haraguchi, K. and Seki, F. (2013). Development of Novel English Education System of Talking with Native Speaker in Sasebo National College of Technology - Build-up Practical Vocabulary by Repeated Presentation Practice. *Proceedings of ISATE2013*.

THE EFFECTIVENESS OF BITE-SIZED TEACHING APPROACH FOR ADULT LEARNERS

Noi Sian KOH[*,a]

[a] School of Information Technology, Nanyang Polytechnic, Singapore

*Koh_Noi_Sian@nyp.edu.sg

Abstract

Research has shown that digital lifestyles and communicative technology have decreased sustained attention overall. Particularly for those who consume more media, they struggle to focus in environments where prolonged attention is needed. Specifically, in the study of content heavy modules with lecture-based delivery still being the dominant form of teaching in many higher education institutions, keeping students engaged through the learning process is an important endeavour. To adapt to changes in the patterns of engagement with learning, this prompted an alternative teaching strategy. Bite-Sized teaching approach is the delivery of content in digestible, small learning units with short focused activities. The paper presents the effectiveness of face-to-face Bite-Sized pedagogy on the learning outcomes for 2 analytics modules offered to adult learners by the School of Information Technology at Nanyang Polytechnic. The methodology involves breaking a typical 1-hour lecture into 3 to 4 short lectures followed by related tutorial / practical exercises relevant to each respective short lecture. A total of 8 lessons were conducted, with 4 lessons using Bite-Sized teaching (experiment group) and 4 lessons using the typical methodology of teaching (control group). A total of 57 participants were involved in each of the control group and experimental group. The results from the exercises show statistically significant improvements in the assessed learning outcomes for the Bite-Sized units over the traditional approach of delivery. Most of the surveyed respondents agreed that the speed of course materials presented in the Bite-Sized units was just right. Majority of the respondents agreed or strongly agreed that Bite-Sized delivery approach helped them to learn better. Although this paper is primarily based on education experiences made within 2 analytics modules, the findings presented are applicable to any other computing related courses or mathematics related courses in general.

Keywords: *Bite-Sized, mini lecture, short attention span, small learning units, microlearning*

Introduction

The educational landscape is evolving with more adult learners returning to schools to update their skills and knowledge. As working adults are often busy and preoccupied with work, their training needs and learning preferences will require a shift from the traditional long lectures to snackable content which will make it easier for them to digest – something that is not possible with lengthy lectures.

Emerging pedagogies in higher education have applied research findings from areas such as student engagement, information processing, and instructional design to improve teaching practice (Bligh, 2000). For example, by using information about students' attention spans, teachers have included one or two brief rests called focus break in their 50-minute lectures (Stuart & Rutherford 1978, Johnstone & Percival 1976). These pedagogical innovations tackle the problems with the way traditional lectures are delivered and have shown that students benefit from changes in teaching practice.

Miller (1956) suggested humans have a limited amount of "working memory" to use when learning. His theory is that the working memory consists of approximately seven chunks. For example, seven random digits are possible to hold in memory relatively easily, but a dozen will be harder without some cognitive tricks. Therefore, a learner's attention span and short-term memory is limited to processing information in chunks. This theory suggests splitting content into small, manageable sections, rather than giving a whole lot of information which makes learning more manageable and easier to integrate into long-term memory. Once it is in the long-term memory, learners can remember and transfer the knowledge to their daily task. Cognitive Load Theory extends those ideas to suggest that our working memory is subject to certain types of load and that overloading working memory impedes learning. From a cognitive load perspective, Bite-Sized lectures will help to better manage working memory than the traditional long hours of lectures (Clark et al. 2005).

If the content of the lecture is rich and the pace of presentation is fast, learners may not have enough time to engage in the deeper processes of organizing their thoughts. By the time the learner selects relevant words spoken by the lecturer, then align it with the words and graphics on the presentation slides for one segment of the presentation, the next segment begins, thus cutting short the time needed for deeper processing. This situation leads to cognitive overload in which the available cognitive capacity is not sufficient to meet the required processing demands. Sweller (1999) referred to this situation as one in which the presented material has high-intrinsic load; that is, the material is conceptually complex. Although it might not be possible to simplify the presented material, it is possible to allow learners to digest intellectually one chunk of it before moving on to the next.

In prior research, it was found that clinical learners respond best to presentations of topics when they are offered "easily digestible bites" or mini-lessons, presented in tandem with clinical problem-solving (Wyer et al. 2004). Baumgartner and Shankararaman (2014), presented three design models of face-to-face teaching sessions for computing courses extensively using enterprise level systems. They found that mini-lectures followed by laboratory tasks are most successful in scenarios when there is a need to introduce completely new concepts or theories to students. The student is able to acquire new skills and abilities as the linkage of the underlying theories to the practical skill are explained in staggered. This finding highlights the possible effectiveness of better learning experiences by having mini lectures with focused activities related to each mini lecture.

As existing studies on Bite-Sized teaching are qualitative and limited on the quantitative studies, we address the gap in the current literature by assessing the effectiveness of Bite-Sized lecture approach on the learning outcomes. Thus, we experimented with a course design where the instructor breaks a typical one-hour lecture into three to four short lectures. Each short lecture is followed by a related tutorial and practical exercises with reference to various cognitive levels based on the Bloom's taxonomy (Bloom et al. 1956). After each tutorial or practical exercise, the instructor will go through the answers and give immediate feedback and clarifications based on the exercises. This process is iterated over three to four rounds per three-hour of face-to-face session. In each session, we assess students based on the learning outcomes related to the topic taught. The findings of the Bite-Sized lecture approach are based on the experiment data which we collected during the teaching sessions to adult learners.

The rest of the paper is structured as follows: The next section describes the details of course used in our experiment. Subsequently, the dataset collection and the evaluation of the results are discussed, followed by a final section that concludes this work.

Course Design and Methodology

The course used in this study was taught to students enrolled in a Specialist Diploma in Business Analytics at the School of Information Technology at Nanyang Polytechnic. One module is taught in the evening and consists of 45 working adults, aged 25 to 65 years old. The classes were held on Wednesday evenings from 6.30pm to 9.30pm. The other module was taught on a Friday from 9am to 5pm and consists of 12 working adults, aged 30 to 55 years old. Majority of the students do not have prior knowledge or background on the subject content. The course content included an introduction to analytics, statistics and predictive modelling. A total of eight weeks of lessons were conducted, with four weeks using the traditional style of teaching (control) (see Figure 1) and four weeks using Bite-Sized teaching (see Figure 2). In the traditional lecture course design, the session begins with an introduction of the topic, followed by one hour of lecture then one hour of tutorial exercises, one hour of practical / laboratory tasks and finally a wrap up for closure for the three-hour lesson. In the Bite-Sized lecture course design, the lecture is broken into three to four mini-lectures of 15 to 20mins each. It is then followed by tutorial exercises and/or practical tasks related to the mini-lecture. Once the student have completed the tutorial exercises / practical tasks, the instructor goes through the answers for the tutorials / practical and then wrap up before proceeding to the next mini-lecture. A common observation during the wrap up for each mini-session is that several students will be asking questions for clarifications related to the lecture, tutorial and/or practical and they seem more engaged.

The selection on the course design is random for the different topics. As a topic could be taught over a span of few weeks, both course design were used for most of the topics. For example, the topic on inferential statistics is taught using the traditional approach for the first lesson and subsequently for the next lesson, the Bite-Sized lecture approach was used.

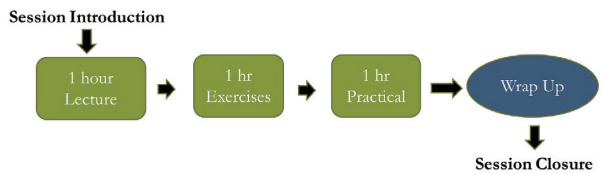


Figure 1. Traditional lecture course design for an analytics course

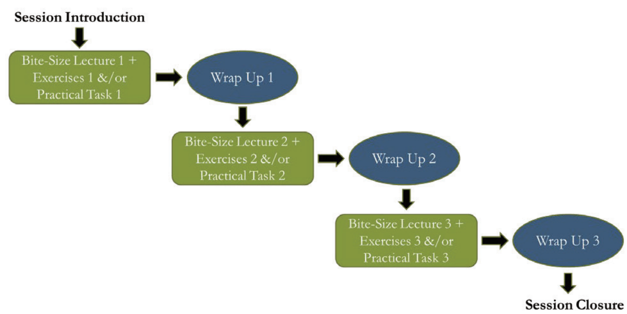


Figure 2. Bite-Sized lecture course design for an analytics course

Results and Discussion

There are two sets of data collected. One dataset on the scores obtained for each assessed learning outcomes in the topics taught using the two different course designs, the other dataset is a survey conducted at the end of the eight weeks of lessons. We created a survey that primed students to think about the quality of the learning experience using Bite-Sized lecture approach. It includes questions on three areas – Competency and Learning

Outcomes, Class Delivery, Students' In-Class Behavior. Qualitative feedback was also sought from the participants. There were absentees when the survey was conducted, hence only forty students responded to the survey.

For each lesson, the students were assessed on their learning. The questions tested consist of multiple choice questions and structured questions. All scores allocated for the questions were standardised to a scale of 0 to 10 marks. The questions tested were classified into various cognitive levels (Bloom et al. 1956). Cognitive Level 1 on Remembering, Cognitive Level 2 on Understanding, Cognitive Level 3 on Applying and Cognitive Level 4 on Analysing. Cognitive Level 5 on Evaluating and Cognitive Level 6 on Creating were out of the scope of the syllabus in this course. Our summative assessments for the 2 analytics modules suggest that the Bite-Sized pedagogy produced higher average scores in the course (see Figure 3). Particularly the Bite-Sized teaching approach is better for Cognitive Level 1 on Remembering and Cognitive Level 4 on Analysing. In the Bite-Sized session, it is observed that most of the students were able to answer the questions without referring to the lecture notes whereas in the traditional lecture session, most of the students had to refer to the lecture notes to answer the questions and yet, many were not able to get the correct answer for the questions that requires application and analysis.

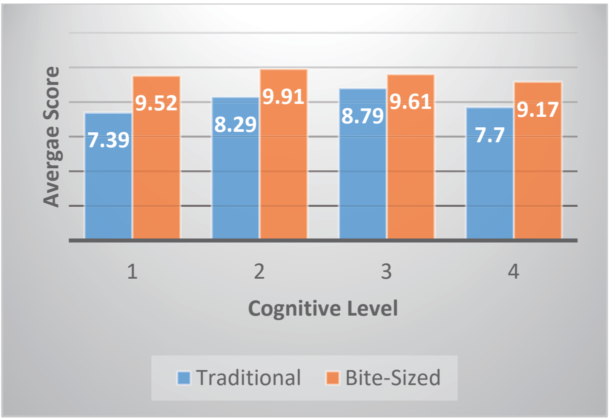


Figure 3. Average score obtained in Traditional course design vs. Bite-Sized course design for the different cognitive levels.

Table 1. Survey on Competency and Learning Outcomes

Questionnaire Number of Students / Survey Respondents: 40			
Competency and learning outcomes			
Rate how useful bite-sized lecture was in helping you to remember concepts. For example, the question on "Describe what a model is".	Very Useful	27.5%	80%
	Somewhat Useful	52.5%	
	Not very useful	15%	
	Not useful at all	5%	
Rate how useful bite-sized lecture was in helping you to understand concepts. For example, the question on "Explain if outliers should be removed in the analysis?"	Very Useful	42.5%	77.5%
	Somewhat Useful	35%	
	Not very useful	12.5%	
	Not useful at all	10%	
Rate how useful bite-sized lecture was in helping you to apply concepts. For example, the question on "Interpret the statistical significance of the variables based on the p-value".	Very Useful	42.5%	87.5%
	Somewhat Useful	45%	
	Not very useful	7.5%	
	Not useful at all	5%	
Rate how useful bite-sized lecture was in helping you to analyse. For example, the question on "Examine the dataset and identify the correct statistical test to use".	Very Useful	32.5%	85%
	Somewhat Useful	52.5%	
	Not very useful	12.5%	
	Not useful at all	2.5%	

A T-test was conducted to check the mean difference between the scores obtained in the Traditional course design and the Bite-Sized course design. The T-test results show that the improvement in test score using Bite-Sized teaching is statistically significant (p-value=<0.0001). The survey on competency and learning outcomes (see Table 1) also indicates that above 75% of the students find the Bite-Sized lecture helpful for them to remember and understand. 87.5% of the students find bite-sized lecture helping them to apply concepts and 85% of the students find bite-sized lecture helping them to analyze problems.

Table 2. Survey on Class Delivery and Student's In-Class Behavior

Number of Students / Survey Respondents	40		
Questionnaire	**(Strongly) Disagree**	**Neutral**	**(Strongly) Agree**
Class Delivery			
Bite-Sized Lecture is preferred over 1 hour lecture for the teaching of "Introduction to Statistics".	7.5%	32.5%	60%
Bite-Sized Lecture is preferred over 1 hour lecture for the teaching of "Descriptive Statistics".	10%	27.5%	62.5%
Bite-Sized Lecture is preferred over 1 hour lecture for the teaching of "Inferential Statistics".	5%	25%	67.5%
Bite-Sized Lecture is preferred over 1 hour lecture for the teaching of "Predictive Modelling".	7.5%	17.5%	75%
Bite-Sized Lecture is preferred over 1 hour	7.5%	17.5%	75%

lecture for the teaching of "Supervised Learning".			
In the Bite-Sized lecture, the speed with which your instructor presented the course material was just right.	7.5%	17.5%	75%
The class exercises are aligned with the content covered during the Bite-Sized lecture.	12.5%	22.5%	65%
The difficulty level of class exercises is manageable in the given time.	5%	20%	75%
Student's In-Class Behaviour			
I am motivated to consume content in short bursts and then immediately apply the concept to test myself on my skills.	7.5%	27.5%	65%
Bite-Sized lectures with exercises enable me to be more focused in class.	10%	30%	60%
Compared to 1-hour lecture, Bite-Sized Lecture encourages me to ask questions and participate in class discussions.	10%	27.5%	62.5%
Compared to 1-hour lecture, in Bite-Sized Lecture, the feedback on exercises were timely and reinforced my learning.	15%	15%	70%
Compared to 1-hour lecture, Bite-Sized Lecture enables me to have sufficient reflection time.	12.5%	22.5%	65%

Please share your thoughts and suggestions on Bite-Sized lectures
• Good to recap immediately • It keeps me focused in class and encourage active learning and application most of the times. • It was useful in quicker learning process. • I preferred the bite-sized approach. However, the pace of the lesson could slow down somewhat. Sometimes, before you were able to digest the content thoroughly, you had to move on to the next bit. • Bite Sized is more effective when the topic involves calculation as we can see how it is applied and how it is interpreted • Bite Sized lectures are very suitable for the new and tougher topics like predictive modelling • It breaks the monotony of listening to lecture. It reinforces some of the concepts being taught • Bite-Sized lecture is effective especially if we are dealing with application type of question, question that need us to digest the concept and understanding and see how the calculation works. • I find it very useful to help me think, apply and seal in knowledge bit by bit. Many times we assume this & that, and we think we understand, but this helps me see whether I really understood it or not, what I had just learnt in class or when I am revising at home. So if this is available, it helps in revision at home especially when topics get more difficult, and I need more time to read and ponder before I can fully understand. Way to go.

Figure 6. Qualitative Feedback on Bite-Sized Lectures

In terms of class delivery (see Table 2), about 60% of the students surveyed agree or strongly agree that they prefer to be taught using Bite-Sized lecture over the one- hour lecture. 75% agree or strongly agree that the speed in which the instructor presented the materials were just right. Figure 6 presents the qualitative feedback on Bite-Sized lectures. The comments suggested that Bite-Sized lectures helps them in learning new topics and is effective when they are "dealing with application type of question" or when "the topic involves calculation".

Conclusions

In this paper, we experimented with the Bite-Sized lecture pedagogy to teach two analytics modules and assessed its effectiveness in acquiring the learning outcomes. The results show that Bite-Sized lecture offer many advantages over traditional lectures. It can augment student learning by allowing the student to "digest" the content in sections. To the best of our knowledge, this is the first study to evaluate the different types of lecture delivery – Traditional vs Bite-Sized, using quantitative assessed learning outcomes. As determined by the questionnaire, the Bite-Sized lecture was more popular than the traditional lecture. We have also provided evidence that the different modes of delivery can affect the different depths of learning as classified by Bloom's taxonomy. Although it seems likely that similar study designs might produce contrasting results depending on the skill and enthusiasm of the teacher, nevertheless the statistical difference in the mean scores in particular areas and survey results suggest effects attributable to the mode of delivery.

Although this paper is primarily based on education experiences made within analytics modules, the findings presented are equally applicable to any other computing education field or even mathematics related education in general. A number of possibilities exist to extend this study. As the course is taught to adult learners, the results may be due to confounding reasons that may not be generalizable for tertiary students. Thus, the same approach can be used and evaluated to see if the results of Bite-Sized lecture still holds for different cohort of students. Future research will be undertaken to investigate this possibility.

Acknowledgements

The author would like thank the management of the School of Information Technology and Nanyang Polytechnic for their support in this research.

References

Baumgartner, I., & Shankararaman, V. (2014). Structure of face-to-face teaching sessions for an undergraduate technology-centered computing course: Establishing a set of best practices. In *Global Engineering Education Conference* (EDUCON), 2014 IEEE (pp. 184-191).

Bligh, D. A. (2000). *What's the Use of Lectures?* Intellect books.

Bloom, B.S., Engelhart, M.D., Furst, E.J., Hilland, W.H., & Krathwohl, D.R. (1956). *Taxonomy of educational objectives, Handbook I: Cognitive Domain*, New York: David McKay, vol. 19, pp. 56.

Clark, R. C., Nguyen, F., & Sweller, J. (2005). *Efficiency in learning: Evidence based guidelines to manage cognitive load*. Pfeiffer.

Johnstone, A. H., & Percival, F. (1976). *Attention breaks in lectures. Education in Chemistry*, 13(2), 49-50.

Miller, G. A. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. *Psychological Review*, 63(2), 81-97.

Stuart, J., & Rutherford, R. J. D. (1978). Medical student concentration during lectures. *The Lancet*, 312(8088), 514-516.

Sweller, J. (1999). *Instructional Design in Technical Areas*. Camberwell, Australia: ACER Press.

Wyer, P. C., Keitz, S., Hatala, R., Hayward, R., Barratt, A., Montori, V. Montori & Guyatt, G. (2004). Tips for learning and teaching evidence-based medicine: introduction to the series. *Canadian Medical Association Journal*, 171(4), 347-348.

EVALUATING A LABORATORY LESSON CONDUCTED FOR SUPPLY CHAIN STUDENTS USING KOLB'S EXPERIENTIAL LEARNING CYCLE

Jing Jin[*, a], Liping Wu[a] and Nicholas Chiang[a]

[a] Republic Polytechnic, School of Engineering, Singapore

*jin_jing@rp.edu.sg

Abstract

Simulated supply chain lab equipped with various latest technologies provides an experiential learning environment for knowledge acquisition and skills training. Incorporating the lab lessons into the curriculum for Supply Chain Management (SCM) related courses exposes students to real-world situations, facilitates their understanding of abstract concepts and enhances their ability of problem solving. More importantly, the application of the SCM concepts and skills through lab-based activities should be emphasized in the course of teaching and learning. In this sense, the Kolb's experiential learning cycle is considered and used to improve the lesson design.

In this research study, a lesson from the module on Warehousing and Storage was enhanced by following the four stages of Kolb's experiential learning cycle to blend the classroom theory with experiments in the lab. This paper describes how the lesson was conducted and underscores its difference from the past run. Furthermore, this study aims to explore how the enhanced lab lesson helped students achieve the learning objectives more effectively as compared to the previous run. The students' learning outcomes were assessed through post-lesson quizzes and analyzed via a t-Test with two samples. The samples came from two groups of Year 2 polytechnic students who took this module in 2017 and 2018 respectively. The quiz result of the students in 2018 was significantly higher than those in 2017 with a P-value less than 0.0001. In addition, the students' feedback in 2018 on the lab lesson was collated and analyzed through text mining to explore what contributed to the students' achievement. It was found that firstly the end-to-end process helped the students form a holistic view on the warehouse operations. Secondly, the simulated workplace environment engaged the students to conquer the difficulties collaboratively. Thirdly, the authentic problems challenged the students and motivated them to apply and integrate the relevant knowledge and skills. Finally, through this study, ideas to improve the lesson and future research work are discussed.

Keywords: *Experiential learning, lab lessons, Supply Chain Management, Warehouse Management, Kolb's experiential learning cycle*

Introduction

As one of the economic pillars of Singapore, logistics industry is seeking a large number of logistics professionals with relevant knowledge and necessary skills. In response to the industry needs, a Supply Chain Lab was set up to simulate an actual distribution center in one of the polytechnics in Singapore in 2015. Since then, lab lessons have been designed and included as part of the curriculum on Supply Chain Management (SCM) so as to deepen the skills of SCM students and prepare them to join the dynamic industry.

The Supply Chain Lab (SCL) is a purpose-built lab facility which is equipped with the latest state-of-the-art logistics technologies, such as Autonomous Guided Vehicle (AGV), Lean Production Line, Robotic Arms, Augmented Reality Picking, Intelligent Robots, etc., shown in Figure 1. As such, this lab benefits polytechnic students by providing a realistic distribution centre environment to facilitate the learning activities. In such context, the logistics industry benefits from hiring polytechnic graduates who are familiar with the real-world supply chain operations through the hands-on experience gained from the lab lessons.

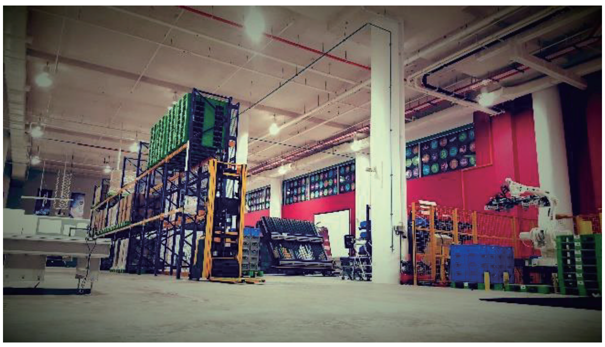


Figure 1 Supply Chain Lab (SCL)

Initially, the lab facilities were mainly used in the form of lab tours for students to observe the operations with explanations provided by lecturers. As SCM is a field closely related to professional practice where knowledge is acquired mainly based on experience (Amy, 2009), some activities were designed to allow students to have a firsthand experience in order to gain a deeper understanding of supply chain concepts and skills. However, to advance students' learning and increase the level of interaction during the lab lessons, it is essential to incorporate the application of the skills and concepts as part of the lesson. With this objective, Kolb's experiential learning cycle was considered and applied to enhance the lab lessons.

Kolb proposed that optimal learning would pass through a cycle of the Concrete Experience, Reflective Observation, Abstract Conceptualization and Active Experimentation (Kolb, 2015), as shown in Figure 2. The vertical axis in Figure 2 represents the knowledge grasping dimension by which knowledge can be grasped through the Concrete Experience or by the Abstract Conceptualization, or by a mix of both. The horizontal axis represents the knowledge transformation dimension. The transformation can be done via the Reflective Observation, or via Active Experimentation (Mahmoud, 2013). Furthermore, Kolb stated that the four stages were equally important in contributing to the learning process. Thus, the lab lessons could be enhanced by the Kolb's cycle to provide a comprehensive learning experience for students.

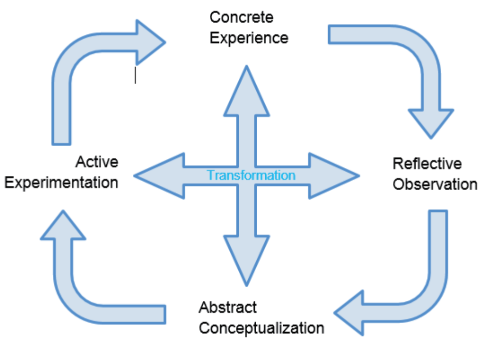


Figure 2 Kolb's Experiential Learning Cycle

In 2018, one lesson of the module on Warehousing and Storage was revamped to incorporate the four stages of the Kolb's experiential learning cycle. Meanwhile, a mixed-method study was conducted to evaluate this lesson in order to find out whether the lesson imposed a postive influence on students' learning. Firstly, this paper describes how the lesson was conducted and underscores its difference from the past run. More importantly, it aims to explore how the enhanced lab lesson using Kolb's experiential learning cycle helped students achieve the learning objectives more effectively as compared to the previous run.

Lesson Design using Kolb's Experiential Learning Cycle

In one of the lessons of the module on Warehousing and Storage, students are required to use the Warehouse Management System (WMS), a software application which helps to manage the warehouse operations, record physical goods movements, inquire information at a transactional level as well as aggregated level, and reconcile the inventory discrepancy found after physical inventory counts. The lesson conducted in previous runs mainly focused on the use of the WMS. However, when it is mapped with the Kolb's experiential learning cycle, only the concrete experience and abstract conceptualization had taken place through the activity of using WMS and lecturer's presentation. The other two essential learning stages, reflective observation and active experimentation could not be implemented during the lesson time. Hence, in 2018, the activities in this lesson were redesigned by adding a series of warehouse operations tasks to be completed in SCL over and above the WMS practice. With this enhancement, all the four stages in the Kolb's experiential learning cycle were accomplished. A clearer comparison is illustrated in Table 1.

Table 1 Mapping to Kolb's Learning Stages

Stages	*In 2017*	*In 2018*
Concrete Experience	WMS hands-on practice: Lecturers demonstrate and guide students	WMS hands-on practice: Lecturers demonstrate and guide students
Reflective Observation	X	Students record observations and reflect based on the questions given
Abstract Conceptualization	Lecturer's presentation via a set of slides	Debrief and Discussion, as well as lecturer's presentation
Active Experimentation	X	Students complete an activity with both physical goods movement and system transactions

The concrete experience was achieved through the WMS practice guided by the instruction manual and lecturers' demonstration. Three questions in an online form were given to students to pen down their observations. This was how the reflective observations were captured. The questions are as follows.

1. *How different is the WMS from what you expected when doing the processes as instructed? Name at least two differences.*
2. *What are the problems you have encountered or seen your classmates encounter? Name at least two. How do you or your classmates solve the problems?*
3. *Do you think WMS can help improve the warehouse operations productivity? Justify your answer with one case on how WMS increases or reduces the productivity.*

The response to these questions not only served as a record of what students had seen and done, but also triggered the students to review how they overcame the learning obstacles in the process. After this, an activity was crafted to let students complete an actual task of both physical movement of goods in the lab and system transactions via the WMS. The scenario used is from a real example of a company's daily operations and briefly described as follows.

PrintYourWorld (PYW) is a distributor in printing supplies. In their small storeroom, it stored 26 different types of products. Today, PYW has a list of inbound and outbound shipment to be completed. Your team is tasked to move the physical goods at the rack area and perform the system transactions in WMS. After you complete the movements and transactions, print out your inventory balance report and verify your physical stock.

The actual goods movement was conducted in a smaller scale via retail shelves and tote boxes shown in Figure 3. The system transactions were done through a WMS software in SCL. The items were put in the tote boxes on the floor to mimic the incoming goods. All retail shelves were labelled with location numbers. The information on the items and shelving locations were configured prior to the lesson to allow students to proceed the operations.

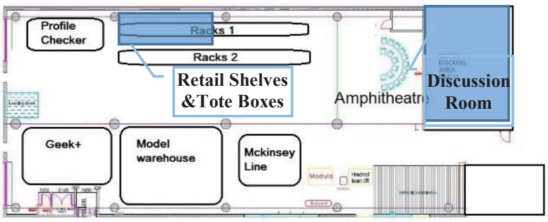


Figure 3 Supply Chain Lab Layout and Activity Area

More details on how the lesson was planned and implemented are shown in Table 2. The four stages of the Kolb's experiential learning cycle are indicated as well.

Table 2 Lesson Plan

Stages	*What Lecturers do*	*What Students do*
	Introduce WMS via slides	Listen to lecturer and set up accounts
Concrete Experience	Guide students on WMS hands-on practice	Follow instruction to practice individually
Reflective Observation	Release the online question link	Record the difficulties encountered and think how to overcome the difficulties
Abstract Conceptualization	Facilitate the discussion on how WMS works	Elaborate on how WMS works and review what have been done
Active Experimentation	Brief the team activity	Understand the activity and assign different roles within the team
	Monitor the activity	Perform physical movement, system transaction and reconcile the inventory discrepancies
	Lesson Summary	Listen to lecturer and submit reports generated from system
		Reflection Journal

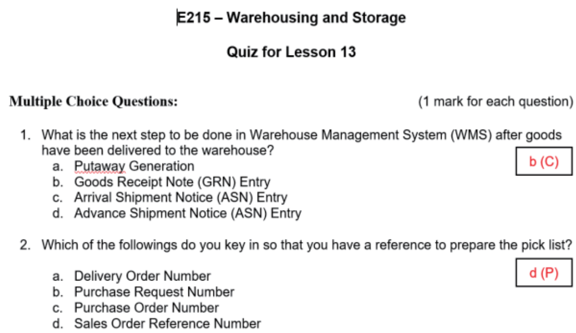
Some pictures during the lesson were taken and shown in Figure 4. Students were actively working together to complete the inbound and outbound processes as well as system transactions. Meanwhile, lecturers facilitated the activity.

Figure 4 Photos Taken during the Lesson

Methodology

In order to address the research question on how the enhanced lab lesson helped students achieve the learning objectives more effectively as compared to the previous run. A mixed-methods study was carried out for the lesson.

For the quantitative part, a quasi-experiment with two post-lesson tests were conducted to find out if the students' results had significantly improved from the year of 2017 to the year of 2018. As the quiz questions were amended in 2018, 5 questions on the same learning objectives were extracted from the entire quiz paper of 2017 and 2018 respectively. The two sets of questions were evaluated by a content expert to ensure that the number of competent, proficient and advanced questions are the same. Both post-tests were conducted after the lesson to measure the students' learning outcomes at the end of the day. A segment of the post-lesson test paper is shown in Figure 5.


E215 – Warehousing and Storage

Quiz for Lesson 13

Multiple Choice Questions: (1 mark for each question)

1. What is the next step to be done in Warehouse Management System (WMS) after goods have been delivered to the warehouse? b (C)
   a. Putaway Generation
   b. Goods Receipt Note (GRN) Entry
   c. Arrival Shipment Notice (ASN) Entry
   d. Advance Shipment Notice (ASN) Entry
2. Which of the followings do you key in so that you have a reference to prepare the pick list? d (P)
   a. Delivery Order Number
   b. Purchase Request Number
   c. Purchase Order Number
   d. Sales Order Reference Number

Figure 5 Segment of Post-lesson Test Questions

Students' ability changes from year to year. In order to have a suitable comparison, 2 groups of students with similar academic performance were sampled from the entire cohort of 2017 and 2018 students respectively. The academic performance was evaluated based on the Grade Point Average (GPA) of the students before they took this module.

Thereafter, a statistical t-Test with two samples was carried out to evaluate whether the test scores of students in 2018 was significantly higher than the scores in 2017. The research design is illustrated in Figure 6 below.

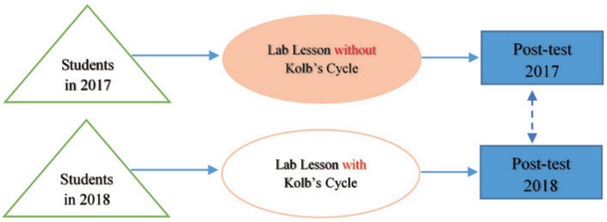


Figure 6 Quasi-experiment Design with Two Samples

For the qualitative part, students' feedback through their reflection journal was used to comprehend students' views about the lesson. Firstly, all the classes were observed to ensure that the students went through each of the four stages in the Kolb's experiential learning cycle. Secondly, the written words from the students' reflection were consolidated and analysed to produce a sentimental analysis on the students' overall impression. This analysis is to identify the students' feedback in terms of positive, neutral and negative through a text mining tool. Lastly, positive feedback and negative feedback were grouped and coded separately to reveal what contributed to student's learning and what might be considered for further improvement.

Results and Discussion

In order to have a more valid comparison, it is better to have two equivalent groups in terms of their academic ability. As such, the two groups of students in the two different years are sampled based on their GPA before they studied this module. The sampled students' GPA distribution is shown in Figure 7. The mean and standard deviation of the GPA is shown in Table 3.

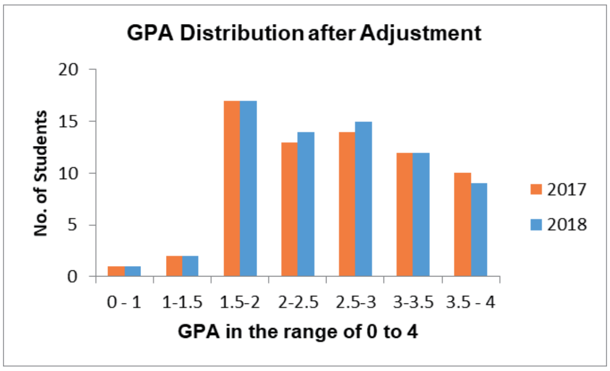


Figure 7 GPA distribution with Sampled Students

Table 3 GPA Mean and Standard Deviation

Students' Batch	*No. of Students*	*Mean*	*Standard Deviation*
2017	69	2.5916	0.7625
2018	70	2.5834	0.6931

It is seen that there are less students in the GPA range of 2 to 3 in 2017 than in 2018; but more students in the range of 3.5 to 4. Overall, the two groups of students have similar average GPA.

The quizzes used for comparison have 5 marks in total. It is noted that in 2017 the quiz was part of students' after-class assignment which students can refer to learning resources or discuss with peer learners; however, the quiz was conducted in the classroom at the end of the lesson and administered by two lecturers in a close-book format in 2018. In this sense, the quiz in 2018 is more challenging than in 2017. The results of post-lesson tests for the two samples are shown in Figure 8. The bars represent the number of students who obtained the scores from 0 to 5. In 2017, the highest score was 4 marks and only one student achieved it. Majority of students in 2017 scored 2 or 3 marks which resulted in the average score of 1.9. In 2018, more than 20 students which is about 30% of the students, reached 4 or 5 marks. Thus, the average score increased to 2.7.

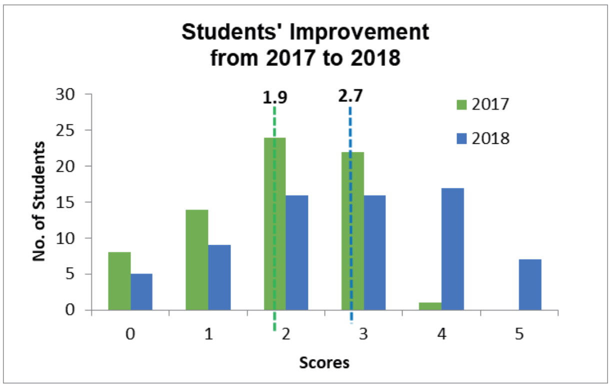


Figure 8 Post-test Result for students in 2017 and 2018

Although the average score has improved from 1.9 to 2.7, it is essential to look at the t-Test result to reveal the significance of the changes. For this t-Test, the null hypothesis is that the students in 2018 will not achieve higher scores than those in 2017. The significance level is set at 0.05. The probability when the null hypothesis is true or P value is calculated via Ms Excel and shown in Table 4.

Table 4 t-Test Result: Comparing Mean Scores of Two Samples

	2017	2018
Mean	1.913043478	2.742857143
Variance	1.051150895	1.990890269
Observations	69	70
Hypothesized Mean Difference	0	
df	126	
t Stat	-3.970656636	
P(T<=t) one-tail	5.98714E-05	<0.0001
t Critical one-tail	1.657036982	
P(T<=t) two-tail	0.000119743	
t Critical two-tail	1.978970602	

The calculated probability, or P-value is 5.98714E-05 which is smaller than 0.05 and even smaller than 0.0001. Hence it is concluded that the students' improvement in 2018 is statistically significant. In addition, given the close-book format, the 2018 quiz is stricter than the 2017 one. Therefore, the enhanced lab lesson using Kolb's experiential learning cycle helped students in 2018 performed better in the quiz assessment than the previous cohort.

Qualitatively, the sentimental analysis conducted through a text mining tool categorized the students' attitudes towards the lab lesson into three types: positive, neutral and negative. The result is shown by a heap map in Figure 9. The yellow area represents the amount of students with positive feedback. The blue area represents the amount of students with negative feedback. The grey area in between is neutral. The tool also helps to quantify the intensity of negative and positive emotions from negative one (-1) to positive (+1). In this analysis, the two extreme responses are -0.72 and +1.

Figure 9 Heat Map Generated from Students' Feedback

It is shown that the overall student feedback from the reflection journal for this lesson is very positive. The number of students showing positive (yellow) feedback on the lesson is absolutely greater than the number showing negative (blue) feedback. After the initial grouping is done, each individual response was read to validate the categorization and coded into themes which disclosed the students' perspectives.

Majority of the students expressed that the lab activities gave them a holistic view of the inter-linked warehousing processes. The various activities that students need to carry out in the SCL are the real processes where typical problems such as wrong location or wrong quantities may occur in any type of warehouses. This authentic learning experience intrigued the students and motivated them to solve the problems.

Samples of students' feedback are quoted here:

"The activity was pretty useful for us in preparing ourselves for the upcoming internship. It helped us to familiarise ourselves with warehouse operation as this activity was designed to be very similar to actual warehouse operation. Usually what we learnt from past lessons were theory based and visiting warehouse to see the operation and process. However, we got to do some hands-on activities for this lesson, which I think it helped the students to visualise better."

"The activities conducted was quite engaging and fun, and it really shows me how theory is really different from the reality of the workplace and the operations we carry out daily there."

The lab activities also enforced team-work through different roles played by different students within the team. The collaborative learning empowered the students to investigate deeper on the issues they faced. By having the hands-on activities, more students or perhaps all students could be more involved in active learning.

On the other hand, a small group of students had some negative (blue in Figure 9) feedback. Some students complained that the time given to complete the activity was not sufficient to investigate the problems. Another feedback by students is that careless mistakes made by one team such as picking a wrong quantity caused the other teams' inventory discrepancy as the entire class shared the same stock. However, lecturers view this positively as the situation created a realistic scenario where the workers in the warehouse are not only responsible for their own behaviour but also affected by others'. With such an incident, students were able to reflect deeply about the importance of inventory accuracy and how to keep inventory records accurate.

Limitations and Future Work

Firstly, it is a limitation that only five questions with five scores are used to assess the students' learning outcomes. The scope of questions mainly focus on the WMS transactions. The questions are not broad enough to test the students' overall understanding of the lesson though they do provide enough evidence to indicate students have gained the insight on using WMS for productivity. Furthermore, practical assessment could be more ideal to find out how proficiently the students have acquired the skills of using WMS. Secondly, the two samples of students were facilitated by different lecturers in the two years. As lecturers also play an important role in guiding students towards the learning objectives in the lesson, this factor should be well managed via a more careful research design.

Conclusion

With the intent to better prepare the future supply chain professionals, SCL provides a real-world environment to expose the students to authentic challenges encountered by industry. As such, the curriculum on SCM has been continously reviewed, evaluated and enhanced to deepen students' knowledge and skills via the hands-on activities in SCL. Kolb's experiential learning cycle has been applied in lab lessons of various engineering fields. It is interesting to find out whether the lab lesson, designed with Kolb's experiential learning cycle helps students to gain substantial improvement in skills acquisition and understanding the related supply chain concepts. A comprehensive lab lesson was designed with the usage of WMS system as well as physcial hands-on activities in SCL to support this study.

The t-Test result proves that the enhanced lab lesson does contribute to a more effective learning as compared to the same lesson conducted in previous years. Moreover, the positive impact on students includes not only the acquisition of knowledge and skills, but also the soft skills such as team work and problem solving. In addition, the analysis on the students' feedback suggests that the real process with authentic problems is the foremost reason to intrigue students to work actively to achieve the learning objectives. It may be more beneficial to extend the lesson duration, for example, from one day to two days, for students to get involved in a series of activities and reflect the purpose of doing them. Meanwhile, class lecturers would have sufficient time to better facilitate the class.

This study can be improved with a more comprehensive assessment on learning by increasing the number of questions in the quiz so that student's learning could be assessed in depth. It also points to further research that can be undertaken on other similar lessons or modules related to SCM so that the SCL facilities could be optimally utilistized to well equip supply chain students to be industry ready in the near future.

References

Amy Z. & Sharon J. (2009) “Integrating a discovery-based laboratory to teach supply chain management fundamentals in an undergraduate management course”, Innovations in Education and Teaching International, Vol. 46, No. 1, February 2009, 71–82.

Kolb, D. A. (2015). Experiential learning: Experience as the source of learning and development. Upper Saddle River, NJ: Pearson Education.

Mahmoud A. & Zoltan K. N.(2013) “Applying Kolb’s Experiential Learning Cycle for Laboratory Education”, Journal of Engineering Education, Vol. 98, No. 3, January, 2013, 283–294.

Development of Community Based Learning Program as an Engineering Education for Regional Revitalization

S. Takehara [*,a], S. Ueshima [a] , Y. Taniguchi [b], C. Araya [c] and N. Fujita [d]

[a] Department of Liberal Studies, National Institute of Technology, Nara College, Japan
[b] Department of Mechanical Engineering, National Institute of Technology, Nara College, Japan
[c] Student Affairs, National Institute of Technology, Nara College, Japan
[d] Department of Electrical Engineering, National Institute of Technology, Nara College, Japan

* takehara@libe.nara-k.ac.jp

Abstract

Nara KOSEN (National Institute of Technology, Nara College) has incorporated a community-based learning (CBL) program into engineering education for regional revitalization since 2015. The program has been conducted in cooperation with universities, local governments and local companies under the financial support of the Ministry of Education, Culture, Sports, Science and Technology (MEXT). This paper describes the content of our CBL program and evaluates it. In the program, students aim to acquire the skills and knowledge for regional revitalization through step-by-step learning. In the first step, students understand the idea and importance of sustainable development in local areas, then investigate basic knowledge about area studies through group work in the classroom. In the second step, students in the advanced course acquire soft skills such as teamwork, communication and facilitation and have a real-world experience through community visits and factory tours. Then they try to solve problems by applying their knowledge of engineering design through project-based learning. In the third step, students in the advanced course work with clients to solve need-based problems as thesis research. In order to evaluate outcomes in our CBL program, participant questionnaires and the evaluation result from the external committee have been analysed. The results indicate that the evaluation of our CBL program by the external committee and stakeholders was high. And then, the results of the class questionnaire indicate that through the CBL program, students not only understood the key concepts for regional revitalization, but also acquired soft skills such as teamwork, communication and facilitation. Finally, issues and the effectiveness of the program as an engineering design for regional revitalization is discussed.

Keywords: *Cooperative education, Community-Based Learning, Regional Revitalization, Curriculum Design, Social Collaboration*

Introduction

There are serious problems in Japan such as economic stagnation, population influx to the urban areas, ageing population, and declining birth-rates. In order to cope with these problems, sustainable development of the region is significant. In such a situation, Nara KOSEN (National Institute of Technology, Nara College) has incorporated a community-based learning (CBL) program into engineering education for regional revitalization since 2015. The program has been conducted in cooperation with Nara Women's University, Nara Prefectural University, several local governments and local companies under the financial support of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) as a program for promoting regional revitalization by universities as centers of community (COC+).

This paper describes our CBL program and evaluates it. The program consists of three subject groups with six classes. In the program, students aim to acquire the skills and knowledge for regional revitalization through step-by-step learning. In the first step, students understand idea and importance of sustainable development in local areas, then investigate basic knowledge about area studies through group work in the classroom. In the second step, students in the advanced course acquire soft skills such as teamwork, communication and facilitation and have a real-world experience through community visits and factory tours. Then they try to solve problems by applying their knowledge of engineering design through project-based learning. In the third step, students in the advanced course work with clients to solve need-based problems as thesis research. To promote collaboration with local industry, local community and academia, we have established five research clusters named TOMO which consist of Medical and Welfare Robotics, Agriculture and Industrial Technologies, Medical-Engineering Collaboration, Information Technology for Smart City and Environmental Engineering. Students' thesis research has been conducted as a part of research projects in the clusters.

In order to evaluate outcomes in our CBL program, interviews with students, participant questionnaires and the evaluation result from the external committee have been analysed. Finally, issues and the effectiveness of the program as an engineering design for regional revitalization is discussed.

Our CBL Program as Engineering Education

The goals of our CBL program are regional revitalization, creating new industries and jobs and developing students who can empower the community as engineers. For these purposes, we designed the learning curriculum which consists of three subject groups with six classes and established five research clusters named TOMO which consist of Medical and Welfare Robotics, Agriculture and Industrial Technologies, Medical-Engineering Collaboration, Information Technology for Smart City and Environmental Engineering. In the program, students learn the skills and knowledge through step-by-step learning.

In this section, we report the contents of each subject group.

Basic Learning: Understanding the Idea of Sustainable Development of the Community

In the first step, students understand the idea and importance of sustainable development in local areas, then investigate basic knowledge through the classes of Geography (1^{st} year), Politics and Economics (3^{rd} year) and Area Studies (5^{th} year).

In the class of Geography (1^{st} year), students are engaged in group work to survey about the culture and history of a specific area in Nara Prefecture, and then they make a poster presentation while focusing on cultural and economic properties such as traditional industries, local cuisine, historical heritage and tourism. Through the learning experience, they acquire the methods about how to know and analyse the community. And they also improve their presentation skills.

In the class of Politics and Economics (3^{rd} year), we conduct classes in cooperation with local financial institution: *Nara Chuo Shinkin Bank* and companies with the aim of deepening the understanding of the local industry and economy. In this class, staff of financial institution and business owners come to the classroom and directly teach about the current situation and issues of industry and economy in Nara. And then students are engaged in group work to make business plans for regional revitalization. In this process, they also acquire strategic planning techniques such as SWOT analysis. Finally, students make presentations in front of the financial institutions' staff.

Area Studies (5^{th} year) is an elective subject. In this class, students are required to approach the issues and problems in a local community using knowledge of engineering design. In the 2018 class, we conducted classes in cooperation with the local Chamber of Commerce and provided the opportunity to do field research. Through the field survey, students talked directly with players in the local economy such as self-employed workers, politicians and the local Chamber of Commerce. And then students recognized and shared the features, structure and problems of their local community.

After these real-world experiences, students were engaged in group work: trying to design plans for regional revitalization or solutions for problems. Finally, students made presentations in front of the local Chamber of Commerce.

Applied Learning: Applying Their Knowledge of Engineering Design

In the second step, students in the advanced course acquire soft skills such as teamwork, communication and facilitation and have a real-world experience through community visits and factory tours. Then they try to solve problems by applying their knowledge of engineering design through project-based learning.

The class of Social Technology for Regional Revitalization: *Chiiki Syakai Gijutsu Tokuron* (advanced course 1^{st} year) is PBL (project-based learning).

In the 2018 class, we collaborated with three manufacturers in Nara Prefecture and provided their factories' tours for deepening the understanding of engineering design.

The feature of this class is learning not only knowledge of local economics and engineering design, but also frameworks for making decisions or facilitation. Students learn and acquire the important skills such as Payoff Matrix, Fishbone Diagrams (cause and effect analysis) and TRIZ Function Analysis.

In this project-based learning, students in the advanced course tried to make solutions for business and technical problems companies were facing, while using the skills above. Finally, students made presentations in front of the staff of the three manufacturers.

Thesis Research: Solving Problems with Community Clients

In the third step, students in the advanced course work with clients to solve need-based problems as thesis research which is named Research Projects for Regional Revitalization. Students can choose this project or normal thesis research for graduating the advanced course in Nara KOSEN.

To promote collaboration with local industry, local community and academia, we have established five research clusters named TOMO which consist of Medical and Welfare Robotics, Agriculture and Industrial Technologies, Medical-Engineering Collaboration, Information Technology for Smart City and Environmental Engineering. Research Projects for Regional Revitalization have been conducted as projects in these clusters.

The activities of these research projects are diverse and cannot be fully explained in this paper. In this section, we will introduce one student's case. He is a student in the Advanced Mechanical Engineering course. In 2018, he chose Research Projects for Regional Revitalization as thesis research. He conducted a one-year study to investigate the causes of accidents and defects of the valve manufacturer in Nara Prefecture which conducts joint collaborative research with his teacher. In this project, he conducted company visits and performed analysis of products by using 3D modelling. Finally, he reported causes of accidents and defects and proposed solutions of stress concentration in the valve product.

According to him, collaborative research, unlike general basic thesis research, has pressure because it must produce results. On the other hand, the research theme is laid out, so it is easy to work on. Moreover, by interacting with engineers in company, he could know things that he could not learn at school.

However, he also said that the meaning of this project was mainly technical consultation and the aspect for contribution to regional revitalization was not felt so much.

Results: evaluating our CBL program

In this section, we will collect and illustrate evaluations for our CBL program.

First, we have got a high evaluation (perfect) by the external evaluation committee. Their score for 2017 and 2018 was 5 out of 5 points since the education program began to operate substantially. Especially they referenced the following 3 points.

(1) The curriculum has been designed so that the multi-level educational program will be taken along with the progress of the academic year.
(2) Some students actively had tried for business model competitions. And some of them had been awarded.
(3) The TOMO five research clusters have achieved remarkable results even from the perspective of research and education.

Second, the interim review by MEXT which provides financial support was not so good: B/S·A ·B·C. Because MEXT's criteria focuses on contribution to promoting employment for local small companies, so we must be careful that it is not "an evaluation of our CBL program" itself.

Third, we have conducted a questionnaire survey on the collaborators since 2016. In the questionnaire survey, there are questions about our CBL program and TOMO five research clusters. For example, the 2018 results of these questionnaire surveys showed that all collaborators rated highly as follows.

Table1 Evaluation of Our CBL Program by Collaborators (2018) (N=12)

A	Excellent	6
B	Good	6
C	Below average	0
D	Poor	0

Table 2 Evaluation of TOMO Five Research Clusters by Collaborators (2018) (N=12)

A	Excellent	6
B	Good	6
C	Below average	0
D	Poor	0

Finally, we will introduce the results of students' self-assessment for the class of Politics and Economics (3rd year) in 2018. This self-assessment was conducted at the last lecture. The number of students was 186 and 170 answered (91%).

For example, in the following three questions: "Through this class I could know the current situation and issues of local industry and economy"; "I was glad to hear special lectures from a local financial institution and companies"; and "I could find the necessity of changing the region", positive answers were much higher than negative ones (Table 3-5).

Table3 Students' Self-Assessment Results about "Through This Class I Could Know The Current Situation and Issues of Local Industry and Economy" (2018)

5	Agree	61	35.9%
4	Agree a little	65	38.2%
3	Neither agree nor disagree	20	11.8%
2	Disagree a little	10	5.9%
1	Disagree	14	8.2%

Table4 Students' Self-Assessment Results about "I was Glad to Hear Special Lectures from a Local Financial Institution and Companies" (2018)

5	Agree	81	47.9%
4	Agree a little	41	24.1%
3	Neither agree nor disagree	20	11.8%
2	Disagree a little	11	6.5%
1	Disagree	16	9.4%

*N/A=1

Table5 Students' Self-Assessment Results about "I Could Find the Necessity of Changing the Region "(2018)

5	Agree	32	18.8%
4	Agree a little	57	33.5%
3	Neither agree nor disagree	40	23.5%
2	Disagree a little	19	11.2%
1	Disagree	22	12.9%

Moreover, in the following three questions: "I understand how to use SWOT analysis"; "I understand how to make a business plan"; and "I understand the necessity for communication skills in planning, management and business", positive answers also were much higher than negative ones (Table 6-8).

Table6 Students' Self-Assessment Results about "I Understand How to Use SWOT Analysis" (2018)

5	Agree	49	28.8%
4	Agree a little	71	41.8%
3	Neither agree nor disagree	21	12.4%
2	Disagree a little	16	9.4%
1	Disagree	13	7.6%

Table7 Students' Self-Assessment Results about "I Understand How to Make a Business Plan" (2018)

5	Agree	52	30.6%
4	Agree a little	70	41.2%
3	Neither agree nor disagree	25	14.7%
2	Disagree a little	15	8.8%
1	Disagree	8	4.7%

Table8 Students' Self-assessment Results About " I Understand The Necessity for Communication Skills in Planning, Management and Business "(2018)

5	Agree	74	43.5%
4	Agree a little	55	32.4%
3	Neither agree nor disagree	20	11.8%
2	Disagree a little	7	4.1%
1	Disagree	14	8.2%

Conclusion and Discussion

This paper reported the content of our CBL program and illustrated various evaluations for it. The results showed that the evaluations of our CBL program by the external committee and collaborators were high. And then, the results of students' self-assessment showed that throughout the class, students not only understood knowledge about community and the necessity of changing the region, but also acquired soft skills such as teamwork, communication and facilitation. In conclusion, we will consider and summarize issues and the effectiveness of the program of engineering design for regional revitalization.

First, we will consider from the perspective of education, the following: We provide students the opportunity to applyng the knowledge of engineering design and natural sciences. We can think that CBL is an appropriate size and easy for students to work on. For them, national size projects will be too big. On the contrary, school size projects will be too small and boring. Through the process of applying the engineering knowledge, they also acquire important skills for engineers such as strategic planning techniques, frameworks for making decisions, facilitation and presentation skills. Students also come to know that engineers need communication skills in addition to engineering knowledge. Moreover, the fact that some students actively had tried for business model competitions beyond class indicate that our CBL program can elicit the students' learning motivation. Thus we can conclude that our CBL program is effective for engineering education.

Second, we will consider from the perspective of regional revitalization, the following: In Japan small and medium enterprises in local community suffer from chronic labor shortages. Through CBL, they can get the opportunity to improve students' awareness of them. And then, collaborative education programs help reinforce relationships between local governments, local companies, financial institutions and higher education. In addition, Nara KOSEN established a consortium: the Nara KOSEN Region Innovation Consortium. This strengthening of networks with the local community will contribute to increase the opportunities for regional revitalization. Moreover, CBL itself may provide the opportunities to make changes in the local communty. Especially, consavaritve areas which often fear change tend to have lost the ability to solve certain problems by themselves. For the above reasons, many of local communities in Nara have an expectations for our CBL program. Thus, our CBL program as engineering education is also effective for regional revitalization.

Acknowledgements

We wish to thank all collaborators for participating and supporting our CBL program. And we wish to thank MEXT Japan for their generous financial assistance throughout the program for promoting regional revitalization by universities as centers of community: COC+.

We would also like to express gratitude to Hidetake Uwano, Hidemi Nakamura, Hirohisa Yamada, Hiroaki Ichii, Kenichi Iida and Manabu Ishitobi who are members of the TOMO five research clusters and made enormous contributions to our CBL program.

References

Davis, R. E., Krishnan S., Nilsson, T. L.& Rimland, P. F. (2014). IDEAS: Interdisciplinary Design Engineering and Service. *International Journal for Service Learning in Engineering Special Edition*. 165–179.

Sato, T. (2017). The meaning of Community-Based Learning. *Bulletin of the Institute for Excellence in Higher Education, Tohoku University*, 3, 183-190.

YAMATO Center for Regional Collaboration and Education of Nara Women's University. (2019). Annual Program Implementation Report 2018 (*Kyoso Kyoiku "YAMATO" Saikouchiku project Heisei 30 Nendo Jigyo Jissi Houkokusho*).

YAMATO Center for Regional Collaboration and Education of Nara Women's University. (2018). Annual Program Implementation Report 2017 (*Kyoso Kyoiku "YAMATO" Saikouchiku project Heisei 29 Nendo Jigyo Jissi Houkokusho*).

VERIFICATION OF THE APPLICATION OF A PARTICIPATORY AND DELIBERATIVE ENERGY EDUCATION POGRAM IN TECHNICAL COLLEGE

T. Kobayashi [*, a], M. Kato [a], A. Minoda[b], M. Yagishita[c] and H. Kimura [c, d]

[a]Dep. of Electronics & Control Eng., NIT, Tsuyama College, Okayama, Japan
[b]Dep. of Electrical Eng., NIT, Matsue College, Matsue, Japan
[c]Institute for Dialogue of Environmental Policy, Tokyo, Japan
[d]Public Outreach, Non-profit, Tokyo, Japan

* E-Mail t-koba@tsuyama-ct.ac.jp

Abstract

In this report, under the theme of "Thinking about energy choice after 30 years", the results of implementing the new program, where the lectures by experts and discussion of students including questions and answers, were summarized. The target students were approximately 30 students in advanced course of Matsue Kosen and Tsuyama Kosen. The implementation method was that five future social image as the figure of Japanese society in 2050 were assumed, eight viewpoints on what to emphasize in energy selection were provided, simulation results of power demand and power supply configuration were added and finally Group discussion was conducted. As a result of the questionnaire, it was found that energy selection emphasized on was mainly on safety, technological innovation, energy security, etc., and there was little emphasized on intergenerational equity and regional relations. In addition, with regard to energy demand, various forecasts were made from decrease to slight increase, and electric power demand was expected to increase. In addition, the dependence on fossil fuels in 2050 was assumed to be about 30% (10 to 40%), and the expectation for renewable energy and nuclear energy were about 45% (30 to 60%) and about 20% (10 to 30%) respectively. With regard to educational effects, most of them were positive evaluations, and a certain effect could be verified as active learning. As the further studies, the need for text editing that diverse students will be motivated, the need for improvement of lectures in TV conference format, the need for combination and sharing of intensive lectures by external lecturers and lectures by technical college teachers, further the necessity of knowledge acquisition of policy and social aspects as well as technological and scientific contents, and the appropriate balance of both are required.

Keywords: Energy education, Participatory education, Deliberative education, Energy choice, Active learning

Introduction

The need for a “participative energy debate program”, in which young people supporting future Japanese society can seriously consider and thoroughly discuss on the future energy choices in Japan as their own debate, had been recognized and its development had been started since the severe accident at the Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Station following the Great East Japan Earthquake in March 2011. The result is the "Next Generation Energy Workshop" [1]. The workshop was held for the first time in 2013 as a program for university students (undergraduate students and graduate students), and since then it has been repeatedly practiced and improved, leading to the establishment of a prototype of the program. Then, the program was applied and developed, further the development and trials of programs for young adults and programs for creating a low carbon society in the community, and challenges have been made to apply the program to lectures at individual universities, consequently acceptable results have been obtained [2, 3].

On the other hand, the application promotion of PBL education and active learning has been enthusiastically promoted [4, 5], and many trials and practices have been advanced in energy related education [6-10].

In this report, we examine the pros and cons of the above-mentioned "participatory and deliberative energy education program" by evaluating the results practiced in actual technical colleges after modifying the program in accordance with the educational needs of technical colleges.

Explanation of energy workshop

Energy workshop goals: The “Next Generation Energy Workshop” is aimed at enhancing the ability of young people to discuss the future of energy selection and the creation of a low carbon society in Japanese society, and to develop the ability to think through on their own. The program, as shown in Figure 1, has acquired basic knowledge on energy issues and climate change issues through learning through texts (collections of information materials) and lectures and questions from experts, and shared them. We aim to have the people who bear the next generation of diverse values and opinions fight with each other, to consider long-term energy choices and the creation of a low-carbon society, and to reach their own positive opinions.

Outline of the energy workshop: The flow of the workshop will be outlined according to Fig.1.

1. Advance learning
   Technical data collection
2. Information sharing
   Students acquire basic information on energy and climate change through expert lectures and questions and answers.
3. Group discussion
   Deepen discussions with others who have diverse opinions and values, and carefully consider energy issues and the creation of a low carbon society, and seek out their own opinions. The point is the combination of similar value group discussion and different value group discussion.
4. Energy simulation
   Conduct quantitative verification, such as whether the discussion results satisfy 3E + S (economic, security, environment, safety).
5. Summary
   Students think through "the energy choice in 30 years later", summarize opinions, and organize problems and issues

That is, the main points are the following two.

A. To share basic information on the creation of an energy and low-carbon society.

B. Participant repeating "group discussion", thinking carefully and getting to a firm opinion.

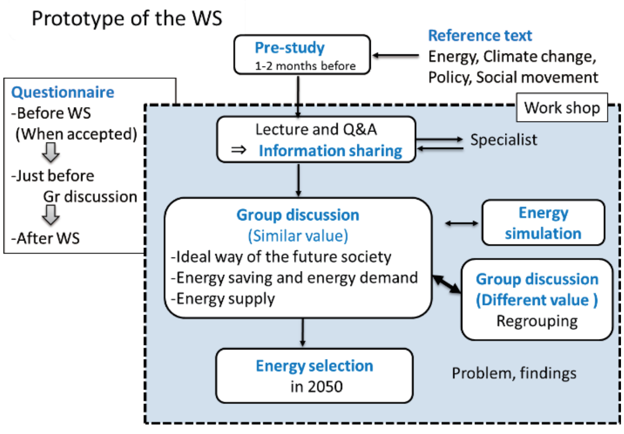


Fig.1 The program of “Next Generation Energy Workshop”

Implementation details and obtained results

Implementation system: This time (FY 2017), a project team was organized by the National Institute of Technology and the Institute for Dialogue of Environmental Policy, and was implemented as a research support project of the New Technology Promotion Watanabe Memorial Society. In addition, Fukushima, Toyama, Tsuyama, Matsue, Kagawa, and each college of Kagoshima participated. In addition, two programs suitable for each advanced course and five years course students were prepared and practiced as shown in Fig.2. In this report, we summarize the contents for the advanced course students that were conducted mainly by Tsuyama and Matsue National College of Technology.

1.Advanced course: Tsuyama NCT, Matsue NCT

Sched.	Place	Content	Participants
14th Dec. 2017	Head office of NCT	Lecture and Q&A by specialists	Tsuyama, Matsue, Toyama, Kagoshima
10-11th Jan. 2018	Tsuyama NCT	WS (Gr. Discussion, presentation)	Tsuyama, 26 Matsue, 4

2.Department: Fukushima NCT

Sched.	Place	Content	Participants
20th Jan. 2018	Fukushima NCT	Extensive WS (Lecture, Gr. Discussion, Q&A)	3rd years students

Fig.2 Two programs prepared for advanced course and five years course students

Outline of implementation contents: In 2017, it was decided to verify the possibility of applying the “participatory / deliberative energy education program” to curricula at NITs, based on the results of the (one) Environmental Policy Dialogue Research Institute explained above. In this report, we summarize the contents for the advanced course students that were conducted mainly by Tsuyama National College of Technology and Matsue National College of Technology. The number of participants was around 30 students. The workshops for Tsuyama and Matsue NCT was designed as a 3-day program to ensure adequate discussion time as shown in Fig.3, and the group discussions were conducted based on the prototype of the "Next Generation Energy Workshop", in which two types of group discussions; “similar values group” and “different values group”, were held. Specifically, (1) formation of the "similar value group" and three discussions in total by the same group, and (2) formation of the "different value group" and the time for dialogue among persons with different values in it were established. In this way, we aimed to clarify the common points and differences of each opinion, and analyse the change of the way of thinking and the reason.

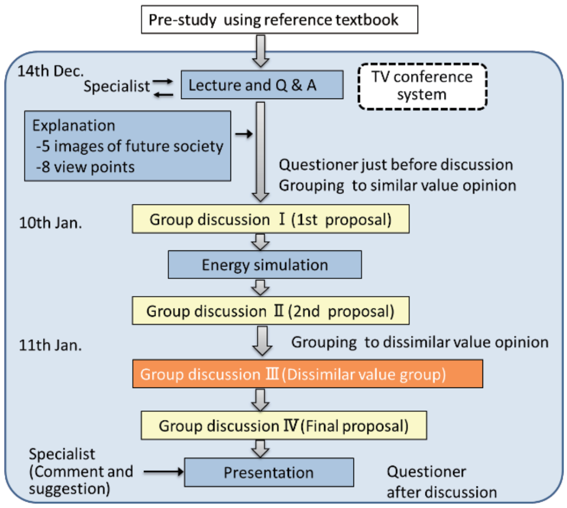


Fig.3 Discussion design of WS in Tsuyama and Matsue NIT (Advanced course)

State of implementation: Information sharing intended to share information on energy in advance learning, expert lectures and questions and answers using texts. The items of the information material collection are as shown in Fig.4.

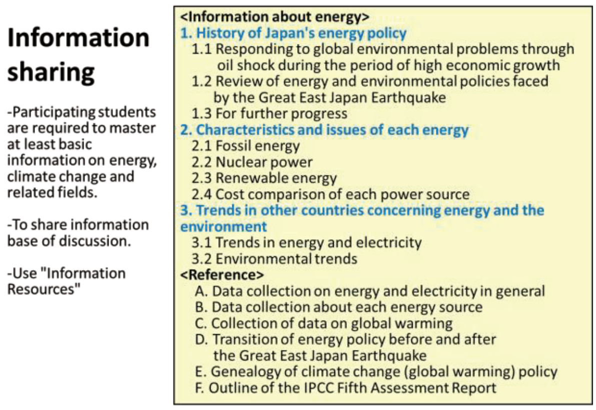


Fig.4 Items of the information material collection

Group discussion was conducted as follows. The participants wrote out their thoughts on the "five future social image" and the "eight viewpoints" on a paper called diamondgram. Subsequently, those who raised the same image of the future society came together to form a group. In Tsuyama NCT students, there were many students in Tsuyama NCT, who chose "Manufacturing integrated society" and "Made in Japan society". On the other hand, for students with a small number of members were joined together with relatively similar groups by comparing diamondgrams, finally five similar value groups were formed.

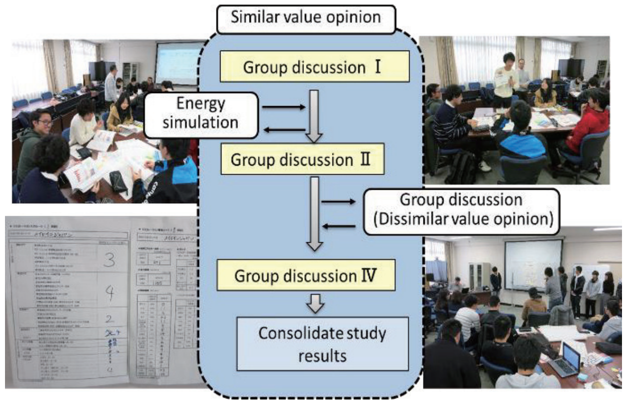


Fig.5 Flow chart of discussions and the state of implementation

Discussions were conducted in the Similar Values Group, and after making the first draft, in response to energy simulation and expert advice, corrections were added and a second draft was created as shown in Fig.6. The third workshop organized a "different value group" and conducted group discussions. Here, the agenda was decided based on the differences between the opinions of each member. Each brought back the discussion results in the different value group back to the original group, and made the final draft of "the future social image and energy structure in 2050". Subsequently, presentations by each group and comments by experts were held. Finally, we conducted an ex post questionnaire.

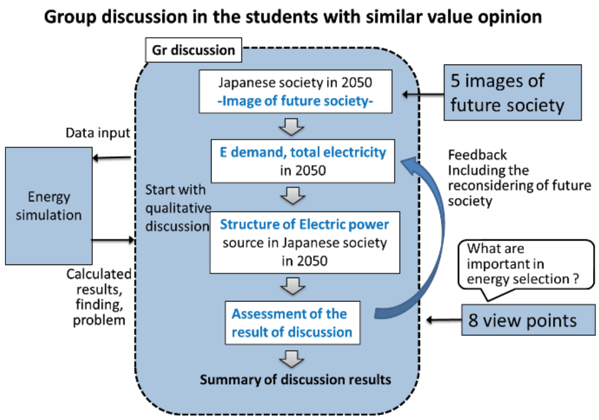


Fig.6 Group discussion in the students with similar value opinion

Fig. 7 shows examples of the final draft of "The image and energy structure of the future of 2050" created by each group. The items described here are as follows.
1. "The image of the ideal future society" to be aimed after 30 years (2050)
2. An emphasis on energy selection: "Stuck" and "Inevitable disadvantages"
3. Energy consumption, energy saving and power consumption in the future society

4. "Power supply configuration" to supply power consumed in the future society
5. "Achievement degree and efforts of low carbonization" in the future society
6. "Discussions and issues of awareness and debate, remaining issues," obtained by the above examination

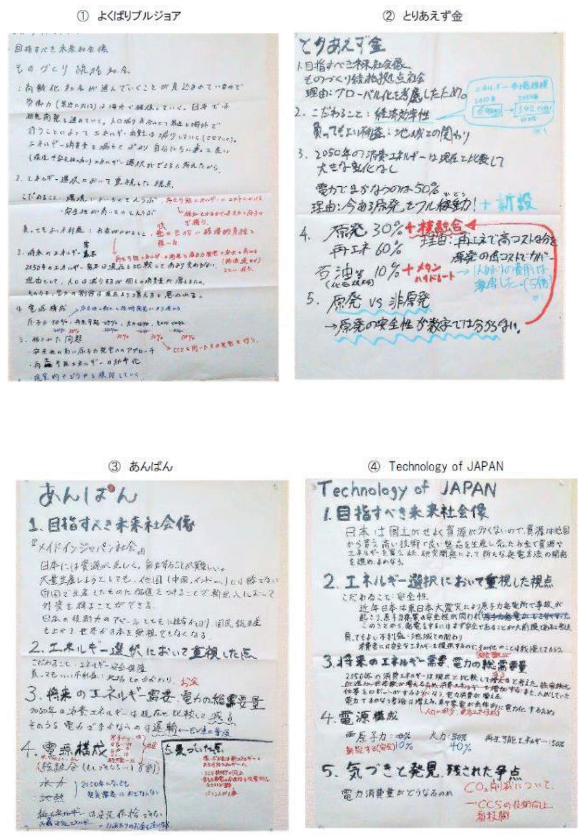


Fig.7 Examples of the final draft of "The image and energy structure of the future of 2050" created by each group.

Conclusions obtained in group discussions: The conclusions on energy selection reached by participants are as following.
1. The emphasis in energy selection is on safety, technological innovation and energy security. There is little emphasis on intergenerational equity and regional involvement.
2. Energy demand: Diverse from slight increase to decrease. Electricity demand is expected to increase.
3. Energy supply (power): It is not convergence in a specific direction.
4. Fossil fuel dependence in 2050 is estimated to be around 30% (10 to 40%).
5. Expectations for renewable energy are generally high. 45% on average (30 to 60%)
6. About 20% of nuclear power is assumed. (10-30%).

Comprehensive response to the workshop by the participants are summarized as bellow.

1. Overall satisfaction ... systematic consideration of energy problems, discussion experience with many peers, learning the importance of fighting diverse opinions
2. There are not a few participants who ended in not being able to find and solve questions.
3. In any case, after intensive learning and thorough discussions, we will reach an energy choice (a vision of Japan's future, energy supply and demand, challenges) that is different from the past, present and future of Japanese society. (Back-casting thinking)

Special notes on the results of the questionnaire survey: We conducted a questionnaire survey on @@ items in advance and after, and surveyed the contents of the workshop, students' attitudes to energy, educational effects, etc. Some of the findings from the new findings are explained below.

(1) Viewpoint to emphasize
1. Economic efficiency
2. Energy security
3. Environment
4. Safety
5. Energy innovation
6. Pursuit of green economy
7. Intergenerational equity
8. Relationship with the community

Through all three times, the weighting score was the highest in “4 Safty” as shown inFig.8. In addition, the results of 1 to 4 including “3E + S” and “5. Energy innovation” are emphasized. Among them, “3. Environment” is characterized by the fact that there are not many people who select it as the first place, but a relatively large number of people give it as the second or third place. In addition, in “7. Generational fairness”, the number of selected people was small in all of the first to third places, and the weighting score also decreased by about 70% in the ex post fact.

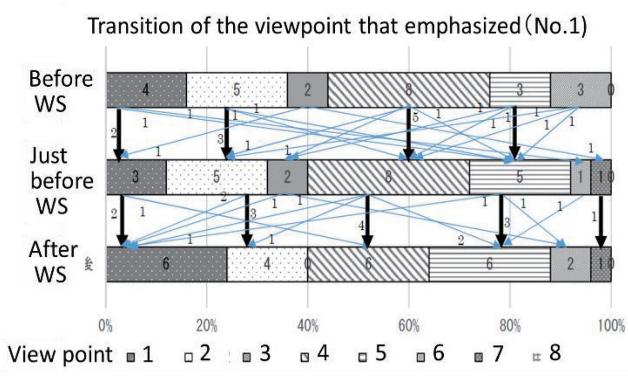


Fig.8 Transition of the viewpoint that emphasized.
(1. Economic efficiency, 2. Energy security, 3. Environment, 4. Safety, 5. Energy innovation, 6. Pursuit of green economy, 7. Intergenerational equity, 8. Relationship with the community)

(2) Desired power supply configuration after 30 years
Coal, oil, and natural gas were recognized as complementary power sources and exceeded basic power sources. On the other hand, renewable energy was very

much more than other energy types by those who considered it as "main power supply". In addition, the total of "main power supply" and "main power supply" increased to 84% in the ex-post, 68% in advance. Those who chose nuclear power as a "main power source" have significantly increased from before to after (2.8 times).
Further, nobody chose "do not use at all" after the fact. This corresponds to the fact that all five groups of Tsuyama National College of Technology and Matsue National College of Technology chose to use nuclear power generation in their final proposal.

(3) About contents of workshop

With regard to the level of understanding of the material collection, the content is extensive and the number of pages is large, so it is considered that the total number of hours to fully understand is insufficient. However, the degree of comprehension was improved after the ex-post comparison.

・ Degree of understanding of material collection
  Understood 18
  Understood if anything 34
  Cannot say either 15
  Could not understand if anything 4
  Could not understand 0
・ Contents of reference materials
  Enough 10
  Enough if anything 7
  Cannot say either 7
  Lacking if anything 1
  Lacking 0

The group discussion was effective for both similar value groups and different value groups, with 84% or more of the students who thought that the issue of the opinion became clear, and it is thought that the significance of the deliberative workshop could be verified.

・ Similar values group discussion
  Effective 12/25
  Effective if anything 9/25
  Cannot say either 3
  Not effective if anything 1
  Not effective 0
・ Different value group discussion (whether the issue of opinion became clear)
  Became clear 15
  Somewhat clearer 6
  Cannot say either 3
  Not clear if anything 1
  Not clear 0

As an overall effect of the workshop, although the issue is very complicated more than 64%, students secured or reached their own opinions.

・ Overall effect

Did your opinion and ideas on energy choices become clear through the workshop?
  Secured own opinion further 5
  Reach own opinion 11
  Questions became clear and own opinion became vague 6
  Not reached own opinion 1
  No particular change 2

Discussion

The application of energy workshops to technical college lectures for advanced courses students has been positively evaluated. Certain effects as active learning were verified.

Issues: Improving knowledge acquisition: the need for text editing that diverse students are willing to study, and the need for improvement of TV conference style lectures

Consider holding multiple consecutive workshops. It is necessary to create a program that matches the actual situation of each technical college, such as combining and sharing of intensive lectures by external lecturers and lectures by technical college teachers.

Efforts to respond as much as possible to the knowledge and acquisition of technical and engineering aspects. At the same time, it is necessary to acquire knowledge on policy and social aspects. Pursuit of balance on both sides.

Conclusion

A new program on energy education, where the lectures by experts and discussion of students including questions and answers for the students in advanced course of NIT, was prototyped, and the following results were obtained from the questionnaire,.

It was found that energy selection emphasized on was mainly on safety, technological innovation, energy security, etc. In addition, the dependence on fossil fuels in 2050 was assumed to be about 30% (10 to 40%), and the expectation for renewable energy and nuclear energy were about 45% (30 to 60%) and about 20% (10 to 30%) respectively. With regard to educational effects, most of students were positive evaluations, and a certain effect could be verified as active learning.

As the further studies, the need for text editing that diverse students will be motivated, the need for improvement of lectures in TV conference format, the need for combination and sharing of intensive lectures by external lecturers and lectures by technical college teachers,

Acknowledgements

Prof. Tamura of the head office in National institute of technology (NIT) made enormous contribution to this project. We are also grateful for the assistance given by Mr. Kabuto and Mr. Mishima in collaboration research center of technology of Tsuyama NIT.

References

[1] Institute for Dialogue of Environmental Policy, *Participatory and deliberative energy education program*. Retrieved from
http://inst-dep.com/free/ws
Participating energy debate program
a participatory and deliberative energy education
[2] Energy Workshop Executive Committee (2018), *Summary of the "Next-Generation Energy Workshop (Student Edition)" (2015 to 2017)*. Retrieved from

http://inst-dep.com/free/documents
[3] Energy Workshop Executive Committee (2017), *Next-generation energy workshop (for young adults).* Retrieved from
http://inst-dep.com/free/documents
[4] Beppu, T., Hara, M., Shibata, M., Shibata, J., Tajima, K., Koda, N. (2017), PBL to enhance engineering design ability, *Journal of Japanese Society for Engineering Education,* Vol.65, No.1, pp.32-39.
[5] Dana M. Barry, H. Kanematsu, Y. Fukumura, T. Kobayashi, N. Ogawa, H. Nagai (2014), Problem-Based Learning Activities in Second Life, International Journal of Modern Education Forum, 3(1), ,pp.7-12.
[6] M. Kato, T. Kobayashi, T. Okada, M. Sato, Y. Ssasai, D. Konishi, K. Harada, H. Taniguchi, H. Toya, T. Inada, H. Sori and H. Yagi (2012), Progression of Technology Education for Atomic Energy Engineering in Tsuyama National College of Technology, *Journal of Power and Energy Systems*, Vol.6, No.2, pp.255-263.
[7] T. Kobayashi, M. Kato, H. Sori, Y. Sasai, M. Sato, T. Inada, K. Harada and T. Okada (2014), Sustainable Progression of Technology Education for Atomic Energy Engineering in Tsuyama National College of Technology, Mechanical Engineering Journal, Vol.1, No.4, pp1-10.
[8] H. Kanematsu, T. Kobayashi, N. Ogawa, Y. Fukumura, D. M. Barry, and H. Nagai (2012), Nuclear Energy Safety Project in Metaverse, , Intelligent Interactive Multimedia: Systems and Services, Smart Innovation, Systems and Technologies, Vol.14, pp.411-418.
[9] H. Kanematsu, T. Kobayashi, N. Ogawa, D. M. Barry, Y. Fukumura and H. Nagai (2013), Eco Car Project for Japan Students As A Virtual PBL Class, Procedia Computer Science, Vol.22, pp.828-835.
[10] D. M. Barry, H. Kanematsu, Y. Fukumura, T. Kobayashi, N. Ogawa, H. Nagai (2013), US Students Carry out Nuclear Safety Project in a Virtual Environment, Procedia Computer Science, 22, pp.1354-1360.

A STUDY OF THE CHANGES IN DELIVERY METHODS OF A STATISTICS MODULE

S. Chua

Republic Polytechnic, School of Engineering, Lecturer, Singapore

*samuel_chua@rp.edu.sg

Abstract

This study aims to explore students' perceptions of learning with different instructional strategies in a statistics module. This module was delivered using Problem-Based Learning (PBL) in Academic Year (AY) 2017 Semester 1 and earlier, and restructured to be delivered using Interactive Seminar (IS) from AY2017 Semester 2 onwards. In the restructured runs, students experience collecting real data outside the classroom in their statistical projects. In addition, the study aims to explore students' achievement when learning is underpinned by the different instructional strategies. This study employs a mixed methods approach using both qualitative and quantitative data. Qualitative data were obtained from two sources: a focus group discussion (FGD) with a group of seven students and a reflection journal (RJ) administered to the entire cohort of 356 students who took the module in AY2018. From both the FGD and RJ, administered after the completion of all lessons in the semester and before the final examination, there is evidence that students enjoy the learning activities and found the activities useful in their learning. They also found working on team projects a meaningful experience, and it gave them an authentic feel of working with real data collected outside the classroom by applying the knowledge learnt in class to analyse data. Specifically from the FGD, students found learning the advanced statistics content using IS a more suitable mode of learning as compared to their learning of advanced content in other modules conducted using PBL.

Quantitative data to measure students' achievement comprises the module grade points, mean lesson grade points and examination raw scores obtained by students. Comparisons of these measures were made across four cohorts of students, with the module conducted using PBL in two cohorts (768 students) and conducted using IS with team projects in the other two cohorts (673 students). Students' achievement are significantly better when the module is conducted using IS with team projects, as compared to the module being conducted using PBL.

Keywords: *Problem-Based Learning, Interactive Seminar, statistics module, focus group discussion*

Introduction

Several past studies point towards the need to reform statistics education (e.g. Cobb, 1992) and describe the need for specific changes in teaching. Instead of traditional lectures whereby students are expected to memorise information that they ~~learnt~~, teachers are encouraged to introduce active-learning activities whereby students are able to construct knowledge. Garfield (1993) suggests the use of cooperative learning activities as a form of active learning to supplement or replace traditional lectures. PBL was first adapted to the statistics module in this study with the implementation of some cooperative learning activities in lessons. In the PBL instructional strategy, students were first presented with a problem statement at the beginning of each lesson. A discussion takes place in class, facilitated by the lecturer, to trigger students' prior knowledge related to solving the problem and to identify their gaps in knowledge. The tasks required to solve the problem statement are discussed. The learning process during the problem solving phase is scaffolded by an accompanying worksheet, enriched with peer collaboration and discussions that take place at the team level. A team typically comprises five students. The learning process was designed to encourage self-directed learning and peer collaboration. Students present their solution to the problem and critique one another's work during the final learning phase of the lesson. However, feedback collected from lecturers and students indicate that students often struggled with learning and understanding concepts in an advanced statistics module facilitated in this way. The difficulty of learning advanced statistics content in this PBL mode might be due to the inherent demanding unknown concepts, distinct notation and unclear procedures. Hence students' perception of learning this module was low, consistently below the department average and institution average in a survey administered towards the end of every semester. The restructuring of the statistics module in this study was then undertaken from changing the PBL to IS, the latter will be elaborated below.

Mazur (2001) reported that an implementation of Peer Instruction (PI) in a calculus- and algebra-based introductory physics courses for non-majors resulted in increased student mastery of both conceptual reasoning and quantitative problem solving. Subsequent improvements to the implementation, designed to help students learn more from pre-class reading and to increase student engagement in the discussion segments, are accompanied by enhanced student understanding. Findings from this literature informed the restructure of the statistics module with IS instructional strategy, which improved learners' interaction with the lesson content, with the lecturer, and with peers. A mandatory pre-reading was put in place, accompanied by a pre-lesson activity at the beginning of each lesson in class. The activity covered the pre-reading content, and took the form of a class discussion, an inter-team competition, an interactive or paper quiz administered to individuals. New concepts were introduced and discussed in class, facilitated by the lecturer. Practical scenarios were designed for application of knowledge, and students collaborated in teams to solve the required tasks. Certain interactive activities used in the pre-lesson activity were also deployed during the main part of the lesson, such as the inter-team competition and interactive quiz, which uses the game-based learning platform called 'Kahoot!'.

In a study by Nolan (1999), an undergraduate statistics course was restructured to allow students to learn statistics through applications, which include collection of data, investigations and analyses in the context of a scientific problem, and detailed theoretical development within the lab. These were designed to encourage and develop statistical thinking. In the student feedback administered at the end of the course, students report that the labs helped them better understand statistical theory. They liked the practicality and concreteness of the course and the relevance to the real world. Team projects were designed in the restructure of the statistics module to activate learning through applications. Students were given five team projects to work on throughout the semester of thirteen weeks. Each project was designed for students to apply their knowledge from lessons and to experience the various stages of a statistical project, i.e. collecting data from labs and various locations in the campus, cleaning data collected, analysing and making sense of the data, presenting findings and recommendations. The team projects were designed to allow peer collaboration.

This study seeks to answer three research questions (RQ).

RQ #1: How do students perceive learning the statistics module using the IS instructional strategy?

RQ #2: How do students experience applying statistical knowledge to projects involving real data?

RQ #3: Is there a significant difference in students' achievement with the restructuring of the statistics module?

Methodology

In this section, three aspects will be discussed, first the FGD, second the RJ and third students' achievement in learning.

An FGD was designed to gather qualitative feedback from students on their learning experience after going through all lessons of the module. Lecturers were asked to nominate one or two students from each of their classes, with the considerations of selecting students who are more vocal and belonging to various performance levels, measured by an average of numerical scores of the students' lesson grades. A total of seven students eventually participated in the FGD. These participants have an average lesson grade of between B and A inclusive. Ethics protocol was maintained throughout the study. The discussion was recorded in audio and transcribed to text.

For analysis of qualitative data such as the transcripts of a focus group discussion, several authors suggest that codes are efficient and help to organise data through its labelling and retrieving access (Miles & Huberman, 1994; Neuman, 2003). One of the well-known proposals in analysing qualitative data is for the researcher to identify and locate patterns and associations within the participants' words and actions (Neuman, 2003), but at the same time remain in close contact with the construction of reality as seen from the participants' perspective. The three levels of analysis as proposed by Neuman (2003), namely, open-, axial- and selective-coding, was adopted for this study.

A total of 40 descriptive codes were obtained from open coding, the first pass, in which all lines of the transcript were read and given a category label. These codes then undergo a second pass known as axial coding, in which the initial codes were examined and organized into clusters of related categories. The initial codes were re-organised into 15 pattern codes and the relationship between these codes were studied and represented in a diagramming memo. During the final pass, known as selective coding, 4 major themes were identified. A theoretical memo is written to summarise the findings and will be discussed in the next section. One student's transcript is used to illustrate an example of how a transcript goes through the various levels of coding, as follows:

Student C: *I like having the team assignment, which allows us to collect raw data from a lab, perform our own analysis, and apply the statistical knowledge from the lessons. This would be really useful and applicable for us when we join the work force.*

At the opening coding level, this was assigned a code 'Activity that students find to be useful'. At axial coding level, it is grouped into a broader cateogry code called ' Lesson structure, activity or resource that students enjoy or find to be useful'. This broader code consists of the highest number (24) of descriptive codes used in the original transcripts. Lastly, in selective coding, this code goes into a theme called 'Students' learning experience and perception of learning'.

Majority of students completed an RJ in the final week of the semester. Two questions from the RJ are selected for this study: (1) To what extent do the activities during the interactive seminar motivate you in learning or help you learn better? (2) Do you think the team projects provide you the opportunity to apply knowledge from lessons to statistical projects by collecting real data outside the classroom?

As the qualitative RJ responses collected was massive, a text mining software was used to study the data using tools and methods such as word cloud, heat map, and sentiment analysis. Data from the FGD and RJ were used to answer to RQ #1 and #2.

To answer RQ #3, four numerical measures were used and two-sample t-tests were conducted using each measure and comparing students from two cohorts with the statistics module conducted using PBL (768) and students from another two cohorts with the module conducted using IS with team projects (673). A summary of the four measures is shown in Table 1. The module grade is computed based on students' grades from the lessons and examinations, with a specific weighting given to each component. The full score for both the mid-semester examination (60) and final examination (100) are the same across all four cohorts.

Table 1: Summary of comparisons

		Mean	Standard deviation	Observations
Mean lesson grade point	IS	2.99	0.67	673
	PBL	2.87	0.59	768
Mid-semester examination score	IS	37.78	8.41	661
	PBL	33.49	10.07	753
Final examination score	IS	59.89	15.08	657
	PBL	57.58	17.42	745
Module grade point	IS	2.38	0.87	673
	PBL	2.14	0.90	768

Results and Discussion

The diagramming memos formed after axial coding (second pass) and selective coding (final pass) are shown in Figure 1 and Figure 2, respectively. In Figure 1, the nodes in darker shades represent codes used more frequently in the transcript and they are given a greater weight in the consideration of the next stage of coding.

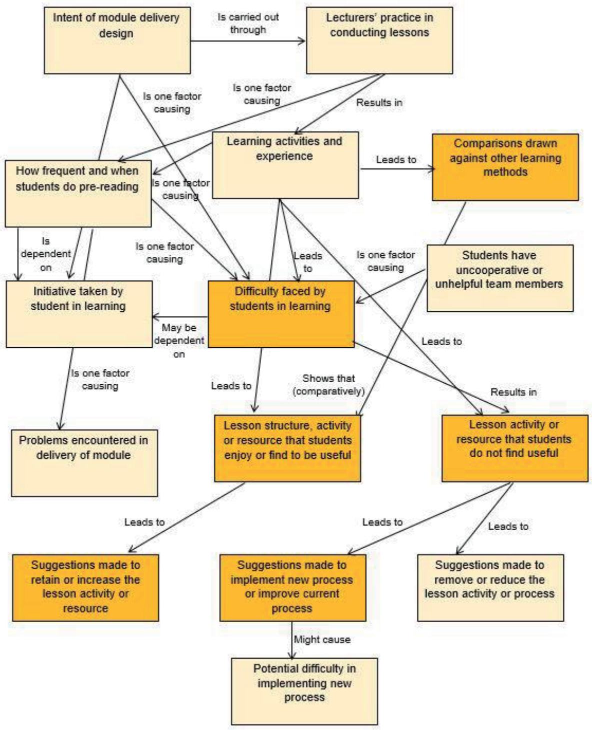


Figure 1: Diagramming memo formed after axial coding

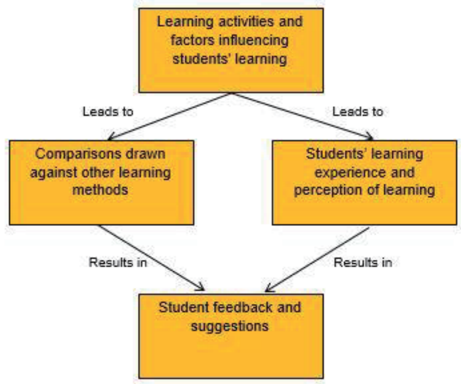


Figure 2: Diagramming memo formed after selective coding

The following is a theoretical memo that summarises the findings from the focus group discussion, achieved from the coding process:

With a redesign of the statistics module's structure and delivery method, a few factors were identified as influencing students' learning in the redesigned module, such as, whether students do pre-reading before attending class, the level of initiative taken by students in learning, and how lecturers carry out the lesson activities.

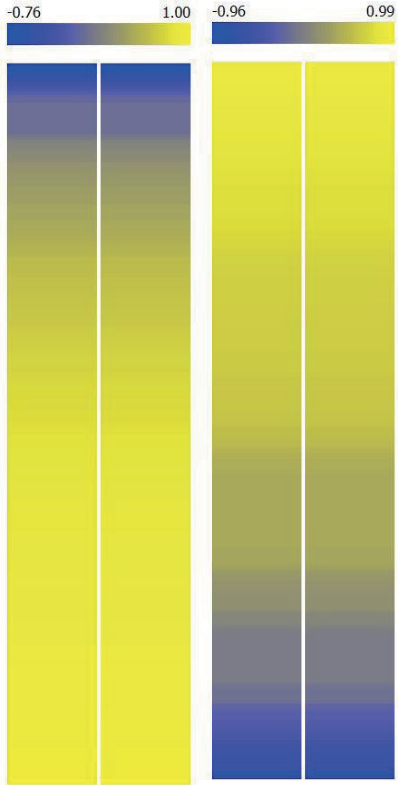
With comparison made between how the statistics module is conducted using interactive seminar (IS) against modules conducted using problem-based learning (PBL), all students stated that the IS method of learning is more suitable and beneficial to their learning, given the technical nature of the content. Students stated various activities conducted during the lesson that helps them in learning, or makes learning more interesting.

Several activities or resources were suggested to be either retained or increased in future runs of the module. Commonly mentioned ones are examples given in the lesson slides which demonstrate application of concepts, a summary of concepts at the end of a batch of lessons covering similar topics, dedicating more time in class for students to work on exercises, and having more inter-team competitions to inject fun into learning and to enable greater opportunity for peer collaboration. Most students agree that working on team projects in the module allows them a refreshing out-of-classroom experience and gives them a real life experience in collecting data and applying what they learnt to analyse the data.

Students also stated some difficulties encountered in the module. One common difficulty faced by students is not fully understanding the pre-reading content or remembering the name of technical terms. Some students take initiative by searching for other sources of pre-reading to improve their understanding, while others write paper notes to enable them to remember technical terms better during the pre-lesson activity. For students who did not take such initiatives, they encounter difficulty during the pre-lesson activity. One suggestion from students is to provide a summary of key points if the pre-reading content contains numerous technical terms so that it does not require any form of memorizing in their preparation for the lesson.

Another difficulty is that when students are grouped with team members who do not contribute to working on the team project, it would usually result in only one or two students doing all the work. One suggestion is to have a task-specific type of peer evaluation form so that students fill in the contributions made by team members factually, with the aim to provide the lecturers with clearer details to do a more accurate assessment of students' contribution towards the team assignment. This may improve the situation of inaccurate or unclear evaluation done by students in the current semester.

Sentiment analysis are performed on students' RJ responses to inform the qualitative results from the FGD. Results showed that majority of the responses to both learning activities in class and team projects are positive. This is demonstrated in the heat maps shown in Figure 3, whereby the negative end of the colour spectrum is blue and the positive end is yellow. Word clouds in Figure 4 and 5 show the commonly used words in the responses on learning activities in class, while Figure 6 and 7 show commonly used words in the responses on team projects.



(a) (b)

Figure 3: Heat maps with responses on (a) class activities and (b) team projects

Figure 4: Word cloud with positive responses on class activities

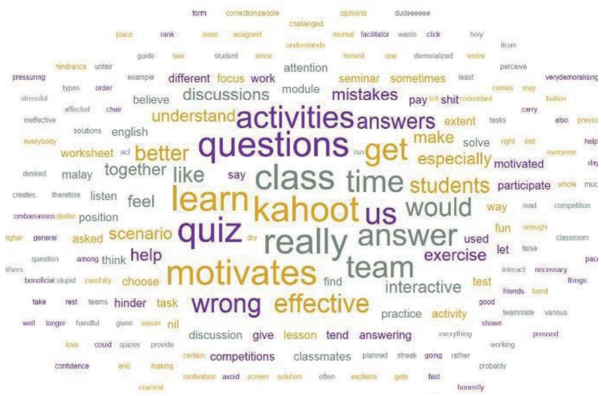


Figure 5: Word cloud with negative responses on class activities

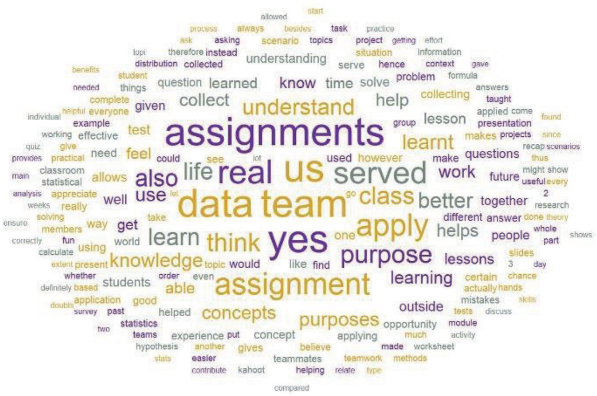


Figure 6: Word cloud with positive responses on team projects

Figure 7: Word cloud with negative responses on team projects

Among positive responses on class activities, some key words that form the word cloud in Figure 4 were studied. 'Team' was mentioned 111 times, of which 103 (92.8%) were positive. Students shared that team-based activities, such as inter-team competitions and solving tasks related to scenarios given in the lesson as a team, are most effective for their learning or engages them the most in learning. 'Kahoot' was mentioned 121 times, of which 111 (91.7%) were positive. Students found the game-based Kahoot! quiz enjoyable and effective for their learning. 'Quiz' was mentioned 78 times, of which 72 (92.3%) were positive. Majority (65.3%) of the positive responses pertain to the Kahoot! quiz, and the remaining responses pertain to the quiz administered at the end of each lesson. Students found motivated to do well in the quiz, as it prepares them for the examinations, and the quiz result is one of the performance aspects for their lesson grade. 'Class' was mentioned 56 times, of which 51 (91.1%) were positive. Majority (86.3%) of the positive responses pertain to class discussions, which students found beneficial to their learning. From the word cloud of negative responses in Figure 5, 'Kahoot' (12 times) and 'Class' (6 times) appeared the most number of times. On closer inspection of the individual responses, only 4 out of 12 (33.3%) responses on 'Kahoot' and 1 out of 6 (16.7%) responses on 'Class' are truly negative. The small group of students found the Kahoot! quiz to be ineffective, citing reasons such as requiring more time to read the questions and not being able to respond in time, and being too caught up in responding quickly to get high scores rather than learn through the activity.

Among positive responses on team projects, some key words that form the word cloud in Figure 6 were studied. 'Team' was mentioned 142 times, of which 117 (82.4%) were positive. 'Data' was mentioned 86 times, of which 73 (84.9%) were positive. Positive responses show that students found the data collection activity of the team project gave them an authentic experience of carrying out a project to solve real issues, which may be similar to what they would do in their future work. The remaining responses were either negative or mixed. A few common negative responses include having incorporative team members who do not contribute to the project, the data collection process being too time consuming and students rather spend the time on learning and doing practice exercises in class, and students not finding relevance or appreciation of the team projects as they either find no relevance in taking the module to their course or future work or they only aim to do well enough to pass the module. From the word cloud of negative responses in Figure 7, Team' (38 times) and 'Data' (19 times) appeared the most number of times. On closer inspection of individual responses, only 13 out of 38 (34.2%) responses on 'Team' and 7 out of 19 (36.8%) responses on 'Data' are truly negative. The findings from these negative responses are identical to those from the negative responses that formed the positive word cloud.

Results from the two-sample t-tests show that students from the two cohorts with the module conducted using IS with team projects performed significantly better than those from the two cohorts with the module conducted using PBL. This result is consistent using all four measures, namely the mean lesson grade point of each student ($P<.001$), students' raw score in the mid-semester examination ($P<.001$), students' raw score in the final examination ($P=.004$), and students' module grade point ($P<.001$).

Conclusions

Results from the qualitative studies indicate that students have a positive perception of learning the statistics module under the current learning model of conducting lessons using interactive seminar and having team projects which provide an element of authentic learning through working with real data collected outside the classroom and applying the knowledge learnt in class to solve practical problems posed in the projects. Most students agree that the interactive activities, mostly team-based, bring value and interest to their learning. All students from the FGD perceive the IS mode of learning to be more suited for learning advanced statistics content as compared to learning such content using PBL. The study also reveals common concerns raised by students, such as their inability to fully understand certain pre-reading content and facing difficulty working with and evaluating peers who do not contribute well to their team projects. Possible methods to improve the module were also discussed in the FGD, which helps in the continual improvement to make learning more effective and meaningful for students from the future cohorts.

However, since the FGD involved seven students, these results are not generalizable but can provide evidence for further in depth explorations.

The quantitiative study shows a distinct improvement in students' achievement after the restructure of the module., However, we may not conclude that the restructure of the module is the sole or main cause of the improvement. Future studies may employ methods such as the exploratory factor analysis or multiple regression to investigate factors that influence student learning.

References

Cobb, G. G. (1992). Teaching Statistics. In L. A. Steen (Eds.), *Heeding the call for change: suggestions for curricular action* (pp.3-43). Washington, D.C.: Mathematical Association of America.

Garfield, J. (1993). Teaching Statistics Using Small-Group Cooperative Learning. *Journal of Statistics Education*, *1*(1). doi:10.1080/10691898.1993.11910455

Nolan, D., & Speed, T. P. (1999). Teaching Statistics Theory Through Applications. *The American Statistician*, *53*(4), 370. doi:10.2307/2686059

Crouch, C. H., & Mazur, E. (2001). Peer Instruction: Ten years of experience and results. *American Journal of Physics*, *69*(9), 970-977. doi:10.1119/1.1374249

Miles, M. B., Huberman, A. M., & Saldaña, J. (1994). *Qualitative data analysis: A methods sourcebook*. Los Angeles: SAGE.

Neuman, W. L. (2014). *Social research methods: Qualitative and quantitative approaches*. Harlow: Pearson Education.

Typing during Lectures as an Alternative for Blackboard Writing

S.Nishimura [*,a]

[a] National Institute of Technology, Oita College, Oita, Japan

* s-nishimura@oita-ct.ac.jp

Abstract

Blackboard writing is one of the most basic method to give a lecture for a long time, but these days, the necessity of handwriting is decreasing due to the widespread use of digital devices. This study proposes an alternative method for writing blackboards: to input contents through PC keyboards and show them on a projector screen.

Keywords: *lecture, blackboard writing, digital material, markup language, modern learners*

Introduction

Teachers often use blackboards (, whiteboards or chalkboards) to give a lecture for all kinds of subjects. They write lecture content on blackboards by hand with chalk. This method needs no special devices except blackboards, and this could be one of the reasons why the method is popular.

There is another major lecture method: using slides by projectors. Since it need projectors, it costs more than only using blackboards, but the slides allow to use expressive, rich figures. Teachers can take enough time to prepare figures and expressions about lecture content in advance.

These two methods, using blackboards and using slides, are obviously good by itself, but moreover, Meo, S.A., et al. (2013) show that combination use of blackboards and slides is more effective. They expressed "Significantly higher marks was obtained by students who were taught on PowerPoint as well as chalkboard (3.41± 0.12) compared to those students who were taught either on PowerPoint or on chalkboard alone. However, no significant difference was observed between the marks obtained by the students who were taught on PowerPoint (3.07 ± 0.14) compared to the students who were taught on chalkboard (3.10 ± 0.13) alone." This indicates that within digital devices such as projectors, some kind of flexible/dynamic methods (blackboard writing, for example) are still needed. More specifically, teachers sometimes need ad hoc explanations for in the classes, and blackboard writing is very helpful for this.

In a broad range of fields, not limited to education field, digital data is appreciated these days, thus teachers should consider to make our lecture materials digital. Slides are digital data in the first place, whereas blackboard writing becomes our issue, and there are some studies as following. Timmins (2004) use a tablet PC to not only to carry forward slide, but also writing additional lecture contents by hand through the tablet. Further, the lecture notes are able to publish on the Internet. The study concludes "The Tablet PC offers what is currently the best mix of computing technology and old-fashioned blackboard flexibility." Ambikairajah (2005) develops "tablet PC as a digital whiteboard," and the method allows you to annotate with handwriting on slide materials. The study said "a key advantage of the system was that the interaction between students and lecturers catered for an increased understanding of the material taught, compared with traditional methods of teaching." Thus, handwriting materials are able to be treated as digital data.

In this study, a trial of further digitalization for lectures is provided: handwriting to keyboard typing. Recently, the necessity of handwriting is decreasing due to the widespread use of digital devices. On this topic, Mangen, et al. (2015) shows study efficiency on writing modalities: handwriting, keyboard and iPad (touch typing), and the evaluation result indicates handwriting is the best on both of free recall and recognition. Thus handwriting is very important to study, although it is difficult to go against the big wave of digitalization. Aragón-Mendizábal (2016) provides another study of a comparison, and results that keyboard typing is good at fast information recording, but not good at memory tasks.

The method provided here is that a teacher inputs lecture contents through keyboards during classes, then show that contents on a projector screen (or a monitor), as if the method is an alternative for blackboard writing. Since the input is done by a teacher during lectures, the method is flexible, and lecture notes are obviously available to publish on the Internet. Notice that the method doesn't use handwriting but has dynamic aspect, which means teachers can change the input content interactively.

Furthermore, the method proposed here has a function of "annotations by students," which means students can add their notations to the description from the teacher, by sending the notations through their smartphones. This function is intended to an alternative for note taking by students. Note taking during lectures is considered one of the efficient way to understanding lectures, therefore we should find a new way to substitute for it even if handwriting is discarded.

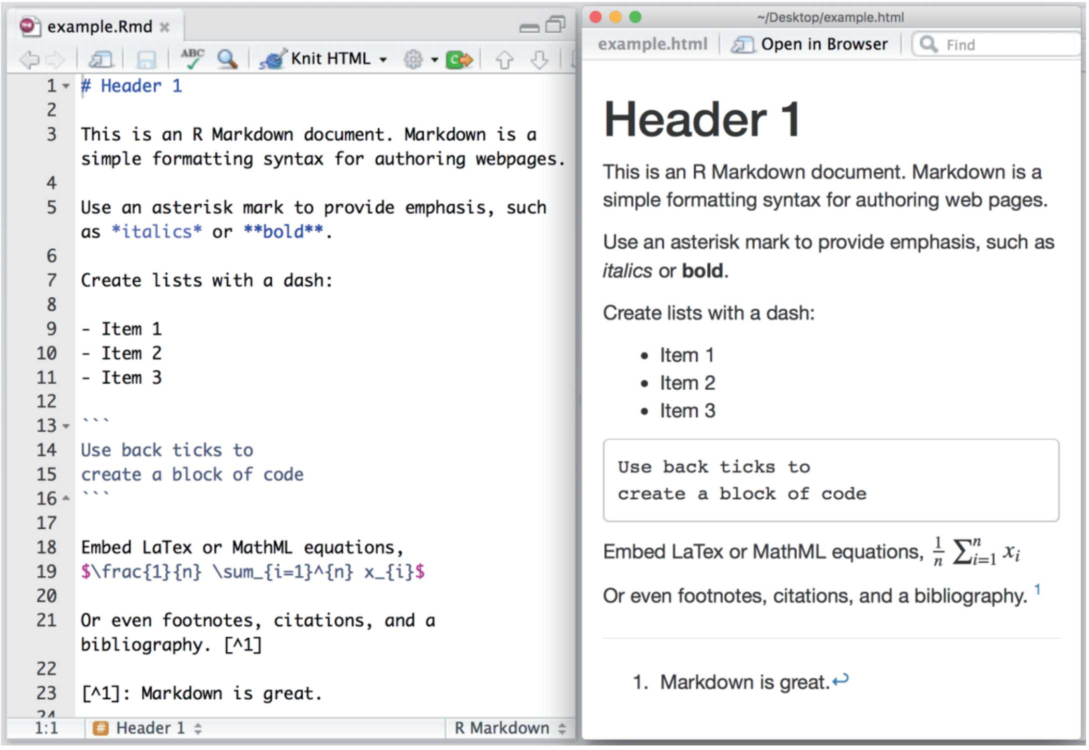


Figure 1. Markdown examples (R Markdown Quick Tour. (2019))

Methods

In short, the method proposed in this article is "input markup language and immediately show decorated output, publish lecture notes afterward," as follows.

Markdown: Markup language (language to decorate texts) is needed to implement the method, and especially lightweight markup language is better because rapid output is demanded. In this study, Markdown is adopted. As shown in Figure 1 (left side is input and right side is output), it has syntax for headers (plural levels), italics, bolds, items, etc. When you input left side texts, decorated output in right side will be obtained.

Mathmatical Notations: Some subjects require to express mathematical notations, and MathJax is useful for this purpose. MathJax allows LaTeX like input notations and output mathematical notation in a browsers. For example,

```
$\lim\limits_{h\rightarrow 0} \frac{e^h-1}{h}$
```

shows

$$\lim_{h\to 0}\frac{e^h-1}{h}.$$

Real Time Rendering: With the method proposed in this study, the input contents should be immediately reflected on a screen. Text editor's preview function (for markdown) is suitable for this purpose. For instance, preview function allows you to get immediately decorated output in a right side window correspond to markdown input in a left side window (just like Figure 1) . In an actual lecture, text editor's preview function is not useful because teachers use their PC with multi monitor mode (one for markdown inputs and the other for decorated outputs on projectors), thus an editor window is difficult to deal with. To overcome this issue, this study adopts *impatient-mode* in emacs text editor: this mode make it possible to show immediately decorated output in browsers. Thus teachers can use input and output window separately with impatient-mode on emacs.

Web Publishing: Obviously markdown texts are available to publish in the Internet directly. If the need arises, you can edit one markdown text among students through web services, such as HackMD. It might be useful for group works.

Annotations by students: As an alternative for note taking, students can append their thoughts to lecture notes on the proposed method. Students bring their smartphones to the class and send an annotation through LINE app (text chat app), as shown in Figure 2. Sent text

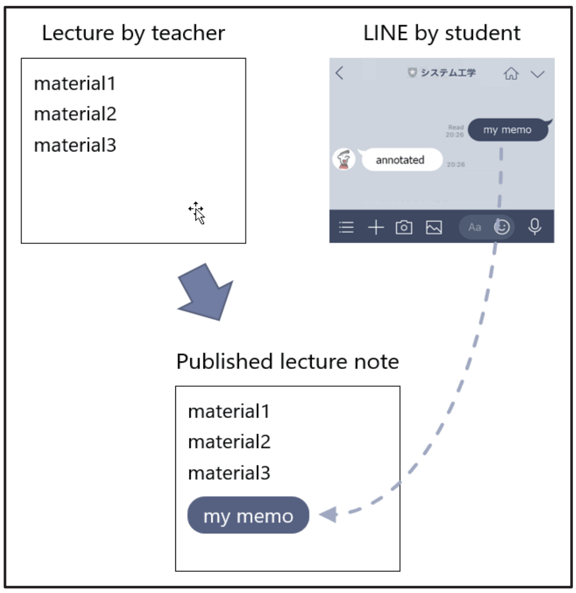


Figure 2. Annotation function

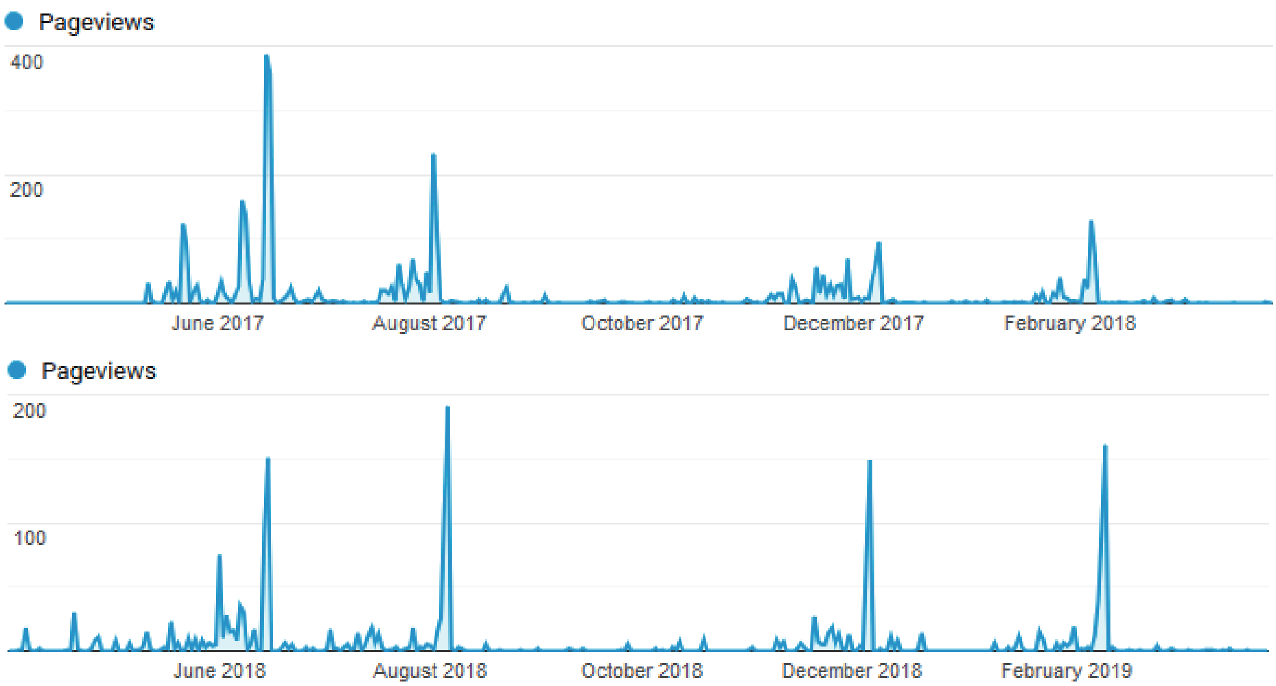


Figure 3. Pageviews distribution for published lecture notes

message, sent time and sent user are stored in LINE server, thus you can gererate personal lecture notes for each students (who sent annotations), which has their annotations to lecture notes by programming.

Case Example

The method is applied for System Engineering Lecture in National Institute of Technology, Oita College, from April 2017 to March 2019, total 77 students of 4th grade (18-19 years old).

Web Pageview: Table 1 shows pageviews of published lecture notes on the Internet. School year 2017 is almost double of school year 2018, and cannot figure out the reason. I guess it is only difference of learning enthusiasm on each class.

Table 1. Pageviews

school year (students)	Pageviews
2017 (39)	3,815
2018 (38)	2,012

Pageviews distribution is shown in Figure 3. Obviously there are four access concentrations for both school years; we have four periodic examinations. Considering for each student, 76.7 pageviews a year, and since there were 13 lecture notes a year, 5.8 pageviews per a lecture note (and a student).

Annotations by Students: Annotation function was implemented for the 2nd half of school year 2018, and usage statistic is as follows.

- Total annotations count: 56 times
- Users (of 38 students): 13 students
- User ratio: 34.2%
- Average annotations count for users: 4.3 times

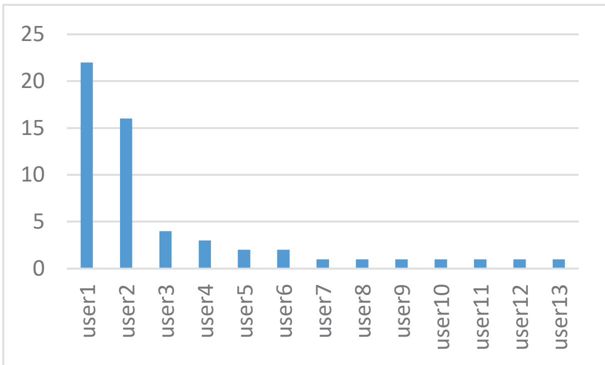


Figure 4. Usage count per user

These data are for a half year, thus this function rarely used by students. Only 34.2% students used and even for user, average annotations count is 4.3 times per a half year. This is substantially below my expectations. About contents of these 56 annotations are as follows.

- What the teacher said: 76.8% (by 8 students)
- Etc(seems meaningless): 23.2% (by 6 students)

Most of them was what the teacher (author) said, either directly or indirectly, and not on the lecture note. The others seems like scribbles. This time 2 enthusiastic users are found: as seen in Figure 4, the most enthusiastic user annotates 22 times and the second annotates 16 times. These two students shares 67.9% of all annotations.

Discussion

Not Available to Compare: It is better to compare blackboard writing to keyboard typing on some aspects, such as examination score or satisfaction level questionnaire, but the target subject of System Engineering Lecture began by the author with typing method in the first place, thus it is not possible to compare these.

Publishing Lecture Notes: As mentioned above, lecture notes are digital data from the first, thus they are very easy to publish on the Internet. When you publish your lecture notes on the Internet, you can check how often students refter to them, and moreover, statistics are also available. The statistics would help to improve you lectures. This advantage is never obtained by handwriting lectures.

Showing Eagerness: Compared to lectures with slides, it is the same on publishing lecture notes since both consist of digital data. But there are is a crucial difference between them: students may feel teachers' eagerness when teachers type keyboard for the students. A teacher types keyboard for no one else but the students there in the classroom, as if blackboard writing. This is a better point than using slides.

Annotations by Students: When I planned to implement this function, I hoped a great number of students will use it. But in fact, only one third of students are users and even the users annoteted 4.3 times per a half year, which fall far short of my expectations. That means this function cannot be a substitute for note taking correspond to blocaboard-writing lectures. Looking at the bright side, two students out of 38 are annotated about 19 times per a half year. I believe that suggests hidden possibilities of annotations function.

Conclusions

Keyboard typing is proposed to substitute for blackboard writing from a perspective of digitalization. The method is to input markup language and to display decorated output immediately, and to publish lecture notes afterward. In addition, students can add their annotations to a lecture note from the teacher, by sending the notations through their smartphones. Considering to publish lecture notes in the Internet, typing is better than blackboard writing because digital lecture notes are naturally generated from markdown language. As compared to lecturs using slides, teachers can show their enthusiasm by typing for the students. A case example was shown: for 77 students of a college. On one hand, published materials are numerously accessed especially before the examinations. On the other hand, about annotating function that was mentioned above, only a few enthusiastic students used, which is far from my satisfactory and there is a room for improvement.

References

Ambikairajah, E. & Epps J. & Sheng M. & Celler B. & Chen, P. (2005). EXPERIENCES WITH AN ELECTRONIC WHITEBOARD TEACHING LABORATORY AND TABLET PC-BASED LECTURE PRESENTATIONS. *IEEE International Conference on Acoustics, Speech, and Signal Processing*, Vol. 5, V-565-V-568

Aragón-Mendizábal, E. & Delgado-Casas, C. & Navarro-Guzmán, J. & Menacho-Jiménez, I. & Romero-Oliva, M. (2016). A Comparative Study of Handwriting and Computer Typing in Note-taking by University Students. *Comunicar*, vol. 24, n. 48, 101-107.

Mangen, A. & Anda, L.G. & Oxborough, G.H. & Bronnick, K. (2015). Handwriting versus Keyboard Writing: Effect on Word Recall. *Journal of Writing Research*, Vol. 7, issue 2, 299-319

Meo, S.A. & Shahabuddin, S. & Masri, A.A.A & Ahmed, S.M. & Aqil, M. & Anwer M.A. & Al-Drees A.M. (2013). Comparison of the Impact of PowerPoint and Chalkboard in Undergraduate Medical Teaching: An Evidence Based Study. *Journal of the College of Physicians and Surgeons Pakistan*, Vol. 23 (1), 47-50

R Markdown Quick Tour. (2019). Retrieved from https://rmarkdown.rstudio.com/authoring_quick_tour.html.

Timmins, S.J. (2004). Tablet PC: Blackboard to the Web. *Proceedings of the 32nd Annual ACM SIGUCCS Conference on User Services*, 296-300

Liberal Arts as a Learning Motivator for NIT Students

Osamu HARAGUCHI*,[a], Takuro FUJITA [a], Yasunobu TESHIMA [a], Yuki MIYAMOTO [a], and Takaaki NAKATSUKA[b]

[a] Humanities and Social Studies, National Institute of Technology (KOSEN), Fukui College, JAPAN

[b] Advanced Course, National Institute of Technology, Fukui College (KOSEN), JAPAN

* osamuh@fukui-nct.ac.jp

Abstract

(I) Introduction

In this paper, we discuss the learning of liberal arts as a motivator for NIT students. Concentrating on the practice of such subjects as English or Japanese history, we also demonstrate an ideal model of liberal arts curriculum for NIT.

(II) Materials and Methods or Pedagogy

It can be said that it is difficult to teach liberal arts to NIT students. The main reason, we point out, is that NIT students cannot imagine how liberal arts would be useful to their future, especially in their workplaces. Hence, liberal arts teachers at NIT are required to encourage their students to understand the importance of the liberal arts. Accordingly, we should illuminate how the learning of liberal arts will inspire students' interests. Our three main points are as follows:

(i) HARAGUCHI, FUJITA, and MIYAMOTO maintain that the learning of technical English enables NIT students to seek their own identities as global engineers and helps to promote career enhancement based on actual case studies. English presentation learning and learning for the 'English Technical Writing Test' are main topics.

(ii) TESHIMA succeeded in designing a new subject for NIT students. He discusses how the new subject 'Human Beings and Society' aims to nurture future global engineers.

(iii) NAKATSUKA, a student in the Advanced Course, demonstrates application software he developed with other members, inspired in part by the abovementioned liberal arts learning. This is a good example of active learning.

(III) Results and Discussion

As a main achievement, both a foreign student and NIT (KOSEN), Fukui College received prizes for distinct excellence from the Minister of Education, Culture, Sports, Science and Technology this March. More applications for grants are expected in response to this result.

(IV) Conclusions

In conclusion, we need to design a sustainable curriculum for liberal arts education at NIT.

(V) Acknowledgements

Note that this presentation is part of achievements supported by JSPS KAKENHI Grant Number 16K02872.

(VI) A Main Reference

Osamu HARAGUCHI et al. *Kosenkyoiku No Kyoyo Towa* (*Liberal Arts for NIT Students*), 2019

Keywords: *Liberal Arts Education, Active Learning, Career Enhancement, Nurturing Global Engineers, English Language Teaching*

(I) Introduction

'Do NIT Students Need to Learn Liberal Arts?'

To this fundamental question, our answer is a definitive, 'Yes, they do'. However, to our great regret, few NIT students and teachers agree with our opinion. There is one main reason for this: NIT students tend to find it very hard to comprehend that liberal arts are essential for their engineering careers. Here, we should recall the dichotomy between the practical and the impractical. Roughly, major subjects belong to the former, while general subjects (liberal arts) belong to the latter. This dichotomy has long been shared by many researchers and students in Japan. Nevertheless, is it suited to this global age? Fundamentally, globalisation should be understood at the very least to be a cross-border style; thus, this dichotomy is considered not only outdated but also a big barrier to nurturing NIT students as global engineers. Therefore, we must stress that the liberal arts should include important elements for distinguishing NIT students. In other words, NIT students must appeal to many people to broaden their knowledge. They should be distinguished from other high school students. However, the humanities as research fields and subjects can be highly specialised, so they should be generalised and provide complete learning for students. Here, the present circumstances surrounding the liberal arts should be recalled: The Japanese government is encouraging us to learn liberal arts as social skills. In short, liberal arts should be redefined as generic skills required to become good citizens in the 21st century.

As an introduction, we confirm that teachers teaching liberal arts subjects at NIT should make and explain adequate connections between liberal arts subjects and major subjects. The objective we wish to pursue in this paper is the correlation, not the conflict, between the two academic fields. In the following chapters, we discuss how to realise this objective.

(II) Materials and Methods or Pedagogy (1)

(i) New Concept of 'Kyoyo (Culture)'

To nurture global engineers, what role does liberal arts education play? Zakaria (2000) aptly explains the current conditions of liberal arts education as follows:

> In an age defined by technology and globalization, everyone is talking about skills-based learning. Politicians, businesspeople, and even many educators see it as the only way for the nation to stay competitive. They urge students to stop dreaming and start thinking practically about the skills they will need in the workplace. An open-ended exploration of knowledge is seen as a road to nowhere. (Zakaria 16)

Reading this quoted passage, whether it concerns 'everyone' or not, we can admit that 'almost everyone' concerned is keenly interested in skills-based learning. In short, it is a question of 'practicality'.

Generally speaking, culture ('*Kyoyo*' in translated Japanese) can be understood in the context of academia. Culture is often easily equated with elitism or snobbishness. In fact, in scrutinising the history of higher education in Japan, to be cultured implied a lot of reading and reminded us of university students. At this point, the amount of knowledge was regarded as essential. In short, a cultured person was definitely required to obtain the broadest range of knowledge possible. The image of a cultured university student during the Taisho era (1912–1926) in Japan presents a cultured person who relied solely on reading and was encouraged to acquire as much knowledge as possible. The resulting emphasis on being cultured could lead to a neglect of one's physical health. The division of soul and body can be pointed out in this context. Needless to say, this condition is poorly balanced, so a harmonised relationship between the two must be pursued.

The Decline of Liberalism in Japan is a book written by Yo TAKEUCHI, who explains the condition of liberalism in Japan. Based on this book, we explain current liberalism in modern Japan. Universities, or higher education, represent key issues in this theme. Although higher educational systems such as universities can provide persons with much essential knowledge concerning culture, the fact that the number of university students sharply increased in Japan especially during the post-World War II era, the Showa era, changed the meaning of liberalism. In short, the popularisation of university emerged. An increasing number of people obtained easier access to higher education. Being cultured ('Kyoyo') is no longer the exclusive possession of a very few persons. Being cultured ('Kyoyo') isn't the mark of the elite, so what style is required to modernise liberal arts education? We propose the following three keywords: interdisciplinary, practicality, and student-centred (autonomous) learning. In the following chapter, we introduce our challenges under these premises.

(ii) The Connection of Liberalism and Engineering: What on Earth is Practicality?

Traditionally, the relationship between general subjects (liberal arts) and special subjects can be shown as in the figure below:

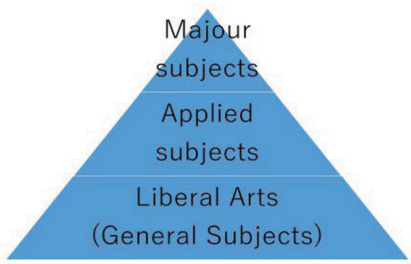


Figure 1. Position of Liberal Arts Subjects at NIT

We must break up this pyramid-shaped, vertical hierarchy. The ideal relationships would be horizontal relationships between general and major subjects for NIT students.

In this chapter, we provide a good example for establishing a new curriculum and the reform of liberal arts education, especially Japanese history at NIT.

TESHIMA mainly tried to rethink the education of Japanese history under the new concept of culture. Traditionally, the teaching and learning of history in Japanese junior or high schools, and even universities, tend to emphasise the amount of knowledge students can acquire. This is why, in the general evaluation, students are asked to demonstrate their knowledge as much as possible. Accordingly, the exam style mainly involves questions about the knowledge itself i.e. the names or date of historical famous accidents, and so forth. In his new style of learning, TESHIMA wanted to break up such obstructions. First, he attaches great importance to nurturing a sense of history. NIT has just established a new common curriculum named the 'Model Core Curriculum' for all NIT colleges in Japan. TESHIMA examined this model core curriculum precisely and showed and practised his own curriculum. Fundamentally, he created a new subject and curriculum. Unfortunately, this syllabus is written only in Japanese, so we translated only a part of it into English:

(1) Name of the New Subject: 'Humans and Society'
(2) Rubric
Ideal Goal:

To understand critical points of view for learning humans or society. To acquire the full ability to compare or scrutinise the outline of complex humans or images of multi-society.

Fields of Study (Five Teachers):
Japanese: (classic *Tales of Genji*)
Social studies: (workhouses; a history of welfare)
Philosophy: (marital status, intercultural aspects)
English: (world Englishes and their ownership)

In short, as an ideal model, liberal arts education should be offered in an interdisciplinary style. Each teacher offers his/her own teaching material based on his/her majors, and under the principle of nurturing global engineers, each material should be integrated into the unity as a subject. In this respect, TESHIMA succeeded in introducing a new liberalism into NIT education.

Furthermore, we must create a new style of subject in the liberal arts that has the flavour of engineering, as this subject differs from the traditional style of liberal arts. Liberal arts for the 21st century are no longer for the very few elite but for everyone to learn elemental skills. Next, we address English education and attempt a new project: introducing English Technical Writing to the curriculum of English education for NIT students.

(III) Materials and Methods or Pedagogy (2)

With respect to English education, we struggled to balance the practical and cultural elements. The ‘Technical English Writing Test’ was our main goal, as technical English attracts NIT students’ interest and inspires their engineering minds more vividly.

FUJITA mainly developed the online learning system. Figure 2 is a part of the system in which students’ tasks can be automatically marked, and more than 80% was set as the required score for all our 1st graders.

Figure 2. Online Learning System

Thanks to this online learning system, our college (‘Fukui KOSEN’) received prizes for distinct excellence (1st graders) from the Minister of Education, Culture, Sports, Science and Technology this March.

ICT is especially essential for liberal arts education in NIT. In the next phase, we present an example of students’ autonomous learning in which liberal arts and student’s specialties are well blended.

(III) Materials and Methods or Pedagogy (2)

Next, we introduce an example of students’ autonomous ICT learning based on their specialities.

An outline of their plan is as follows. NAKATSUKA explains it:

This app has ‘four-choice questions’ and ‘fill-in-the-blanks questions with multiple choices’. Originally, it was supposed to be an app with only these two functions, but we decided that additional functions should be created to develop the functions of a dictionary or word list.

We used ‘Android Studio’ to develop this app. Android Studio is the official Integrated Development Environment (IDE) for Android app development based on IntelliJ IDEA. In addition to IntelliJ’s powerful code editor and developer tools, Android Studio offers more features that enhance productivity for building Android apps.

(i) Main Menu

The main menu has four sections: ‘Four-choice question’, ‘Fill-in-the-blank question with multiple choices’, ‘Vocabulary note’, and ‘Word search’.

Figure 3. Application Programme for Self-Study of Technical English (1)

(ii) Four-choice question

When one Japanese word and four English words are shown, I set a one-correct-answer word in English, but the problem of English words appearing and selecting the answer from among four Japanese words occurred.

The order of words uses a random function. A problem that appeared once was deleted so that the same problem did not appear twice in a row. If I select ‘止める (stop)’, we go to the main menu.

Figure 4. Application Programme for Self-Study of Technical English (2)

Figure 5. Application Programme for Self-Study of Technical English (3)

(iii) Fill-in-the-blank question with multiple choices

A fill-in-the-blank question is a question in which a part of the English sentence appears as '( )', and the correct word or phrase to be used can be selected from among four options.

Four Japanese or four English words are displayed.

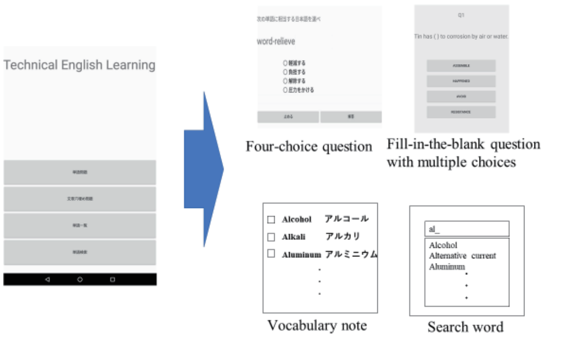


Figure 6. Application programme for Self-Study of Technical English (4)

(iv) Vocabulary Note

The word list contains commonly used words in Technical English. I am now planning to add a function to flag wrong words in the 'Four-choice question' and 'Fill-in-the-blank question with multiple choices'.

(v) Word Search Function

We plan to add a search function for Japanese and English words.

(vi) Use for Job Hunting

In Android Studio, I wrote a programme using the Java language and was thus able to acquire knowledge of Java. In my job interview, I explained that we had developed the app in a club for job hunting. By showing the process of making the app and the actual machine, I became interested and began to think I could advance my job-hunting activities in an advantageous manner. I also think that programme-related jobs provide me with good exercise because I can actually develop the application.

Future plans are as follows:

(1) Create a function to flag wrong words.
(2) Increase the number of English words.
(3) Manage English and Japanese words.

(1) is a necessary function to leave the result of learning.

Given that speaking aloud is also important in learning English, I will consider implementing a word speech function.

As for (2) and (3), to increase the number of words, we are attempting to create a tool to easily collect English words and a function to organise the increased number of words.

There are many apps for learning English, but not many are specialised in technical English. There are quite a few materials to learn. Therefore, I think that there is a demand for English apps for Technical English. These days, many students have smartphones, so they can use the app to study and be live during their classes. They should be able to confirm their weak points just before the Technical English Test, and the app can be very useful for learning.

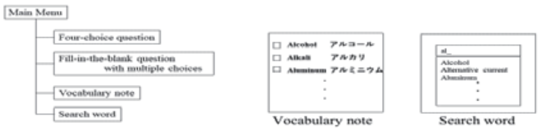


Figure 7. Application programme for Self-Study of Technical English (5)

Inspired by liberal arts education, NAKATSUKA aptly uses English as a skill, blending it with his engineering mind. This is a good example of liberal arts practice as a learning motivator for NIT students.

(IV) Materials and Methods or Pedagogy (3)

We conclude this paper with an explanation of the new curriculum learning English at NIT. Figure 8 shows the NIT English education curriculum model created by HARAGUCHI, FUJITA, and MIYAMOTO. This is the Japanese version, so we introduce some main points of this curriculum in English as follows.

Figure 8. Ideal Curriculum for English Education

(i) Left side in the above graph (curriculum)
Seven-year Successive Curriculum

AD 1st and 2nd grade

All students must give presentations and write abstracts about their own majors in English. Their achievements are filed or published as a report of AD graduation research. Some will be able to join international conferences based on these materials.

5th grade

To be aware of English learning as a global gateway to both academic fields and workplaces

4th grade

To study English as a practical tool by taking the TOEIC: All students have a common goal in taking this examination.

3rd grade

There are two main objects for students: English presentation and first steps toward the TOEIC.

English presentations by students are characterised by the title 'Fukui to the World', in which students become interested in the local society. As they are starting to learn TOEIC content, they are aware they must take the TOEIC in the next grade.

2nd grade

To nurture a KOSEN mind as global engineers, students must take the Technical English Writing Test with the help of an online learning system created by FUJITA.

1st grade

FUJITA and MIYAMOTO are co-writers of some well-known English textbooks on science and technology.

These textbooks are published by Seibido in JAPAN. Learning from these textbooks, our KOSEN students can focus on their own goals as global engineers and start to learn English with this special curriculum.

(2) Middle parts in the above graph

In addition to the seven-year learning curriculum, we should promote a variety of programmes not only to students but also to teachers and office workers at Fukui Kosen, to develop common goals and team spirit.

The 'English Café' on the campus of Fukui Kosen is open to all students and staff and presents special programmes such as a variety of lectures, special courses for examinations, or lectures by specialists. Certain lectures may be presented by teachers or staff, who give a variety of lectures based on their experiences of business trips in Taiwan or Hong Kong.

As a result, students may be widely inspired in their academic interests.

(3) Right part in the above graph

Owing to the seven-year successive curriculum, the promotion of autonomous learning with ICT, and some contests, there have been quite a few major achievements. JSPS KAKENHI and FUKUI prefecture represented the main grants, and the superiority of local contributions was proven. The development of a global atmosphere at the NIT Fukui campus further enhanced student incentives and led to these achievements.

(V) Results and Discussion

As a main achievement, both a foreign student and NIT (KOSEN), Fukui College received prizes for distinct excellence from the Minister of Education, Culture, Sports, Science and Technology this March. In response to this result, more applications for grants are expected.

We show some notable achievements of our students under this curriculum. Figures 9 and 10 show articles from a popular local newspaper about their achievements. In Figure 11, four reports written by teachers on liberal arts education at NIT are shown to have been published so far.

南越丹生

アミルさん 大臣賞

工業英検3級、全国トップ

編入留学「学び深めたい」

Figure 9. Newspaper Article (1)

「JICAエッセイ」審査

上田さん（福井高専）県OB会長賞

国際協力機構（JICA）が主催する本年度の「国際協力中学生・高校生エッセイコンテスト」で福井高専3年の上田倫人さん(18)が青年海外協力隊福井県OB会長賞に選ばれ27日、同校で表彰を受けた。

コンテストは次代を担う中高生に、開発途上国の現状などに理解を深め、自分たちがどのように行動すべきかを考えてもらおうと毎年実施している。「世界のために私たちができること」をテーマに作品を募り、高校生の部は県内の191点を含む3万4738点が寄せられた。同OB会長賞は県内の作品が対象で、中高両部門で1点ずつ選んだ。

上田さんの作品は、小学生の頃からの夢だという建築士になり、アフリカの子どもたちのために学校や住宅をつくりたいという内容。「健康に生活できる建物で教育の機会を得て、夢を追い掛けてほしい」と話した。

この日は福井県OB会役員の西村奈奈さんら2人が同校を訪れ、賞状などを手渡した。同校は応募点数の多い学校に贈られる学校賞にも選ばれ、表彰された。（前田[illegible]）

県OB会長賞に選ばれた上田さん＝27日、鯖江市の福井高専

Figure 10. Newspaper Article (2)

Figure 11. Four Reports Previously Published on Liberal Arts Education at NIT

(VI) Conclusions

In this paper, as a new educational approach at NIT, we attempted to reform liberal arts education. As main processes, we reaffirm the five steps as follows:

(I) To redefine liberal arts education for NIT students

We should redefine liberal arts education required for NIT students. During this phase, we need to trace the outline of liberal arts education based on the thinking of 'Culture (Kyoyo in Japanese)', and for future generations, liberal arts will be no longer be the exclusive possession of the upper class. In short, liberal arts education does not symbolise division among people but a bridge between them. The notion that the liberal arts provide generic skills for the future has been widely acknowledged around the world. In this respect, we connected liberal arts education for NIT with traditional liberal arts principles. Liberal arts education required for NIT students should comprise generic skills NIT students can use to become global engineers. Thus, liberal arts education can be understood in the context of daily life, and autonomous learning is required for NIT students.

(ii) Creating a New Subject: 'Humans and Societies'

We introduced some of our practices as follows: First, in the curriculum development phase, we implemented the instance of the new subject, 'humans and societies' designed by TESHIMA. We attached great importance to its interdisciplinary nature. Based on the common principle of nurturing global engineers, each teacher of a general subject course offered materials for the class and combined them into one as a new subject. In this way, an identity for liberal arts education at NIT was created.

(iii) Activities in the English Café Facilities

Our style of liberal arts education aimed to combine metaphysical elements with practical ones. Among the subjects of liberal arts education, we picked up English and history as main targets. With respect to English, as an important practical element, we use the 'Technical English Test' and have all 1st graders take it.

For preparation classes, FUJITA developed an online learning system, and HARAGUCHI and MIYAMOTO offered some special lectures or activities in the English Café facilities at NIT Fukui campus. As a result, both a foreign student and NIT (KOSEN), Fukui College received prizes for distinct excellence from the Minister of Education, Culture, Sports, Science and Technology.

(iv) Promoting Students' Autonomous Learning

As a possible final goal, we showed an example of students' autonomous learning. Two years ago, in 2017, NAKATSUKA and HARAGUCHI formed a group of voluntary students and attempted to develop an application software for English learning. Having continued this project until now, NAKATSUKA, an advanced course student, developed a new version of the app. He also used this project to get a job. He is a model student of the NIT seven-year liberal arts education.

(v) Future Prospects

To conclude, we confirm that liberal arts education can contribute to education at NIT. We have already pointed out the three steps: First, we should be conscious of the necessary connection between liberal arts and NIT education. Second, to nurture global engineers, we should especially stress the multiplicity or interdisciplinarity of liberal arts education. Third, as a practical example, we can promote autonomous learning with ICT to students, so that they can use English as a generic skill more practically and confidently.

As a future prospect, we are now aiming to win some scholarships to nurture NIT brand global engineers sponsored by JSPS KAKENHI Grant, National Institute of Technology, or other organisations.

In short, redefining culture (Kyoyo) through history, reforming liberal arts education at NIT, and promoting autonomous learning by students could lead to an ideal liberal arts education at NIT which is valued by both students and teachers. Therefore, as a final word, we strongly maintain that the liberal arts could be an effective learning motivator for NIT students

Acknowledgements

Note that this paper is a part of achievements supported by JSPS KAKENHI Grant Number 16K02872.

References

Osamu HARAGUCHI et al. (2019) *Kosenkyouiku No Kyouyou Toha* (*Liberal Arts for NIT Students*).

Osamu HARAGUCHI et al. (2017). *Nurturing Future Global Engineers through the Teaching of English at NIT*, Fukui College *ISATE Proceedings*. 818–23.

Osamu HARAGUCHI et al. (2016). *The Teaching of Technical English for NIT Students as Future Global Engineers*. *ISATE Proceedings*. 217–22.

Takuro FUJITA. *Moodle English Learning System*. Online: http://www.ge.fukui-nct.ac.jp/~eng/.

Yo TAKEUCHI. (2003). *Kyouyoushugi no botsuraku* (*The Decline of Culturalism in Japan*). Chukou Shinsho.

Zakaria, F. (2015). *In Defense of a Liberal Education*. W. W. Norton & Company.

Development of IoT Car Experiment Teaching Materials in the K-SEC Project

Shigeo DOI*,a, Takuya MUKOHIRA[b]

[a] Dept. of Engineering for Innovation, National Institute of Technology (KOSEN), Tomakomai College, Tomakomai, Japan
[b] Advanced Course, National Institute of Technology (KOSEN), Tomakomai College, Tomakomai, Japan

*E-Mail: doi@tomakomai-ct.ac.jp

Abstract

National Institute of Technology (KOSEN) started the K-SEC project, which nurtures KOSEN students to acquire information security skills not only the students whose major is computer science and engineering, but also the students whose major is the other area. In this project, we have been developing a variety of teaching materials of information security including information literacy, information moral and fundamental computer engineering. In this paper, we focused on the students whose major is computer science and engineering as a part of the project. So we developed experiment teaching materials to be able to learn how to set up a secure server by the students themselves. The materials consist of three elements. First, we use the IoT car, which equipped a Raspberry PI 3 and a motor driver. The Raspberry PI 3 and the motor driver are connected through GPIO on the Raspberry PI 3. Students can move the IoT car through a program or a web interface. The IoT car was developed by the collaboration of NIT Kochi College and a company. Second, we developed the experiment manuals. Students do practice using the manuals including such as how to capture pictures from a camera connected to the Raspberry PI 3 and how to move the IoT car using a programming language. Last, we developed the supplemental presentations including how to find vulnerabilities. We used the materials and run the experiment for third-year students in computer science and engineering course for six weeks. They haven't learned anything about information security through lectures yet before the experiment, but they have just learned how to program with C-language and how to use basic UNIX commands. These materials are also applicable to setting up secure servers. Recently we firstly plan to advocate the material to the KOSENs in the Hokkaido-Tohoku region, then to all KOSENs.

Keywords: *IoT, Information Security, Education, Experiment Design, Evaluation*

Introduction

National Institute of Technology started the K-SEC project, which nurtures KOSEN students to acquire information security skills. This project categorizes students into three types. First, all students will acquire basic information security skills such as computer literacy and information moral. In other words, when they are ordered to install computer systems or IoT systems, they can consider not only the specification of systems but also security-related things. Second, computer-related engineering students must design a computer system which is satisfied about security specification. Last, Highly skilled students can pursuit the latest information security techniques.

In this paper, we focus on 3rd year and computer-related engineering students and design an experiment of six weeks. In our college, the students have learned basic computer programming using C language and basic UNIX command operations. We planned to use IoT cars equipped with Raspberry PI 3 and programming of web interfaces on the IoT cars. The reason why we use the IoT cars is that it is easy to understand what happened for the students.

Materials and Methods or pedagogy

1. Current Situation around IoT-related areas

IoT means "Internet of Things", which means that various things and services will be connected to the Internet, where only computers such as PCs and servers were connected[1]. According to the white paper of the Information and Communication Technology edition published by Ministry of Internal Affairs and Communications in 2018[2], the number of IoT devices has been increasing with the price reduction and high functionality of hardware. Also, the number of IoT devices, which was about 17 billion as of 2016, will be about 30 billion in 2020. The number of IoT device will be doubled from 2016 to 2021.

Many IoT device are connected to the Internet, so IoT devices will be attacked and possibly hijacked by malicious users and so on. As one of the attacks using IoT devices, a large-scale Distributed Denial of Service (DDoS) attack by the IoT botnet occurred in 2016[3].

This was a case of infecting and hijacking malware called “Mirai” to IoT devices such as security cameras and home appliances, and launching large-scale attacks targeting companies. This attack had continued even in 2018, and has been alerted by the National Police Agency[4]. In addition, there are sites where you can look through the images of security cameras due to improper settings. As described above, there is a possibility that the user who uses or installs the IoT device may unintentionally contribute to the perpetrators through attacks or malware diffusion that use the IoT device as a stepping stone due to a defect. Under these circumstances, when we design IoT devices, we need to design and develop in consideration of security based on the concept of "security by design" and supply IoT devices as safe as possible.

OWASP (Open Web Application Security Project) is an organization that spreads, enlightens, and share information about software security technologies and processes such as the Web. OWASP announced OWASP Top 10 in 2017[5]. Here, the developers had pointed out the points to be noted in security regarding the formulation and use of web applications. IoT devices are often configured through a web interface. In addition, National Institute of Information and Communication Technology (NICT) has been alerting about the setting of IoT equipment through a project called NOTICE[6]. However, even if the vulnerability is actually pointed out, the response is left to the installer of the IoT device. The Information Processing Promotion Organization has issued guidelines for cyber security measures and human resource development that are required in the IoT era, and practical lessons are presented, but the curriculum is for graduate students[7]. The National Institute of Technology is currently carrying out a project called K-SEC[8], and aims to produce human resources from the age of 15 by acquiring the basics of cyber security. In learning security, not only theory but of course the ability to practice it is also important, and it is thought that learning security from a young age is meaningful and of great significance.

2. Contents of Experiment of IoT Security

There are many IoT devices that can be operated and configured from SSH (Secure SHell) client or web browser, and it is considered that in the setting of IoT devices, settings will be made through the Web browser in the future. Therefore, it is thought that when developing IoT devices will need to design the Web interface used for setting etc. For this reason, this time we will include the following elements in the experimental items.

(1) Encryption
When IoT devices are installed and set up at remote locations, the communication channel to the remote location must be encrypted to enable safe communication.

(2) GPIO
Learn how to operate the hardware connected to the IoT device from command line interface and Web interface when operating the IoT device.

(3) Server construction
Since hijacking and information leakage of IoT devices can occur even if the server settings are not correct, learn a safe setting method.

(4) Web application programming
When designing a Web interface, make sure that you understand how vulnerabilities are embedded and how to prevent vulnerabilities.

From the above, when designing a system that operates IoT devices from the Web, we should understand what kind of vulnerability will be embedded. In this teaching material, students learn and try to attack the actual web interface for this experiment. In addition, the goal is to have you understand how to program in order to prevent vulnerabilities. In this teaching material, student use an IoT car as an IoT device and find out how to move the IoT car by command line interface, web settings and vulnerabilities embedded in the Web interface, and what kind of design is required as an IoT device designer intended to be understood.

3. Teaching Materials of Experiment of IoT Security

In this teaching material, three teaching materials of “IoT car”, “text data” and “applications with vulnerability” were created and used[9].

(1) IoT car
This time, IoT car is used as IoT equipment. The IoT car is equipped with a Raspberry Pi 3 Model B (hereinafter referred to as Raspberry PI), a camera module, and a motor driver board (Maple Syrup) in a car-type chassis that can travel forward, backward, leftward and rightward. Raspberry PI and motor driver in a IoT car are conmnected through GPIO (General Purpose Input/Output) on the Raspberry PI. Students create a program written in a language such as Python, and they run the program on Raspberry PI on which the Raspbian OS is running on an IoT car. Also, IoT cars can be connected to the network via a wireless LAN on Raspberry PI.

(2) Text Materials
The text materials consist of an experiment manual, an IoT car environment setup guide, an application program manual on the IoT car, and a slide document about vulnerability. Figure 1 shows a part of a slide document that shows hints for finding vulnerabilities.

(3) Vulnerable applications
A vulnerable applications consists of a Web interface. Students can operate the IoT car andmanage images captured by a camera module. Two forms are available at the web interface. One is a field to specify a filename

to capture. Another consists of two fields to log in the picture management screen. The web interface is shown in Figure 2.

Figure 1. Part of slide data (in Japanese)

Figure 2. Web interface with vulnerability such as OS command injection and SQL injection

The Web interface shown in Figure 2 is vulnerable to command injection attack[10] in the output file name specification field for camera-captured images, and SQL injection attack[11] in the login form to the management screen. There is a risk that the designer can execute an unintended operation by inputting a certain character string from the form using these vulnerabilities.

(1) Setting up the environment

From the 1st week to the 2nd week, referring to the environment setup guide presented to the students, they download the Raspbian OS running on Raspberry PI, and set up the IoT car as a Linux machine. Specifically, students download the latest image of the Raspbian OS from the Internet and write the image to the SD card. After that, they boot Raspberry PI in the IoT car using SD card of Raspbian OS.

After that, they configure SSH login using public key infrastructure and server programs such as Apache, which is Web server software, install the latest applications using apt (Advanced Package Tool).

Configuration of Web server includes to install the web interface created as teaching materials. These procedures are similar for setting up a web server on Linux and UNIX-like operating systems. We will also investigate different key authentication algorithms that can be used with SSH and the setting to change the port of the SSH server from the default of 22 and ask them to consider their meaning. This is intended to make it possible to construct a server more safely, because SSH login may be required in configuring such as VPS (Virtual Private Server).

(2) Discovery and Experience of Vulnerability

From the third week to the fourth week, students operates the web interface, which was set up from the first week to the second week, and check how the interface works normally. Then, and the program source of the web interface to have students check for embedded vulnerabilities. Here, students seem to have little knowledge of vulnerability, so lectures on attack methods such as command injection attacks and SQL injection attacks are conducted. After the lectures, they are actually discovered on the basis of what they learned. At the same time, let the students experience the position of the attacker and consider how to defend against the same attack.

(3) Examination and correction of how to deal with vulnerability

In the 5th to 6th weeks, after explaining the vulnerabilities found in the third to fourth weeks, students consider the reason of the problem and how to avoid incorporating the vulnerability. The Web interface in Figure 2 embeds the vulnerability of command injection attack and SQL injection attack, and have them investigate measures to deal with them. At this time, it is possible to obtain information by Internet search, but there are cases where the basis is poor. Therefore, based on an authoritative Web site or book published by the Information Processing Promotion Organization. We have you take countermeasures based on the basis.

Results and Discussion

Actually, the experiment designed in Chapter 2 was conducted from October 2018 for three hours a week, for six weeks, for 41 third grade students in our college. In the experiment, the group was configured so that one IoT car could be assigned to two people. In order to connect the IoT car to the network, we prepared one wireless router, and set up an environment where remote login from the laptop computer to the IoT car was possible, and it was possible to install and modify the Web interface. In addition, it is an environment that can be connected to the Internet from a laptop computer or IoT car. In addition, we decided to correspond in principle about the notebook computer by BYOD (Bring Your Own Device), and loaned the notebook computer to students who do not have a notebook computer. The BYOD laptop was asked to install an SSH client and a Web browser.

Although there were troubles such as network trouble and installation of web interface with vulnerability, there were also assistance by TA and students following each other, and progressed as planned. Figure 3 shows a scene of the experiment.

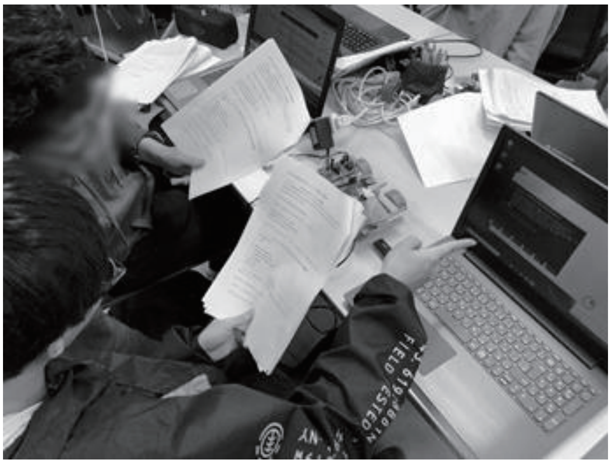


Figure 3. Information security experiment

Evaluation of teaching materials

In order to evaluate what kind of knowledge and skills the students could acquire using this teaching material, we carried out the self-assessment before and after the experiment. In addition, to improve the experiment, we also carried out a questionnaire.

1. Self-assessment

At the beginning of the first week of the experiment, students who participated in the experiment were asked to make a self-assessment in five stages on the following six items. The implementation was conducted using Microsoft Forms[12].

(1) Please rate your security technology skills.
(2) Please rate your knowledge about encryption.
(3) Please rate your knowledge about GPIO.
(4) Please rate your knowledge about server configuration. .
(5) Please rate your knowledge about web application programming.
(6) Please rate about your expectations about the experiment.

In (1), I asked for a five-point evaluation of 1 = beginner, 2 = novice, 3 = normal, 4 = advanced, 5 = expert. In (2) to (5), I asked for a five-point evaluation of 1 = do not know, 2 = know a little, 3 = know, 4 = understand, 5 = understand well. In (6), I asked for a five-step evaluation of 1 = not expected, 2 = a little expected, 3 = normal, 4 = expected, 5 = very expected.

The results of prior evaluation are shown in Table 1. The item numbers correspond to the items in parentheses, and the corresponding cells of the table indicate the number of people who answered the evaluation.

Table 1. Self-assessment before the experiment

Item	**Evaluation**					
	1	**2**	**3**	**4**	**5**	**Average**
(1)	24	9	5	3	0	1.68
(2)	17	11	4	9	0	2.12
(3)	35	4	1	1	0	1.22
(4)	25	10	2	3	1	1.66
(5)	18	15	7	1	0	1.78
(6)	1	1	12	9	18	4.02

Table 1 shows that the security technology before the experiment was self-assessed as not very high. This is because the content learned in the class etc. was not included in the content related to security. In addition, expectations were high, and it can be said that the desire to learn security was high.

In the same way, the self-assessment after the experiment was also conducted. The meaning of the question items and the five-point evaluation is as follows.

(1) Please rate your security technology skills.
(2) Please rate your knowledge about encryption.
(3) Please rate your knowledge about GPIO.
(4) Please rate your knowledge about server configuration. .
(5) Please rate your knowledge about web application programming.

In (1), I asked for a five-point evaluation of 1 = beginner, 2 = novice, 3 = normal, 4 = advanced, 5 = expert. In (2) to (5), I asked for a five-point evaluation of 1 = do not know, 2 = know a little, 3 = know, 4 = understand, 5 = understand well.

Table 2 shows the results of the ex-post evaluation. The description method is the same as in Table 1.

Table 2. Self-assessment after the experiment

Item	**Evaluation**					
	1	**2**	**3**	**4**	**5**	**Average**
(1)	3	12	17	7	2	2.83
(2)	2	0	15	21	3	3.56
(3)	3	18	12	7	1	2.63
(4)	4	11	15	7	4	2.90
(5)	1	4	18	17	1	3.32

From Table 1 and Table 2, comparing the self-assessment before the experiment with the corresponding items, it can be seen that the assessment of the experiment increased by one or more for any item. In addition, if the Wilcoxon rank sum test is performed on each item corresponding to item (1) to item (5) from pre-self-assessment and post-self-assessment, all items have a significance level of 1% "before and after the experiment" The null hypothesis that there is no difference in the representative values of evaluations was rejected. Therefore, it can be seen that this experiment feels that students have grown in acquiring security technology.

2. Questionnaire to improve the experiment

At the same time as the post-self-assessment, students were asked to evaluate the experiment. The items were as follows.

(1) Was the amount of work done in the experiment appropriate?
(2) Was the explanation of the experiment materials easy to understand?
(3) Was the explanation of the slide easy to understand?
(4) Was the amount of assignment appropriate?
(5) Was the difficulty of the task appropriate?
(6) Was the speed at which the experiment proceeded appropriate?

The items (1) to (6) were asked to rate 1 = very bad, 2 = bad, 3 = cannot say, 4 = good, 5 = very good.
Table 3 shows the results of the questionnaire after the above questions. Each item is distributed with an average of 3.83 to 4.15, centered on 4.0 "Good", and it is considered that the evaluation of the experimental materials was good.

Table 3. Evaluation of the questionnaire after the expetiment

Item	Evaluation					
	1	2	3	4	5	Average
(1)	0	2	12	18	9	3.83
(2)	0	2	8	20	11	3.98
(3)	0	2	8	21	10	3.95
(4)	0	1	8	18	14	4.10
(5)	0	1	10	19	11	3.98
(6)	1	0	7	17	16	4.15

In addition, the questionnaires on improvement items of the experiment and what they wanted to know more were evaluated by free description.

The improvement items of the experiment were raised, such as "I took time to download the OS installation image" and "Heavy network". In this experiment, 21 IoT cars were connected to one Wi-fi access point in 2.4 GHz band, so it seems that the network was heavy. We plan to improve this by connecting the two IoT cars to the bridge via Ethernet, adjusting the placement of the desk, and connecting this bridge to a 5 GHz band Wi-Fi access point. In addition, hardware malfunctions such as "motor driver malfunction" and "camera module malfunction" are caused by insufficient confirmation in advance, and thorough preparation is required.
What has been raised as something we want to know in the experiment is that the items not covered in the experiment, such as “common key cryptography”, “HTML”, “scp” and “permissions” are also raised, and students want to learn about security and implementation technology.

Table 4. Web Application Risks by OWASP Top 10 and Correspondence in our materials

Risks	Cover?	Remarks
A1: Injection	YES	The web interface has SQL injection vulnerability and OS command injection vulnerability.
A2: Broken Authentication	YES	No limit to try to log in through the web interface. Passwords are preserved as plain text. Default user name and password still remains on the IoT car
A3: Sensitive Data Exposure	YES	No encrypted channel was used for communication of the web interface.
A4: XML External Entities (XXE)	NO	No function to process XML in this experiment.
A5: Broken Access Control	YES	IoT cars are controlled without user authentication.
A6: Security Misconfigurati on	YES	Default user name and password still remains on the IoT car.
A7: Cross-Site Scripting (XSS)	NO	No output using raw query by user.
A8: Insecure Deserializatio n	NO	No serialization and de-serialization were performed.
A9: Using Components with Known Vulnerabilities	NO	Latest software was installed, so known vulnerability was not found.
A10: Insufficient Logging&Mo nitoring	YES	We do not collect user authentication log, only web server log..

3. Status of OWASP Top 10

Table 4 shows the correspondence status of this teaching material based on the OWASP Top 10 evaluation criteria in 2017.

“YES” means that the item is included in the experimental item, and “NO” means that the item is not included in the experimental item. The six items marked with “YES” are implemented in this teaching material, and the four items marked with “NO” are not addressed in this teaching material. "XML external entity reference", "cross site scripting" and "insecure deserialization" are not implemented because they are not required as functions in this Web application. Also, "Use of components with known vulnerabilities" is not applicable because we are using the latest images and packages on the Internet this time.

Conclusions

In this paper, we developed teaching materials related to IoT security, and created experimental plans, text materials, and applications with vulnerabilities. Based on this plan, an experiment was conducted for 41 students in our third year of computer science and engineering from October 2018. In addition, before the start of this experiment, we conducted a self-assessment of skills related to information security technology used in this experiment, a post-self-evaluation questionnaire, and a questionnaire for improvement of the experiment.

In the future, the content of the experiment will be improved based on the self-assessment of the skill improvement by this experiment, and obtained by the questionnaire and feedback from students.

The cyber security field is also rapidly changing. We will develop into one that incorporates the latest attack methods etc. In addition, we plan to develop this teaching material to other KOSENs, taking Hokkaido and Tohoku districts at first, and plan to deal with the problems that have appeared there.

Acknowledgements

We thank for the K-SEC project to have opportunity to develop IoT security materials.

References

[1] Hironobu Suzuki (2017). Seriously interesting security lecture thinking about reasons for an accident and practical measures, Technical Review Company, Co.LTD. (In Japanes)

[2] Ministry of Internal Affairs and Communications (2018). White paper of Information and Communications. (In Japanese)

[3] Hirosato Tsuji(2017). Emerging IoT Security Threats and Countermeasures. Retrieved from https://www.ipa.go.jp/files/000062277.pdf (In Japanese)

[4] National Police Agency (2018). About the situation of threat over cyber space in the first half of 2018. Retrieved from https://www.npa.go.jp/publications/statistics/cybersecurity/data/H30_kami_cyber_jousei.pdf (In Japanese)

[5] Open Web Application Security Project(2017). OWASP Top 10, Retrieved from https://www.owasp.org/index.php/Top_10-2017_Top_10

[6] National Institute of Information and Communications Technology (2019). The NOTICE project. Retrieved from https://notice.go.jp/ (In Japanese)

[7] Atsuhiro Goto (2018). Cyber security measures and human resource development required in the IoT era. Retrieved from https://www.ipa.go.jp/files/000070338.pdf (In Japanese)

[8] The K-SEC Project (2019). The K-SEC Project, Retrieved from https://csinfo2018.kochi-ct.ac.jp/ (In Japanese)

[9] Takuya MUKOHIRA and Shigeo DOI (2018). Teaching materials development about IoT Security, In Proceedings of IEEJ Section C Symposium. (In Japanese)

[10] Information-technology Promotion Agency (2007). IPA ISEC Secure programming lecture: Web Applications, Chapter 6: Countermeasure of Command Injection Attack. Retrieved from https://www.ipa.go.jp/security/awareness/vendor/programmingv2/contents/501.html (In Japanese)

[11] Information-technology Promotion Agency (2007). IPA ISEC Secure programming lecture: Web Applications, Chapter 6: Implementation of Countermeasure of SQL Injection Attack. Retrieved from https://www.ipa.go.jp/security/awareness/vendor/programmingv2/contents/502.html (In Japanese)

[12] Teppei SHIMADA, Takuya MUKOHIRA and Shigeo DOI (2019). Teaching materials development and its evaluation about Information Security, In Proceedings of IEEJ Symposium. (In Japanese)

Pedagogy for the Contemporary Learner

NURTURING SMART CITY PROFESSIONALS THROUGH STEM PROJECT OF UNMANNED ELECTRIC ROVER

Kelvin K. T. To [*,a], Dr Joe K.W. Lo**[,b], K. C. Ng***[, a], Jonathan K.F. Lee****[,c]

[a] Department of Engineering, Hong Kong Institute of Vocational Education, Hong Kong SAR
[b] Jockey Club Heavy Vehicle Emissions Testing & Research Centre, Hong Kong Institute of Vocational Education, Hong Kong SAR
[c] IVE Engineering, Vocational Training Council, Hong Kong SAR

*kelvinto@vtc.edu.hk
**kwlo@vtc.edu.hk
***kcng@vtc.edu.hk
****jkflee@vtc.edu.hk

Abstract

STEM learning is about designing creative solutions for real-world problems. A STEM project of creating an Unmanned Electric Rover have been established from IVE Engineering Discipline with the aim of building a low-cost solution of converting outdoor electric vehicle to be driver-less with the ability to follow pre-defined path and avoid obstacles. The project is also targeted to arouse interest students from electrical and mechanical engineering programmes of Smart Mobility and sustainable development.

Electric vehicle with reduced greenhouse gas emissions is essential to sustainable development of a Smart City. Autonomous electric vehicle has the benefits of not only reduced greenhouse gas emissions but also reduced accidents caused by human errors. Driver-assist or autonomous technology can also improve energy efficiency by driving the car more smoothly, eliminating certain human driving habits such as kicking-down or hard-braking. The prototype has been developed by modifying a commercially available outdoor EV to override the steering, throttle, brake and signal systems. Lidar, Sonar, GPS and inertial measurement units have also been equipped for navigation control and object avoidance. With the adaption of IoT control electronics and GPS-guided path similar to technologies widely applied in unmanned aerial vehicle (UAV), the prototype is capable of object avoidance, identify the correct path at outdoor areas and follow it to stop at desired destination.

The prototype developed in this project can be further applied to covert existing outdoor electric vehicles such as golf cart, lawn mower, forklift and all-terrain utility vehicle into autonomous vehicles for tasks that are too dull, too dirty or dangerous for human. The autonomous outdoor EV have the advantages of ability to work in extreme weather conditions, eliminating the need of human operator can also increase the safety at workplace, and reducing manpower cost of work tasks. The student involved in the project have also shown stronger interest in the joining the career as Smart City professionals.

Keywords: *Smart Mobility, STEM, Smart City, Autonomous, Electric Vehicles, Unmanned, IoT*

Introduction

In recent years, electric vehicles (EV) have been getting popular among drivers in Hong Kong. As at end of May 2019, there are 11,857 electric vehicles (EV) for road use in Hong Kong, up from less than 100 in the end of 2010. Replacing conventional vehicles with EVs can help to improve roadside air quality and reduce greenhouse gas emissions as EVs have no tailpipe emissions.

An autonomous car is a vehicle that is capable of sensing its environment and moving with little or no human interventions. Autonomous driving combine a variety of sensors to perceive their surroundings to identify obstacles and to follow the appropriate navigation paths. Research and study on autonomous vehicle (AV) have also been attract significant attention around the globe. For example, The Government of United Kingdom have established a Centre for Connected & Autonomous Vehicles (CAVs) in 2015, aims to further develop, produce and make use of the autonomous vehicles and associated technologies.

By combining the autonomous driving and electric vehicles, it has the potential benefits of not only reduced greenhouse gas emissions but also reduced accidents caused by human errors. Semi-autonomous technology such as driver-assist can also help the driver to drive the car more smoothly, eliminate human driving habits such as kicking-down or hard-braking. Driver-assist or autonomous driving can also improve the overall energy efficiency of EVs and increase the maximum driving distances.

Due to increasing demand of the research of development in autonomous electric vehicles, it is necessary that student to be interested in learning about the essentials of the technologies involved and joining the career relating to it.

The Hong Kong Institute of Vocational Education Engineering Discipline (IVE Engineering) encourage teaching and learning in a multi-discipline and project-based environment. This is because Project-based Learning (PBL) have been known to be effective for the development of real-world skills such as problem solving, critical thinking, information analysis, teamwork skill and communication skills (Duch, Groh, & Allen, 2011).

IVE Engineering have established the Unmanned Electric Rover (UEV) project in 2018 which involved teaching staffs and students. There are two purposes to this project: Firstly, for teaching staffs' and students to work together and apply their skills to build a low-cost solution of converting outdoor electric vehicle to be driver-less with the ability to follow pre-defined path and avoid obstacles. Secondly, to arouse study interest of student from electrical and mechanical engineering programmes and increase their interests to join a career relating to autonomous driving and electric vehicles.

Materials and Methods or pedagogy

The first stage of the project includes the development of the hardware. An outdoor EV which is originally a fully electric riding mower is donated from one of the industry partners of Vocational Training Council (VTC) for this project. After research conducted by the student and discussed, the design specifications decided by the project team were to make the mower driver-less, able to navigate through pre-defined path and avoid obstacles along the way. The project team have identified three major systems are required to fulfil the design specifications: vehicle control, sensing and computing systems.

Figure 1 - A Fully Electric Riding Mower to be converted to Unmanned Electric Rover

A fully electric riding mower consist of basic vehicle control components: steering wheel with rack and pinion, electronic throttle and brake-by-wire. For the steering and brake-by-wire system, servo motors have been used to simulate the driver input. And a variable resistor with control board have been used to simulate the current output for the electronic throttle.

Sensing the environment is also essential for a driver-less vehicle to avoid objects and collision while navigating the road. To detect objects around the vehicle ultrasonic sensors and Lidar are equipped in the vehicle. From installing the sensors, student have learnt that from placement of the sensors is very important to the safety of the vehicles and the range and blind spots of different sensors.

A computing system must be in place with all the sensors data to be received and analysed, to actuate different signals to control the rover. A single board computer "The Cube flight controller" which is commonly used for Unmanned Aerial Vehicle (UAV) is mounted on the vehicle and used to coordinate all sensors data, controller implementation, and generation of actuator signals. This computer is selected as it supports an open source unmanned vehicle Autopilot Software Suite called 'ArduPilot'. It also contains sensors such as Inertia Measurement Unit (IMU) and contain enough input and output pins for connection to the other devices.

One of the most important features for the UEV is to navigate along a pre-defined path. This is achieved by installing one global positioning system (GPS) module 'Ublox NEO-M8N GPS with compass' in the vehicle and using 'ArduPilot' for path planning. The path will be plotted as GPS coordinates and processed by the on board 'The Cube Controller' to control the UEV to follow the path.

Figure 2 - Testing Route

Testing of the UEV are conducted at the parking lot of IVE Tsing Yi which simulates a real-world environment for driver-less vehicle navigating around an outdoor car park. The tests are performed repetitively and involved the following tasks:

1. Follow the pre-defined path to go around the parking lot (Figure 2 shows the testing around)
2. Perform parallel parking
3. Perform 90-degree angle parking
4. Stationary object avoidance

To study if the involvement of this project can arouse interest of student study smart mobility-related subjects and increase their interest to further join smart mobility-related career. A pre-survey in early stages of the project and a post-survey after the project have completed testing have been conducted.

Results and Discussion

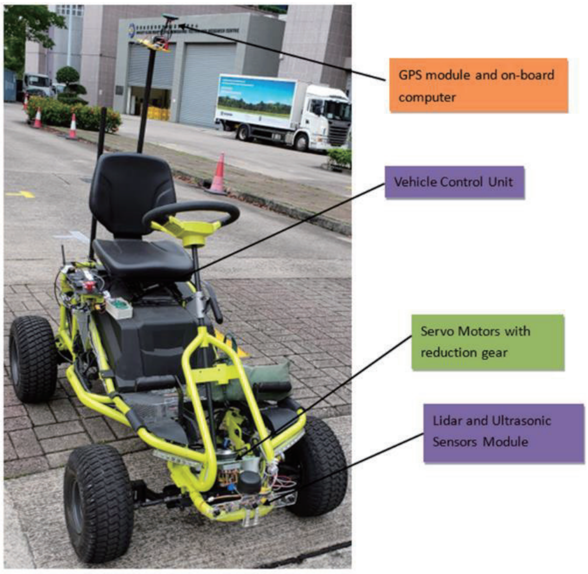


Figure 3 - Unmanned Electric Rover after modifications

Initial tests have shown that UEV is able to follow the pre-defined path but failed to stay in the centre of the lane and often come quite close to hitting the kerbs of the road. Also, the closer is the UEV to the building, the worse is the accuracy for following the path. While turning, it is also found that it often over steer or understeer.

It is found that there were two key issues which was causing the UEV to not perform as expected. Firstly, the GPS module have an accuracy of up to 2.5 m with the use of "GLObal NAvigation Satellite System" (GLONASS). This accuracy level is not sufficient for the UEV to follow a path and the lane is only 4 metres in width.

Secondly, although the computer have tried to steer the UEV to the correct path, the servo motors for steering control are too slow to react to the command and therefore understeer.

To address the GPS module issue, real-time kinematic (RTK) positioning is employed by a change of GPS module and addition of a base station. Real-time kinematic (RTK) positioning is a satellite navigation technique used to enhance the precision of position data from satellite-based positioning systems. It uses measurements of the phase of the signal's carrier wave in addition to the satellite the signal and uses a base station for interpolations to provide real-time corrections. The accuracy could go up to as high as 0.025m.

For the steering issues, gear ratio is adjusted and also vehicle control have to be calibrated according to the vehicle dynamics to have better response to the command signals from the computers.

After the adjustments, UEV is able to perform all the expected tasks of the test.

It is shown that a 32% increase in student interest in studying smart-mobility related subjects and 27% increase in their interest to join related careers in the future.

Survey results are shown in the table below:

Interest to study in smart mobility-related subjects					
Pre-Survey			Post-Survey		
Neutral 12%	No 50%	Yes 38%	Neutral 8%	No 22%	Yes 70%
Interest to join a smart mobility-related career in the future					
Neutral 22%	No 32%	Yes 46%	Neutral 9%	No 18%	Yes 73%

Conclusions

To conclude, project team consist of teaching staff and student successfully created a prototype of driver-less vehicle which aligned which the initial design specifications. The study have shown the accuracy of GPS system would greatly affect the path following capabilities of driver-less vehicle.

The prototype developed in this project can be further applied to covert existing outdoor electric vehicles such as golf cart, lawn mower, forklift and all-terrain utility vehicle into autonomous vehicles for tasks that are too dull, too dirty or dangerous for human. The autonomous outdoor EV have the advantages of ability to work in extreme weather conditions, eliminating the need of human operator can also increase the safety at workplace, and reducing manpower cost of work tasks.

From the survey results, it is shown that Involving student in smart mobility related project along with teaching staff could greatly increase their interest in study or join related careers.

References

Duch, B. J., Groh, S. E., & Allen, D. E. (2001). Why problem-based learning? A case study of institutional change in undergraduate education. In B. Duch, S. Groh, & D. Allen (Eds.), The power of problem-based learning (pp. 3–11). Sterling, VA: Stylus.

A Classroom Study of TOEIC E-Learning Involving Fourth-year Kosen Students at NIT, Hakodate College

Mariko Okuzaki[a], Takuya Hirano[b], and Hayato Maruyama[b]

[a] General Department, NIT Hakodate College, Hokkaido, Japan
[b]ALC PRESS INC

*okuzaki@hakodate-ct.ac.jp

Abstract

Hakodate College started teaching its mandatory TOEIC e-learning course to all fourth-year Japanese students in 2018. This classroom research study focuses on one specific class, the fourth-year mechanical engineering majors at the Production System Department in fiscal year 2018.

By reflecting on how the class was conducted, which included holding start-up discussions among English teachers, setting up feasible goals for students, controlling and tracking students' learning pace, counselling to prevent drop-outs, and performing evaluations, several insights have been observed to improve teaching the following year.

1. Students with total scores of 350 or lower tend to spend much less time on e-learning comparing with those who 500 or more.
2. Students with total scores of 350 or lower tend to spend much less time on the TOEIC examination comparing with those who score 500 or more.
3. Seventy-five percent of the students engage in 'inappropriate' e-learning because of their unpredictable learning attitude.
4. A teacher's face-to-face learning confirmation facilitates lower-level students' self-efficacy.

Based on the study results, the reluctance of the 2019 class in learning English using LMS has been addressed.

Keywords: *TOEIC, e-learning, inappropriate learning, self-efficacy*

Introduction

The NIT, at Hakodate College requires 15 credits of mandatory English subjects for five-year-courses, 12 of which are provided within the first three years of the courses. Because of the technological college curriculum, engineering subjects concentrated in the fourth and fifth years of the course, consequently, credits for general subjects such as English decreased to 2 in the fourth year, and 1 in the fifth year. However, fourth-year Kosen students are the same age as university freshmen. Therefore, the society expects fourth-year Kosen students to be well-cultured and have university-level English skills. These students have also to empower themselves for their future career and cultivate the foundations for autonomous long-term development.

Therefore, the English department at NIT, Hakodate College started teaching a TOEIC e-learning course to fourth-year students to help the students achieve the necessary TOEIC score for their future career through a self-learning program provided by ALC, called the ALC NetAcademy NEXT: target 500/600/730 Course for the TOEIC®L&R test, which aims to help students pass the 500, 600, and 730 points thresholds in the mandatory subjects Practical English 1A and 1B.

The class of 2018 had 170 students, four of them foreign students. Forty-eight students had taken the TOEIC test in the past three school years. Figure 1 shows a bar chart of the frequency distribution of these 48 students' TOEIC score. While the most frequent range of scores was 300-350, the default score of the whole group was at 300 because only one-third of the fourth-year students took the TOEIC test, and the target score of the TOEIC e-learning program was 350 in the first semester and 400 in the second semester.

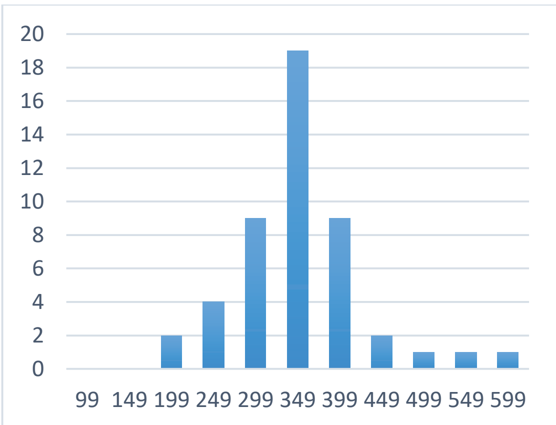
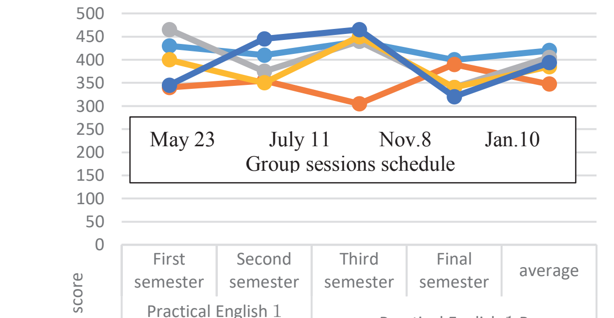


Figure 1: Frequency distribution of the TOEIC scores of 48 students in the past three years

External Lecturer



	First semester	Second semester	Third semester	Final semester	average
	Practical English 1 A		Practical English 1 B		
A	430	410	440	400	420
B	340	355	305	390	348
C	465	375	440	340	405
D	400	350	450	340	385
E	345	445	465	320	394

Figure 2: Five students' TOEIC conversion scores

We invited an external lecturer to teach extra sessions to motivate our students for TOEIC learning and to avoid the Golem effect (Watanabe 1994), phenomenon where students who feel underestimated by regular teachers tend to lower their remarks, which is the opposite of the Pygmalion effect. We provided two types of extra class activities as follows: one was teaching the entire 200 student class in the auditorium, and the other was teaching selected students as group sessions of 20 students each. As for group members, the lower-middle rank, with a total score of 400, was decided as the target. Then, the teacher asked 4SM, and five students volunteered for the group session with the other class after their class, four times a year before the examination, from 16:30 to 18:00. Figure 2 shows the total TOEIC score changes and the average scores of the volunteer students A, B, C, D, and E. Although five students joined the first session, they gradually lost interest after scoring 400. Regarding the learning attitude, four students (student A, C, D and E) did not place much value in joining the session after achieving a score of 400 or above because the objective for this session was to exceed 400. Student B, meanwhile, gave up on the group session after failing to score 400 three times.

Class Syllabus

Before the 2018 fiscal year started, five regular English teachers and Mr. Hirano and Mr. Maruyama from ALC PRESS. held several meetings to design a new class syllabus including e-learning. Each regular teacher would manage one specific class for a year and take responsibility in improving each student's score in the class. Eighty percent of the evaluation was based on the TOEIC score, and 20% was on the attendance and e-learning progress. The e-learning material, the ALC Net Academy NEXT: TOEIC® L&R test has six trial TOEIC examinations. Four were used for each semester while the other two were used as supplementary tests. Mr. Maruyama remotely controlled the beginning and closing time of the examinations and the order of questions to discourage students from cheating by looking at the next screen.

Special Tutorials

In the first-semester midterm examination, five students who scored under 350 and lower than 100 in the reading section were required to take supplementary lessons provided by the teacher. One of these students was Student E mentioned earlier. They practiced English dictation (Iwamura and Smillie, 2004) by listening to an English CD at a natural pace. Through dictation, they understood the grammatical structure of sentences and linked sounds. The lesson was given four times before the final examination of the first semester. The students scored higher than 350 in total and increased their reading score from 45 to 110.

In the examination of the second semester, two students were taken care of by the teacher. They fell asleep during the examination and had lower scores than their classmates. One was Student B (mentioned earlier) whose score was 305 and the other was Student F, whose score was 285. After the midterm examination, the teacher provided counseling support to improve their learning attitude. The two students admitted feeling inferior to others and giving-up on themselves in their TOEIC study. According to Kashima (2018), a self-assertive mental condition is described as self-esteem. Bandura (1977, 1994) defined perceived self-efficacy as one's belief in their ability to produce outcomes. Self-efficacy determines how people feel, think, motivate themselves and behave. The teacher considered that the TOEIC study lowered these two students' self-esteem and self-efficacy. Therefore, she proposed holding 10-minute supplementary lessons after lunch. This involved an active-learning style in which students chose one or two questions from the TOEIC workbook (2017) and explained their solving process to the teacher. The teacher stated that a learning approach that respects their inquisitive mind would help them increase their self-esteem and self-efficacy. The students agreed to the proposal and continued the short lessons for two weeks during lunch breaks. Although Student B scored 390 and Student F scored 355 in total, both failing to reach 400 in the second final examination, Student B scored 420 in the final supplement and earned the credit. Student F passed the confirmation examination given in April, 2019.

Class Average of TOEIC Conversion Score by Examination

Table 1: Average score in the examination and number of students who achieved at least 400 in the TOEIC conversion score

Examination	1st mid	1st final	2nd mid	2nd final
Total average	420	368	447	410
Number of scores 400 or above	22	11	27	19

Table 1 shows the 4SM class' average TOEIC overall score and the number of students with at least 400 in each examination. The average score and number of students who scored 400 or above did not increase with time. Through the whole fiscal year of 2018, 33 of a total of 37 4SM students (89%) scored at least 400, hitting the Practical English targets.

Inappropriate E-Learning Study

To investigate the 4SM e-learning attitude, questionnaires were administered by Mr. Hirano of ALC PRESS in July 2018 and February 2019. Mr. Hirano observed that 90% of the students spent fewer than 35 hours on e-learning, which is the recommended studying time for the ALC NetAcademy NEXT: Target 500/600/730 Course for the TOEIC®L&R TEST (Figure 3).

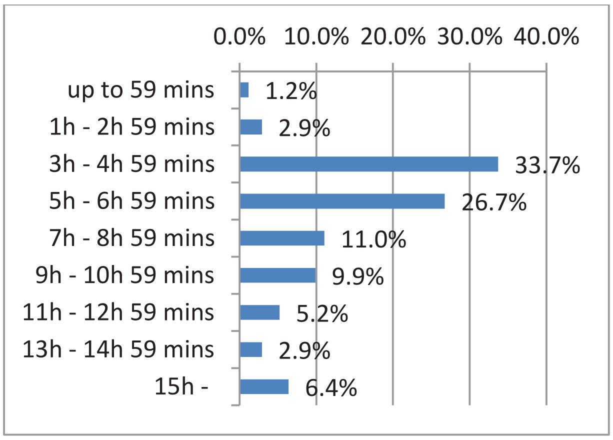


Figure 3 Total duration of the study time of the fourth-year students in the fiscal year 2018

Comparing the average time in the entire TOEIC mock examination between the first midterm and the first finals, students who scored below 350 in total took the exam 30 minutes faster than students who scored more than 500 in total (Table 2).

Table 2 Comparison of the time fourth-year students spent in finishing the TOEIC mock exams

examination period	overall mean	mean of scorers of 345 and below	mean of scorers of 500 and above
1st (June 2018)	1:18:54	1:05:01	1:38:28
2nd (August 2018)	1:32:10	1:22:41	1:54:35
3rd (November 2018)	1:32:49	1:09:33	1:47:26
4th (February 2019)	1:22:55	1:13:49	1:44:52
mean	1:26:42	1:12:46	1:46:20

Watanabe and Aoki (2011) defined a case of inappropriate study, where a student does e-learning within a much shorter time than required for completion based on their competence and task volume. Figure 4 shows that the top answer to the question regarding the e-learning schedule is "the time frame and the length to study e-learning are different every day (75%)." This means that 75% of the students do not spend the required time for e-learning and also perform inconsistent learning tasks. According to Ogasawara et-al. (2016), inadequate learning should be observed anywhere including in e-learning, which may be introduced to students without a set learning goal, frequency, and comprehension-feedback.

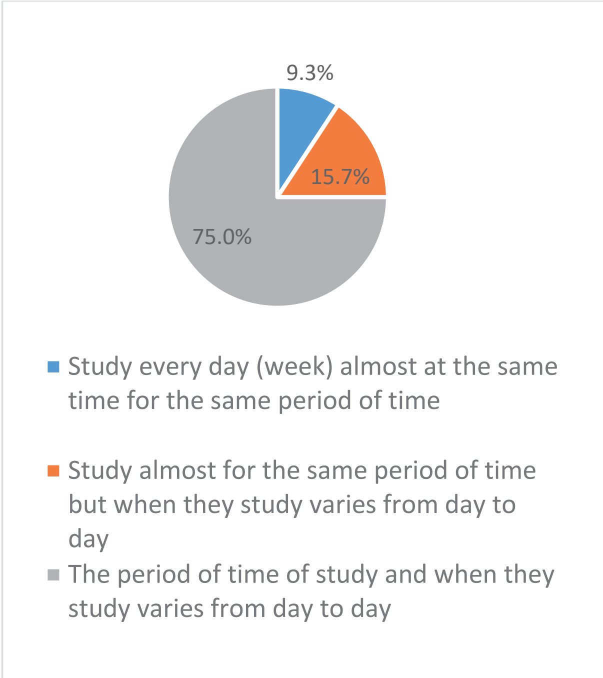


Figure 4 Responses to the question regarding when and for how long do fourth-year students study "the NetACademy NEXT TOEIC Course" outside the classroom

E-learning Instruction Improvement

As indicated above, for effective e-learning performance, teacher's support is indispensable in enabling students to deliberately work on e-learning practices with continuity and each learning goal, which was not enough in 2018.

Abe (2007) observed that the disadvantages of using a PC as a learning tool include its monotonous work and ease of learning pretense. Inaba (2017, 2018) suggested that letting students set their learning goals, achievement objectives, and e-learning self-evaluation would facilitate their learning metacognition and help them take responsibility for their own e-learning. Kozuka (2018) considered that for low-level students, most of whom have difficulty and dislike learning English, e-learning would have a certain effect on their learning, however, human support is crucial for its effective application.

Next year's e-learning programs should include helping students realize their learning goals by regularly monitoring their learning status together with the teacher and facilitating their independent learning attitude through e-learning.

The 2018 e-learning program started without confirming every student's actual TOEIC test data, which resulted in supplementary lessons after the midterm of each semester. Therefore, the 2019 fourth-year class was required to take the TOEIC IP test in November 2018 as third-year students. Based on the students' actual test score data, the syllabuses for Practical English 1A and 1B should be designed to improve students' learning performance in 2019.

Notes*

1. In this research, the TOEIC L&R test and the L&R institutional test (IP) are referred to as TOEIC tests.

2. In this research, the score attained in the examination of ALC NETAcademy NEXT: Target 500/600/730 TOEIC®L&R TEST is referred to as the TOEIC conversion score. Takashima (2006) reported the quality and validity of questions in the ALC NetAcademy test.

Acknowledgments

This study was partly conducted using the discretionary expenses of the president of NIT, Hakodate College. We would like to thank all the students who allowed us to use their personal data for this research.

References

Bandura, A. (1977), Self-efficacy: Toward a Unifying Theory of Behavioral Change, Psychological Review 1977, Vol.84, No. 2, pp.191-215

Bandura, A. (1994), Self-efficacy. *V. S. Ramachaudran (Ed.), Encyclopedia of human behavior* (Vol. 4, pp. 71-81). New York: Academic Press. (Reprinted in H. Friedman [Ed.] *Encyclopedia of mental health*. San Diego: Academic Press, 1998)

Abe, N. (2007), A Report on TOEIC-oriented English Lessons for the 4th Year Students at Ariake National College of Technology, Research reports of the Ariake National College of Technology Vol.43, pp57-63

Inaba, M. (2017), An Analysis of Students' Approach to English Active E-Learning, Liberal Arts and Education 17, pp.5-15

Inaba, M. (2018), How to Make English E-learning More Effective: Offering Opportunities for Personal Goal Setting, Self-assessment and Reflections, The journal of the Teaching Career Center Vol.3, pp.67-74

The Institute for International Business Communication (2017), *Official TOEIC® Listening & Reading Workbook 3*

Iwamura, K. & Smillie, B. (2004), *English Grammar, Listening, Writing, Reading, Speaking: From dictation to Conversation- A workbook*, ALC

Ogasawara, S., Hiroe, A., Okuda, A., Collins, W. (2016), The effects of Extracurricular Studies Using Two Kinds of e-Learning Materials-Based on Data Obtained from G-TELP Test Scores and Student Surveys -, Journal of Center for Language Studies Nagasaki University Vol.4, pp.139-161

Kashima, K. (2018), Resilience in Adolescence: From the Viewpoint of Self-esteem, The bulletin of the Graduate School of Ryukoku University, Vol.40 , pp.79-102

Kozuka, Y. (2018), Present and future prospects of English learning via e-learning in Aichi University of Education, Liberal Arts and Education 18, pp.10-18

Takashima, H. (2006), An Attempt to Improve the Students' TOEIC® Test Scores, Memoirs of the Kure National College of TechnologyVol.68, pp.35-44

Watanabe, T., Aoki, N. (2011), Effects of an English e-learning program: Task completion rate, time on task, and improper study based on TOEIC score gains, Hiroshima Journal of International Studies Vol.17, pp.105-119

Watanabe, M. (1994), Unintended Effects in Instructional Organization (<Special Issues> The State of the Art and Prospects of the Study on School Administration: Based on the perspectives of related disciplines), Bulletin of school administrationVol.19, pp.6-11

Benefits of Mentoring Relationships From the Perspective of the Mentor in Engineering Education

Tommy H. Y. Cheung*,[a], W. K. Lee[a], Billy M. H. Chow[a] and Frankie Y. C. Leung[b]

[a] Department of Engineering, Hong Kong Institute of Vocational Education (Haking Wong), Hong Kong SAR
[b] Department of Engineering and Construction, Hong Kong Institute of Vocational Education (Tuen Mun), Hong Kong SAR

*tommychy@vtc.edu.hk

Abstract

Generation Z (Gen Z) is the fastest growing group of employees, the task of higher education are not only to aid the Generation Y, but also to nurture and foretell the workplace needs of the rising Gen Z. Gen Z has their own characteristics, it is no doubt that institutions shall realize Gen Z and to nurture them in a right way, thus helping Gen Z be prepared in entering the next stage. Among all the higher education, teaching takes place in a totally different way, engaging students in terms of lectures, service learning projects, experiential activities and through technology, by instructors, or facilitators those are highly trained in their area of expertise. Teaching also occurs between and among students as they work together and at times mentor each other in and outside the classroom. The mentoring relationship is clearly an important developmental relationship. Mentoring has been found to be related to protégés' career mobility, promotions, compensation and career and job satisfaction. High-quality and committed mentors are crucial to the success of formal mentoring programs.

To nurture people fit for the mentoring relationship, a series of training program and authentic workplace environment were provided to twenty-three students to understanding the benefits of mentoring from the focal point of the mentor. The benefits of mentoring suggest that mentors achieve personal satisfaction from passing knowledge and skills on to others, exhilaration from the fresh energy provided by protégés, enhance studying interest, sense of belonging to the college, and promote identity. In view of the mentors to be trained are sub-degree students (i.e. studying in Higher Diploma), the protégés are selected from a lower level of studies (i.e. Diploma, secondary and primary). The purpose of the paper is to summarize existing research that has focused on the mentor, including the factors that underlie the willingness and motivation to be a mentor to others, mentoring relationship satisfaction, and the benefits of mentoring others.

Keywords: *Gen Z, Nurture, Mentoring, Satisfaction, Benefits*

Introduction and Background

Over the past ten years, technology has developed rapidly, however the new generation entering the workplace recently is accustomed to those fast technological developments. That new generation is Generation Z (Gen Z). Gen Z is the generation after Millennial (Gen Y), which is born in the year of 1996 and till now. Gen Z is not the generation consisting only kids, the true is that the oldest members of Gen Z are now up to 23 years old. That group of people are the current entrants to the workplace and become the fastest growing group of employees. The task of higher education are not only to aid the Gen Y, but also to nurture and foretell the workplace needs of the rising Gen Z to achieve different generations can work successfully (O'Neil, 2010). Gen Z, those born after 1995, will represent more than 30% of the workforce, it is crucial to understand who they are, and how do they think. Arora and Sharma (2019) summarized that the characteristics of Gen Z are: Tends to be more impatient, instant minded, high dependency on the technology, less attention span, individualistic, self-directed (which those points were discussed in Generational White Paper 2011); Slavin (2015) found that the Gen Z wants to be heard irrespective of their young age, and technology is a part of their identity but lack of problem solving skills although they are tech savvy; Coombs (2013) makes this distinction, Gen Z have not demonstrated the ability to look at a situation, put in context, analyse it and make a decision; informal, individual and very straight way of communicating; and a Do-It-Yourself generation. It is no doubt that institutions shall realize Gen Z and to nurture them in a right way, thus to be prepared in entering the workplace.

Among all the higher education, teaching takes place in a totally different way, engaging students in terms of lectures, service learning projects, experiential activities and through technology, by instructors, or facilitators those are highly trained in their area of expertise. The teaching process can also be occurred between and among students as they work together and at times mentor each other in or outside the classroom. The mentoring relationship is clearly an important developmental relationship. To understand and nurture Gen Z fit for the mentoring relationship, a series of training program and authentic workplace environment were provided to twenty-three Gen Z students to understanding the benefits of mentoring from the focal point of the mentor.

The Two Tiered Mentoring Programme (TTMP)

The main objective of providing mentoring is to cultivate independence and responsibility, unlike managing, which creates dependency. A two tiered mentoring programme were created, forming in two tiered groups, the first tiered was two mentors to twenty-three Gen Z students as protégés and the another tiered was that twenty-three Gen Z students as mentors simultaneously to seventy-two Gen Z students as protégés. Some background information of these two groups are listed in the table below:

The First Tiered Mentoring	
Mentors	Two lecturers from campus majoring in Electrical and/ or Electronics Engineering.
Protégés	Twenty-three higher diploma students from campus majoring in Electrical or Computer Engineering.
Period	Mid-January to mid-May.
Mode	Face to face meeting weekly and connected by online messengers.
Outcomes	*In view of mentors:* -Train the protégés as next generation mentors; -Understand the behavior of Gen Z; and -Cultivate the protégés' independence and responsibility by soft skills training. *In view of protégés:* - Understand the concept and purpose of mentoring; - Understand the skills and tools used by mentors; and - Implement the stages of a mentoring process.

Table 1. Background Information of the First Group Mentoring

The Second Tiered Mentoring	
Mentors	Twenty-three higher diploma students from campus majoring in Electrical or Computer Engineering. (the protégés from the first tiered)
Protégés	Seventy-two students from campus studying in Diploma in Engineering.
Period	Mid-February to mid-May.
Mode	Face to face meeting weekly and connected by online messengers.
Outcomes	*In view of mentors:* -Apply the learnt skills to help protégés finishing a specific engineering project. *In view of protégés:* - Finish a specific engineering project.

Table 2. Background Information of the Second Group Mentoring

The mentors and the protégés was matched in a project bias, the matching process was in a random based. In the first tiered of mentoring, one mentor is from Generation X (Gen X) while one is from Gen Y, the group was more focusing on providing training in regarding to protégés' whole person development, mainly on communication, problem solving, critical thinking, adaptability, teamwork, time management and empathy throughout a series of curriculum, pedagogical guide, introduction of Gen X, Y and Z, and exercises. Meanwhile, in the second tiered, those mentors (from the first group protégés), aiming to supervise second tiered protégés to finish a specific engineering project.

Findings and Results

The protégés' abilities were highly demonstrated when they were being mentors, serving the students from the diploma level. This flipping process allowed original protégés in understanding theirs personality, building up their confidence, self-reliance and making ultimately happiness from passing knowledge and skills to others, joyousness from the fresh energy, enhance interest, and the most crucial parts, applying those soft skills within this authentic workplace environment. The double paths mentoring program provided a good mentoring experience to those original protégés and letting them to be a good mentor in future.

Figure 1. Gen Z Mentors with Diploma Students

In certain studies, it is found that the most affected willingness and motivation of those protégés to mentors is the previous mentoring experience, including previous experience as a mentor and previous experience as a protégé. Both experience are positively relate to future willingness to mentor others (Allen, 2003; Allen, Poteet, & Burroughs, 1997; Allen, Poteet, Russell et al., 1997; Bozionelos, 2004; Ragins & Cotton, 1993; Ragins & Scandura, 1999). Various factors can explain this finding, Kram (1985) summarized that, for those who had previous mentoring experiences, they would be more likely appreciate the benefits of mentoring due to their firsthand knowledge. This finding also consist with the model of behavioral consistency, which suggested that past behavior is a reliable predictor of future behavior (Wernimont & Campbell, 1968). Finally, the impact of previous mentoring experience likely also reflects the reciprocal specification (Gouldner, 1960). Individuals who have been protégés are motivated to reciprocate the help they have received by being mentors to others (Allen, Poteet, & Burroughs, 1997).

Those trained Gen Z student also mentoring a group of secondary school students and a group of primary school students from mid-April to mid-July and March respectively. These two mentorship goal are aim to develop Gen Z mentors confidence and self-reliance by helping protégés make a specific model car. It is surprised that Gen Z mentors those protégés with their own way, like providing tailored materials, welcome to communication and take place online and providing video to watch, which reflecting that how Gen Z use technology differently as well.

Figure 2. Gen Z Mentors with Secondary School Students

Figure 3. Gen Z Mentors with Primary School Students

Pre and post quantitative data were collected from first tiered protégés. The data were collected via questionnaires that measured a range of variables including social and academic integration. Those questionnaire reflected the self-evaluation on first tiered protégés' improvement. It is found that there are a significant positive improvement in these two aspects; their communication skills and participating in projects and tasks eagerly.

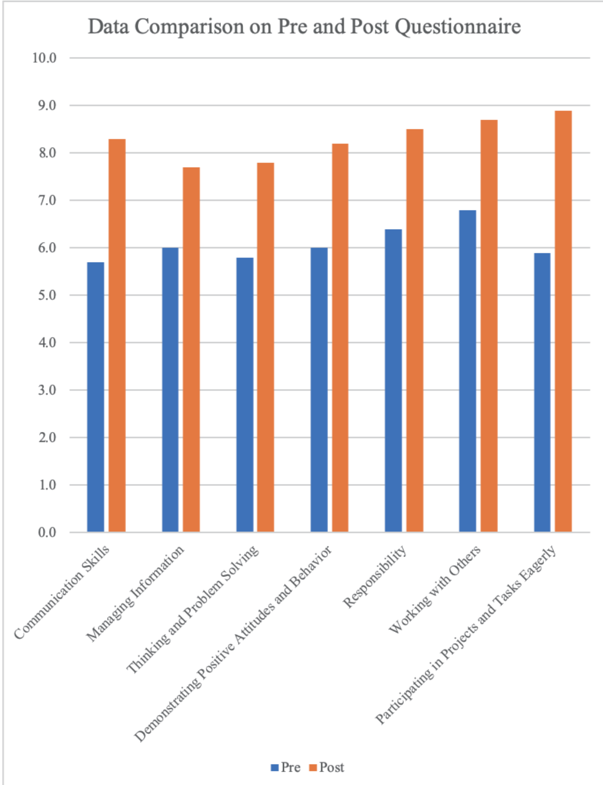


Figure 4. Data Comparison on Pre and Post Questionnaire

Conclusions

Gen Z seems to be a totally different than the earlier generations, they own unique needs and need to nurture them in a right way. The TTMP offered a new platform for mentoring among a project, unlike traditional mentoring programme, which limit among a same institute/ organization. The TTMP seems provides a lot of benefits to potential protégés to become mentors and makes them to be more work ready. However, quantitative studies are limited to access this scenario. In future, multiple methodologies shall be employed to ensure and confirm the findings.

References

Allen, T. D. (2003). Mentoring others: A dispositional and motivational approach. *Journal of Vocational Behavior*, 62, 134–154.

Allen, T. D., Poteet, M. L., & Burroughs, S. M. (1997). The mentor's perspective: A qualitative inquiry and future research agenda. *Journal of Vocational Behavior*, 51, 70–89.

Allen, T. D., Poteet, M. L., Russell, J. E. A., & Dobbins, G. H. (1997). A field study of factors related to supervisors' willingness to mentor others. *Journal of Vocational Behavior*, 50, 1–22.

Arora, D. and Sharma, B. K. (2019). Understanding the Attitude of Generation Z towards Workplace.

International Journal of Management, Technology And Engineering.

Bozionelos, N. (2004). Mentoring provided: Relation to mentor's career success, personality, and mentoring received. *Journal of Vocational Behavior*, 64, 24–46.

Coombs, J. (2013). *Generation Z: Why HR Must Be Prepared for Its Arrival.* Retrieved from https://www.shrm.org/resourcesandtools/hr-topics/talent-acquisition/pages/prepare-for-generation-z.aspx.

Gouldner, A. W. (1960). The norm of reciprocity: A preliminary statement. *American Sociological Review*, 25, 161–178.

Kram, K. E. (1985). *Mentoring at work*. Glenview, IL: Scott, Foresman.

O'Neil, M. (2010). Generation Preferences: A Glimpse into the Future Office. Knoll research white paper.

Ragins, B. R., & Cotton, J. L. (1993). Gender and willingness to mentor in organizations. *Journal of Management*, 19, 97–111.

Ragins, B. R., & Scandura, T. A. (1999). Burden or blessing? Expected costs and benefits of being a mentor. *Journal of Organizational Behavior*, 20, 493–509.

Wernimont, P. F., & Campbell, J. P. (1968). Signs, samples, and criteria. *Journal of Applied Psychology*, 52, 372–376.

Introduction of "Liberal Arts Discourse Meeting" at National Institute of Technology, Yonago College

M.Aoto [*a], A.Takeuchi[*a], K.Fuse[*a], H.Kato[*a], Y.Horihata[*a], M.Harada[*a], K.Ohba[*a], M.Nakashima[*a], M.Ohno[*a], and O.Tsujimoto [*a]

[*a] National Institute of Technology, Yonago College, Japan

aoto@yonago-k.ac.jp

Abstract

National Institute of Technology, Yonago College established "Center for Liberal Arts" in 2016, aiming for further improvements of liberal arts education. One of the features in the NIT is that there are quite a few students who have a deep interest in a specific field. "We should make use of them for the liberal arts education!" This is how we started "Liberal Arts Discourse Meeting."

The Liberal Arts Discourse meeting is an opportunity for students to have discussions about a topic. For example, students who have developed a deep knowledge of a specific field through their hobby give lectures. The faculty develops the idea, associating the topic with current affairs and then participating students engage in discussions. The Discourse Meetings were held seven times during a period from May 2017 to December 2018.

The purpose of this meeting is not to draw any conclusions but to impress upon students the point that there are various perspectives or situations. The important thing is to share common awareness of the issues. The meeting should not be a debate. Therefore, it is not appropriate to decide which is better. However, in order to foster the ability of thinking logically, students are encouraged to show the reasons when they make a statement.

At every meeting, we conducted questionnaires both for the audience and for the lecturer. We analyzed the results and they showed how effective the meetings were. Every meeting has a different topic. We show some case-based examples. From the results of questionnaires conducted afterwards, these discourse meetings received favorable reviews.

We also provide negative aspects and things we should know when you organize this kind of meetings.

The most important thing in this discourse meeting is to create an atmosphere of the freedom to speak and to feel comfortable. Then students can make comments even on abstract questions.

Keywords: *liberal arts education, ability of self-learning, students' interests, questionnaire, National Institute of Technology*

1. Introduction

The importance of liberal arts education for engineering students has been increasing. National Institute of Technology (NIT), Yonago College established "Center for Liberal Arts" in 2016 as a forerunner among technical colleges to improve liberal arts education. "Liberal Arts Discourse Meetings" started as a part of this in 2017.

In these discourse meetings, students who have a deep interest in a particular field give lectures. The faculty develops the idea, associating the topic with current affairs or current events and gives the participating students the opportunity to have discussions about the topic. The Discourse Meetings were held seven times during the period from May 2017 to December 2018 in the form of voluntary participation. From the results of questionnaires conducted afterward, these discourse meetings received favorable reviews. Furthermore, some students among the audience were inspired by the discourse meetings and spontaneously offered to be a lecturer, which was beyond our expectation. The meetings are continually held in a sustainable way. Also, some inspired students took voluntary actions to show their independent studies at the school festival.

In this paper, we introduce the accomplishment of Liberal Arts Discourse Meetings and mention operational notes.

2.1. What is Liberal Arts Discourse Meeting

One of the features in the NIT is that there are quite a few students who have a deep interest in a specific field. "We should make use of them for the liberal arts education!" That was the start of Liberal Arts Discourse Meeting.

In the discourse meetings, a student who has expertise delivers a speech on his hobby. The faculty develops the idea associating the topic with current affairs, social problems, philosophical questions, technologies, etc. and encourages the participating audience to have a discussion regarding the topic. The meetings are held in the form of voluntary participation. For example, a student whose hobby is birdwatching talks about his hobby and then asks the audience "Have you noticed the number of birds and the number of types of birds are increasing?" He explains this is partly due to the expansion of abandoned farms and then promotes a discussion about the issue and then takes the idea one step further to think about agricultural problems or the issue of national self-sufficiency in food. This is a typical style of the liberal arts discourse meeting.

2.2. Rules

The meeting should be held on a weekday afternoon in order to have as many students as possible participate. The meeting should last at most 45 minutes so that students can remain concentrated. The first half should be used to offer the topic by the lecturer. The last half should be used to for audience to talk about the idea. The purpose of this meeting is not to draw any conclusions but to impress upon students the point that there are various perspectives or situations. The important thing is to share common awareness of the issues. The meeting should not be debating. So it is impossible to decide which is better. However, to foster the ability of thinking logically, students are encouraged to show the reasons when they make a statement. Any comments are accepted, but pulling others down and abusive behavior are prohibited.

2.3. Procedure

How Liberal Arts Discourse Meetings is held is described below.

1. List the names of students who have deep knowledge in a specific field. (After the fourth meeting we no longer have to list the names since students volunteered to be a lecturer.)
2. The faculty makes a study if their topics could be associated with current affairs or not.
3. Once the faculty confirm the potential of enlivening the topic, we ask the lecturer to prepare for the meeting and we design a poster and try hard to keep every student informed about the meeting.
4. To enhance the content of the meeting, the faculty listen to the lecturer and ask questions as audience, so the lecturer can have a rehearsal on the topic.
5. At the actual meeting the faculty should act as an adviser and forge an atmosphere that encourages every participant talk freely. At the end of the meeting the faculty settle the discussion.
6. After the meeting the faculty analyzes the questionnaires for future reference.

It usually takes about a month to follow these procedures. To satisfy the audience we prepared in a careful manner for every meeting.

2.4.1. Questions to the audience

To examine the effects and to improve the Liberal Arts Discourse Meeting, we conducted questionnaire after every meeting. Students are asked to rate the following questions on a scale of 1 to 5.

1. The meeting was fun.
2. The topic provided was interesting
3. The discussion was active
4. The discussion would be useful in the real world
5. Your "Liberal Arts" was well educated by the discussion

We defined the positive answers to question 1 as satisfaction level. We also let them have any comments regarding the meeting to see how they recognize "liberal arts".

2.4.2. Questions to the lecturer

We also asked the lecturers following questions on a scale of 1 to 5 to see their awareness.

1. Preparation for the presentation was fun
2. You were cultivated through preparation
3. One month for preparation was long enough
4. Presentation was fun
5. You were cultivated through the preparation and presentation
6. 15 to 30 minutes for presentation was long enough

Then they are asked to give us their opinions and request about the meeting.

3. Case Report

3.1 The first Liberal Arts Discourse Meeting

The first meeting was held on May 31, 2017. The lecturer was a great fan of railways. The title was "The appeal of Keihan Electric Railway". He introduced the charm of Keihan Electric Railway and then explained that the charm was based on their management strategies.

Figure 1 : The first Liberal Arts Discourse Meeting

In the meeting, a question "what is the charm of Keihan Electric Railway?" led to a philosophical issue and talked a lot about what charm is. At first the question seemed a little too abstract, but a question "what are you fascinated by?" created a pleasant atmosphere for participants. They concluded that charms enrich your life. The important thing is to have a heart to feel attraction to things.

The number of participants was twelve.

3.2 The second Liberal Arts Discourse Meeting

The second meeting was held on June 21, 2017. The lecture was an award winner in the photo contest. The title was "The appeal of photography, through the pictures of airplanes." He introduced what kind of pictures were interesting and how to take interesting pictures. The discussion was focused on art.

To encourage students to join the discussion, we asked if they agree to digitally recreated images. We expected that students at technical college like digital recreation and there will be some debate between silver halide photography and digital images, but in contrast to our prediction, only a few students accepted them. Then they began to talk about the charm of photography. We summarized the discussion with the idea that "Art is the work appealing to our heart and has nothing to do with good or not."

The number of participants was 19 and seven of them were returning participants. Some of them were so inspired by these discourse meetings that they volunteered to hold an exhibition of their photographs at the school festival in November.

3.3 The third Liberal Arts Discourse Meeting

The third meeting was held on July 25, 2017. The lecture possessed deep knowledge of battleships. The title was "lessons that battleships left." At first we traced the history of battleships. He explained that they had a unique experience of evolution through Taikan-Kyoho Shugi, the Japanese Navy's strategy that the battleships should be bigger like Dreadnought. In consequence, the Japanese Navy could not keep up with the times and lost.

The discussion was focused on "to doubt established fact", which blinds ourselves, from the lessons that battleships left. To stimulate discussion, we asked participants to give some examples which seem like common sense but they are actually not. Then one of the teachers, who was not in charge but volunteered to be in the meeting, gave some timely advice and discussion deepened a lot. They concluded as follows. Not to be bounded by established values it is important to have our own opinion and to be careful not to be influenced by others.

The number of participants was 13 and eight of them were previous participants. From this time one of the participants volunteered to be the lecturer. They presented not only the topic of the discussion but also how the discussion should be developed. It is thought that these discourse meetings increased their awareness of issues.

3.4 The fourth Liberal Arts Discourse Meeting

The fourth meeting was held on December 14, 2017. The lecturer was good at mathematics and he volunteered to be the lecturer. The title was "The bright side and the dark side of a mathematician Gauss." The lecturer introduced Gauss's great accomplishments. Since he was an extreme perfectionist, he only publicized part of his research. If he had been an average mathematician, he might have advanced mathematics for tens of years.

As stated above, he had thought the development of the discussion. In concrete terms, he regarded Gauss's attitude as today's problem. He asked the audience which is better, "rough and ready" or "slow and elaborate"? As students at technical college, we predicted most of them would criticize "rough and ready" so we prepared the cases of high-quality finished works. However students knew scientific research these days seemed to be more on "rough and ready". And most of them think positively about Gauss.

The number of participants was 16 and nine of them were previous participants.

3.5 The fifth Liberal Arts Discourse Meeting

The fifth meeting was held on April 24, 2018. The lecture was interested in business management. He volunteered to be a lecturer. The title was "business management learnt from military strategy, how the weak beats the strong". He introduced "Lanchester strategy" which originated from military strategy. He explained that Napoleon's strategy and Haagen-Dazs's strategy are both based on Lanchester strategy.

The lecturer had planned how to lead the audience to talk about their overall strategy in their own lives on the basis of Lanchester strategy. However it seemed a little difficult for students to discuss strategies for their lives. Then we encouraged participants to point out similarities and differences between business strategies and Lanchester strategy. Some students were stimulated and told there were certain principles among business strategies. Others were amazed at the similarities between Lanchester Strategy and "The Art of War by Sun Tzu". Then they found it easy to talk about their strategies for their lives.

The number of participants was 13 and seven of them were previous participants. Two students among the audience offered to be lecturers voluntarily. Now the discourse meeting seems to continue by itself.

3.6 The sixth Liberal Arts Discourse Meeting

The sixth meeting was held on November 19, 2018. The lecturer was interested in logic and the title was "Is your version of common sense correct? What is Godel's incompleteness theorems?" At first the theme seemed too difficult but he began telling audience a famous paradox and introduced the theorem and told them what we should learn from the theorem is to doubt what we call common sense. That made it easy to accept the topic and the discussion went well.

The number of participants was 13 and six of them were previous participants.

3.7 The seventh Liberal Arts Discourse Meeting

The seventh meeting was held on December 17, 2018. The title was “Who is myself? Persona through changes in novel description”. The lecturer had a good knowledge of literature. He explained the difference between what the main character in a novel was conscious of himself and what others think the character according to times or works. Then he asked the audience what the real yourself was. The question was very difficult to answer but he asked the question after he gave his opinion so it made audience easier to make statements and vigorous discussion began. According to the questionnaire, everyone agreed the discussion was very active.

Because the topic was about literature, the number of participants was only seven. But all of them were previous participants. We can say we have built a solid base of an audience now.

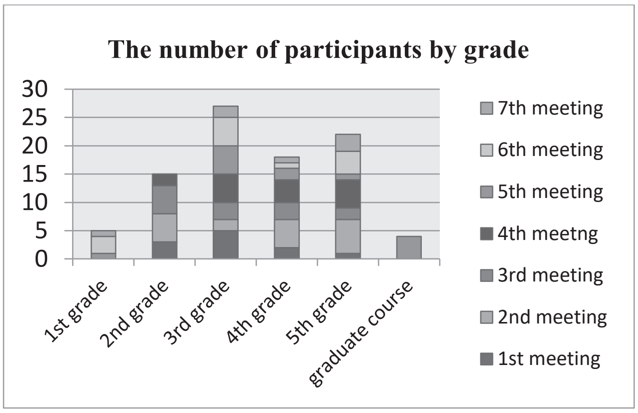


Figure 2

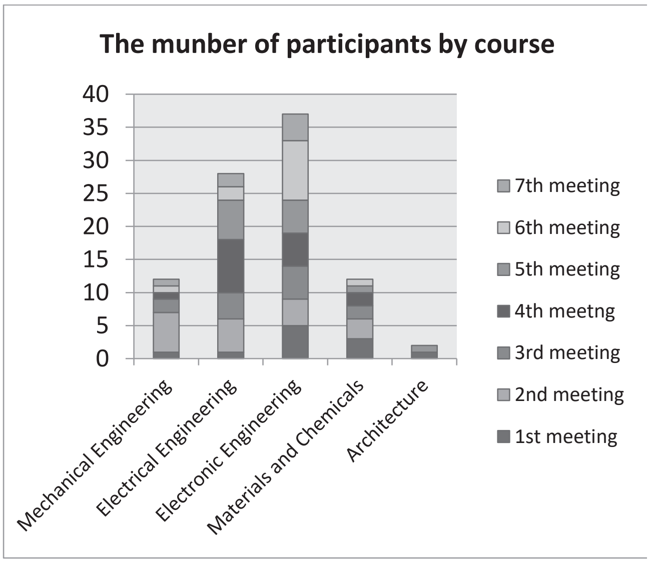


Figure 3

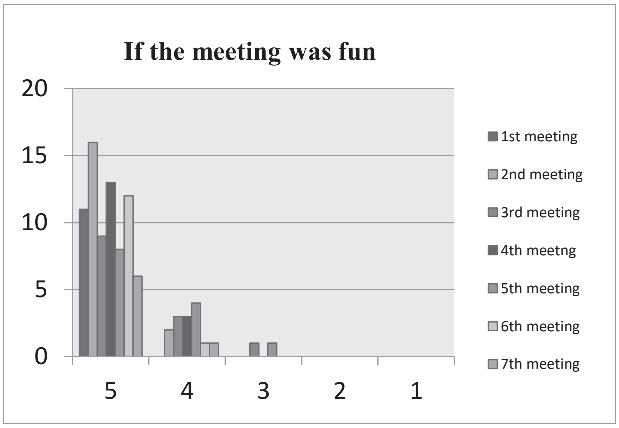


Figure 4

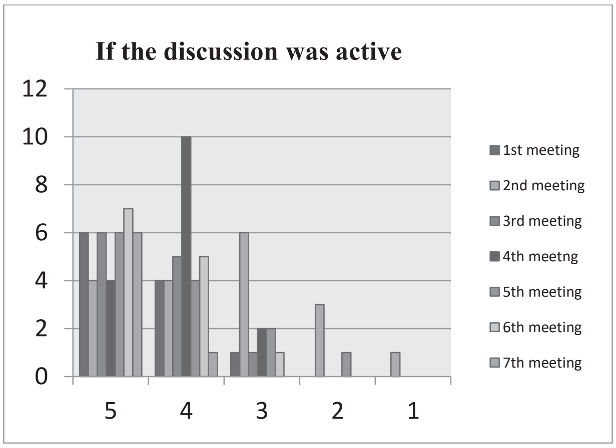


Figure 5

4. Analysis

4.1. Analysis of Attendees

Figure 2 shows the number of participants by grade and Figure 3 shows the number of participants by course. According to them, we had few participants from first grade students or architecture students. We have some room for improvement concerning the methods to inform them.

4.2. Analysis of Satisfaction Level

Figure 4 shows the satisfaction level and Figure 5shows if the discussion was active. According to Figure 4, the overall satisfaction level is 98%. We can say that our discourse meetings were successful.

Figure 5 shows that 80% answered the discussion was active. In more details, in 1st, 3rd, 4th, 5th, 6th, and 7th meeting, the answers were 91%, 92%, 88%, 77%, 92% and 100% respectively. However in 2nd meeting, the lecturer spent as much time as 50 minutes on his presentation and only little time was spent on discussion. The purpose of the discourse meeting is to let the audience have discussions. This taught us a lesson that the presentation should be 30 minutes at most and set aside enough time for discussion.

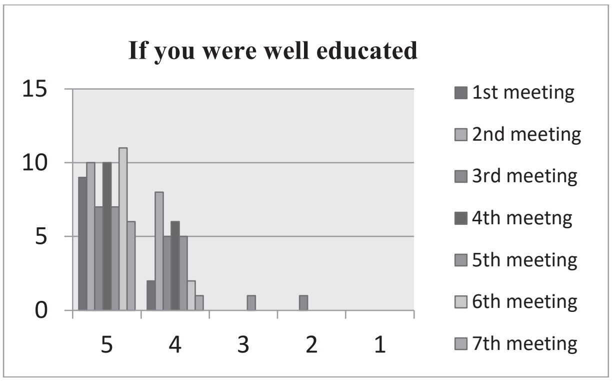


Figure 6

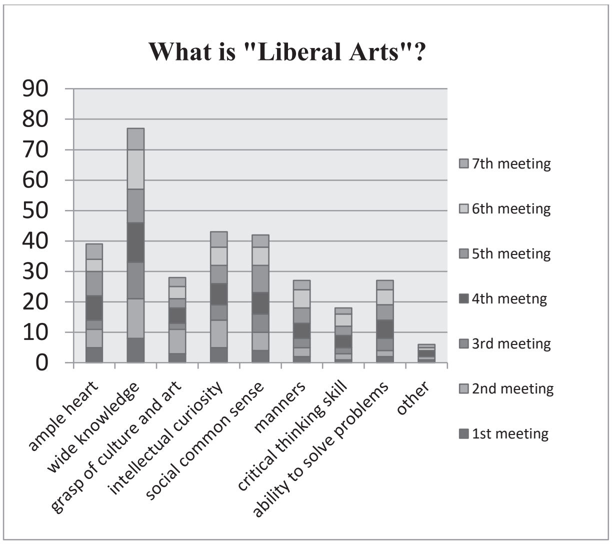


Figure 7

4.3. Feedback from participants

Figure 6 shows if the participants think they were well educated. It tells us that as much as 98% thought they were well educated in the meeting. Figure 7 shows the ideas participants had about Liberal Arts. They regards cultured as “wide knowledge”, “intellectual curiosity”, “social common sense”, and “ample heart”, which are socially accepted ideas. In comments described in the questionnaire there were a lot of positive feedback such as “It was very interesting to know a new world”, “It was good to hear many different opinions on one topic” and “It was interesting a talk on a hobby broaden our horizons.”

4.4. Feedback from lecturers

We conducted questions to the lecturers. To the question “Is one month for the preparation long enough?” 1 answered “a little too short”, 1 answered “a little too long” and 5 answered “adequate”. Preparation period was basically adequate and we can say we didn’t overburden the lecturers. To the question “Were you cultivated through the preparation and presentation?” all answered positively. Among their opinions and request about the meeting, some of them wrote that they want to be a lecturer again on a different topic. It seems that they enjoyed talking about their hobbies.

5. Effect

5.1. Effect of Liberal Arts Discourse Meetings

It is extremely important to make a fair assessment of Liberal Arts Discourse Meetings objectively. However, since Liberal Arts Discourse Meeting takes the form of voluntary participation, we don’t conduct exams in the context of encouraging the participation. Therefore, to show the effect of meetings objectively, it is best to describe the changes in behavior of lecturers. We can say that the following cases shows that the lecturer increased awareness of the issue.

5.2. Case 1

Since the third meeting, we have had a lecturer for following meetings. This is beyond our expectations. We don’t have trouble finding a new lecturer any more. The meeting continues by itself now. In addition, the lecturer not only presented the topic but also carried a sense of direction for discussion. This is considered because they understood the purpose of the meeting and became conscious of the problems.

5.3. Case 2

After the second meeting which focused on the appeal of photography, some students among the audience were inspired to organize an exhibition of their own pictures at the school festival in November, 2017. It is thought that they were inspired by the words, “Art is the work appealing to our heart and has nothing to do with good or not.” This exhibition was held in 2018, too.

5.4. Case 3

The number of audience members is 12 to 19 students, which is an appropriate size for frank discussion. In fact almost everyone made a comment at every meeting. Since the second meeting about one third to two thirds of students have been previous participants. We can say that most of the audience were satisfied with the meetings. In addition, some regularly participating students often opened the discussion on the topics and made it easier for others to make comments. This is considered that they understood the purpose of the meeting: to share common awareness of the issues.

6. Cautions when operating the meetings

One of the features of Discourse Meeting is to develop the idea of students into current affairs. In order to achieve the objectives, one teacher from each subject was selected as a member of Liberal Arts Discourse Meeting and looked for every direction to develop the student’s idea. Sometimes, however, student lecturers did not understand the purpose of the meeting, so the pre-meeting which was held in advance in which teachers’ presence was very important. In the actual meeting it is important to shorten the time of presentation and have enough time for discussion. It is also important to foster an atmosphere for students to make comments.

Concretely speaking, after the presentation teachers asked the audience a question which was easy to answer and encouraged the audience to make comments. In addition, we showed our approval by praising their rich imaginations and their fresh perspectives to lower the hurdles for making comments. If we create the atmosphere for students to feel comfortable, it turned out they made comments even on abstract questions.

7. Conclusion

National Institute of Technology, Yonago College established "Center for Liberal Arts" in 2016. Liberal Arts Discourse Meeting started to improve liberal arts education. In the meeting students who have a deep interest in a specific field give a presentation and teachers develop the idea into current affairs and participants discuss the topic. The meetings were held seven times and we found the meetings had favorable comments.

Some students volunteered to be lecturer and this discourse meeting turned to continue by itself. Some students among the audience were inspired to hold an exhibition at the school festival.

The most important thing in this discourse meeting is to make presentation short and have enough time for discussion and to create the atmosphere for students to feel comfortable. Then students can make comments even on abstract questions.

We plan to enhance liberal arts education by making liberal arts discourse meeting a regular class at NIT Yonago College in the future.

References

Keiji Fuse (2013). Attempt to Develop Voluntary Thinking about Currrent Social Problems – Use of Presentations in the Humanities and Social Sciences -, *Kosen kyoiku*, 36, 327-332.

Akitsugu Takeuchi, et al. (2018). Introduction of “Liberal Arts Discourse Group” at NIT, Yonago College, Journal of the Japan Association for College of Technology 23(3), 7-12

Akitsugu Takeuchi, et al. (2018). Liberal Arts Discourse Group at NIT, Yonago College, Engineering Education 66(6), 98-103

INNOVATIVE STEM WORKSHOPS FOR ENGINEERING EDUCATION

C. H. Siu*, K. W. Lam, Y. K. Miu, Y. L. Tse and Jonathan K. F. Lee

VTC STEM Education Centre, Vocational Training Council, Hong Kong

* joseph.siu@vtc.edu.hk

Abstract

The core of engineering education is to provide a solid knowledge of the STEM (Science, Technology, Engineering and Mathematics) related subjects to our students and inspire their mind-set to be more creative and innovative. In order to nurture young STEM talent, VTC STEM Education Centre was established to inspire a growing community of STEM learners and professionals, in line with Hong Kong Government's efforts to cultivate smart people for the forthcoming developments in Hong Kong.

This paper aims to propose an innovative pedagogy on conducting STEM workshops to motivate and inspire students for acquiring 21st century skills, which cover the development of teaching packages, from design to implementation. Based on the diversity of the learner's background and interest, STEM Education Centre developed three series of STEM workshops: Maker Series (providing hands-on experience through product making by using multidisciplinary knowledge), Exploration Series (learning the latest technology) and Foundation Series (providing basic STEM knowledge to the learners).

We will share our teaching experience with some case studies, such as how to use the resources for running STEM workshop in an efficient way, how to better use of Technology Enhanced Learning approach to facilitate the STEM workshops. At the end of the paper, there are some recommendations for teachers in conducting STEM workshops.

Keywords: *STEM, innovative pedagogy, technology enhanced learning, multidisciplinary knowledge, learner diversity.*

1. Introduction

STEM Education serves as the foundation of Engineering Education, in order to nurture the young STEM talents, VTC STEM Education Centre was established to inspire a growing community of STEM learners and professionals in line with Hong Kong Government's efforts to cultivate smart people for the forthcoming developments in Hong Kong.

In our centre, the Mathematics and Science Corner was set up to arouse students' interest in STEM and enhanced their STEM knowledge through different kinds of innovative STEM workshops.

2. Methodology

We developed three series of STEM workshops: Maker, Exploration and Foundation. In Maker series, we focus to develop learner's hands-on experience and problem- solving skills and try to arouse their interesting in STEM. In Exploration series, we focus on developing students' innovative mind-set. In the Foundation series, we focus on providing students with solid fundamental knowledge of STEM-related subjects.

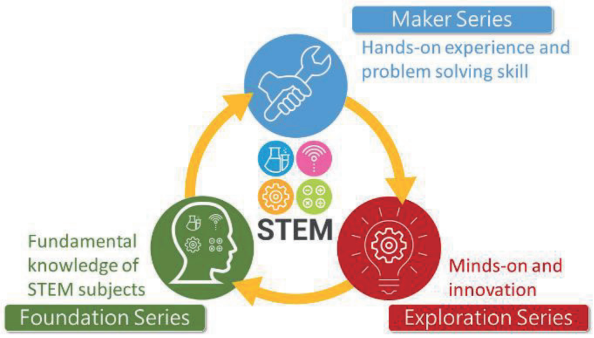


Figure 1: Three series of innovative STEM workshops

In the traditional learning process, students usually learn most of the basic knowledge first before design and implement their ideas into an application. There will be some drawback on this approach, students may not know the whole picture of how those knowledge related to each other. They will be easy to give up on the early stage due to lots of knowledge and concepts need to study while the fun part (application) is at the end of the learning process.

Therefore, a reference to the idea of the flipped classroom (張輝誠, 2015; 葉丙成, 2015) which reverses the traditional classroom-based learning and homework, we attracted and motived the students through the Maker series. Then we would open up students mind on Exploration series. Finally, we provide solid fundamental STEM knowledge to them through the Foundation series.

2.1 Core Design Elements of STEM Workshop

When designing the STEM workshop, we will focus on the following four design elements:

1. *Fun and interactive*
   This is the most important part to motivate students for learning. The teacher should think out of the box to explore all possibilities for integrating STEM knowledge through game-like activities. Despain, W. & Acosta, K. (2013) suggest 100 principles on game design which serves as a good reference.

2. *Focus on 1-3 main STEM concepts*
   The teacher should focus on delivering 1-3 main concepts that student should acquire after the workshop and if possible, add a few extended concepts for those students that want to learn more. This is very important when handling learner diversity.

3. *Multidisciplinary knowledge*
   In each workshop, the teacher should not focus only one single subject knowledge on STEM subjects, try to integrate with multidisciplinary knowledge.

4. *Technology-enhanced learning*
   Try to use technology to facilitate/enrich the learning experience of the students. Teachers are encouraged to self-develop system/tools for teaching and learning as it would be the best fit for the workshop that they designed.

3. Case Study

3.1 Maker Series

In this series, we focus on providing hands-on experience to students and developing their skills in making and problem-solving. They will learn while on making in a fun learning environment.

3.1.1 Self-walking Gravity Toy Workshop — "Animal that 'Rocks' with Gravity"

Target students: age 6-14
Duration: 1 hour
Main Concepts: (1) Gravitational force (2) Pendulum motion

This workshop aims to help students relate daily objects with concepts of science. In this case, a self-walking mechanical toy in rocking motion driven by gravity alone acts as the teaching medium.

The workshop has two parts, the first part is the delivery of basic knowledge. It incorporates demonstrations of children's toys and assembled stationery to introduce the concepts of gravitational force, centre of gravity and pendulum motion and explain the mechanics principles behind (Figure 2).

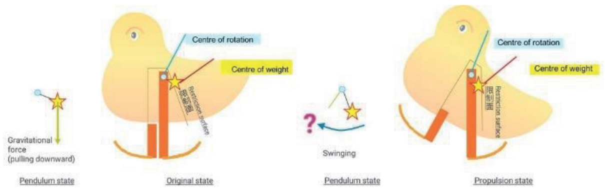


Figure 2: Mechanics principles of the workshop

Following the explanation of working principles is the hands-on "maker" session where students build the paper toy model with handy materials. In the process, they are also required to adjust the centre of gravity of the model by experiments given the fixed-gradient inclined platform as a control variable.

Students will learn to analyse the motion of the toy from a "dismantled" approach, i.e. break down the motion frame-by-frame and study the parts that contribute to the rocking and translating motion.

They are inspired to observe mechanism of daily life objects and able to gain knowledge from the processes of model-building and hands-on experiments. This handmade toy is fun-to-make and fun-to-play, students feel a sense of achievement when seeing their own animals come to live (Figure 3).

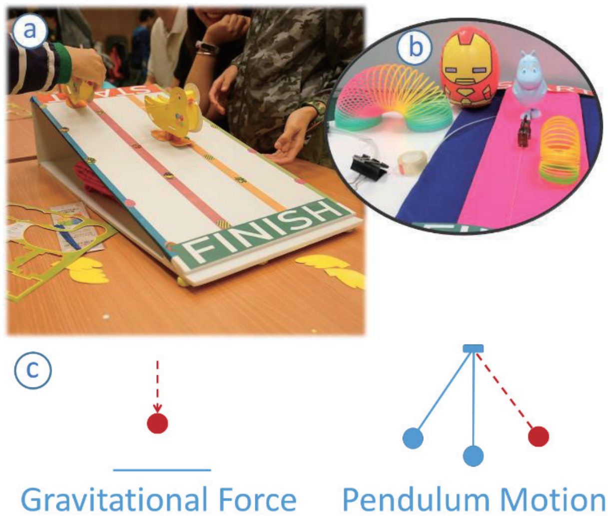


Figure 3: (a) Students testing their paper gravity toy model. (b) Simple everyday items as demonstration kit. (c) Main concepts introduced in the workshop.

3.1.2 Spinning Top e-Drawing Workshop

Target students: age 3-12
Duration: 1 hour
Main Concepts: (1) Centroid (2) Stability

In this workshop, students use recycled material to make a spinning top of different shape, i.e. circle, rectangle, triangle and irregular shape. First, students need to find the centroid of the shape they got and then making their own spinning top.

By spinning it, the trail of the spinning top creates a unique and fascinating digital drawing. Students will experience the basic concepts of physics (centroid, stability) and computer vision (object tracking), which will also inspire their creative and artistic mind (Figure 4).

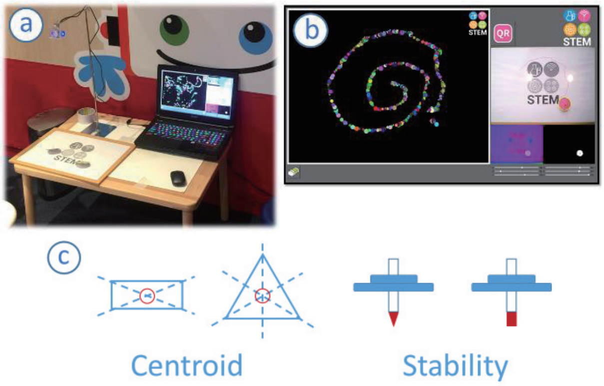


Figure 4: (a) Set up of the workshop. (b) e-Drawing by tracking the trajectory of the spinning top through computer vision. (c) Main concepts of the workshop.

3.1.3 LED Galaxy Music Box Workshop

Target students: age above 12
Duration: 3 hours
Main Concepts: (1) Basic circuit (2) Principle of speaker

In this workshop, incorporating both theory and practice components, allow students to learn the principle of a speaker and taste the use of tooling and handcraft techniques. LED will be used to imitate the starry sky, in addition to explain the working principle of LED, it also introduces the basic astronomical principles to students.

Students have to build their own work from scratch. They need to use different tools like electric drill and screwdriver to install the music box components. Different constellation map can be chosen for their composition in the music box, which also increases their creativity and hands-on experience (Figure 5).

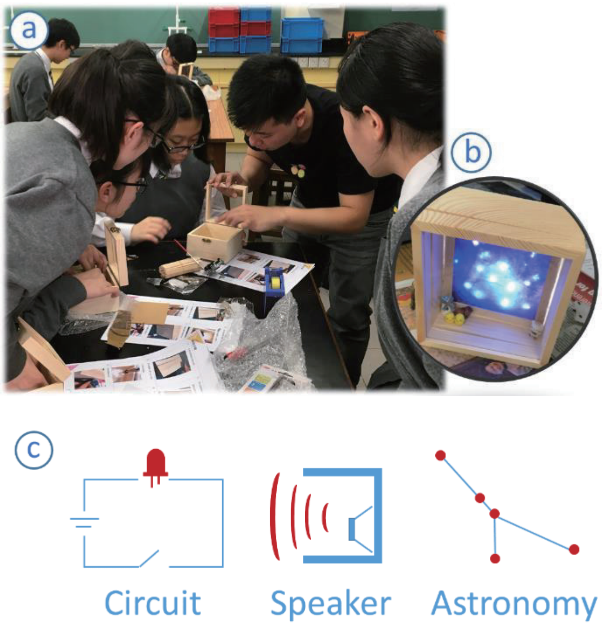


Figure 5: (a) Instructor explain the procedure to the students. (b) LED galaxy music box (c) Main concepts of the workshop.

3.1.4 micro:bit Walking Trolley Robot Workshop

Target students: age above 12
Duration: 5 hours
Main Concepts: (1) Programming (2) Robotics

In this workshop, students are required to assemble a robot for carrying a load by using laser-cut and 3D-printed material. They can learn about the programming the micro:bit and related robotics theories through interactive and real-life examples (i.e. simulated construction environment).

The students will learn the programming skills and motor control algorithm from the workshop. Student can remote the robots though micro:bit to complete tasks like transporting materials used in construction works (Figure 6). The pros and cons of automation and robot development will also be introduced in the course.

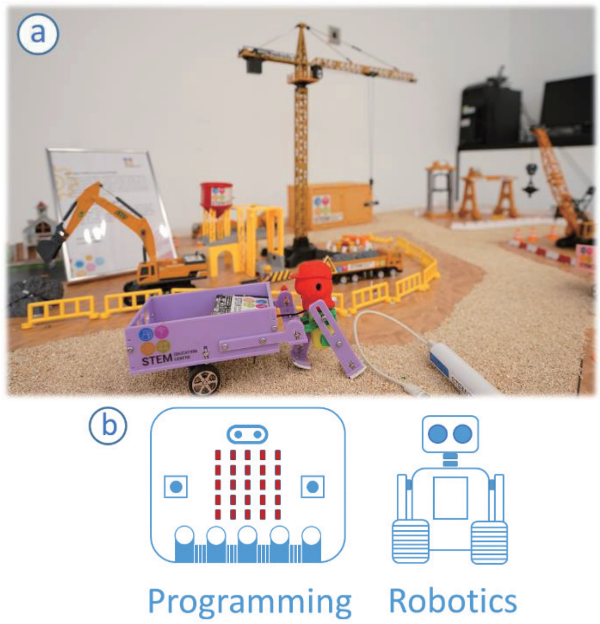


Figure 6: (a) micro:bit Walking Trolley Robot on the simulated construction environment. (b) Main concepts of the workshop.

3.2 Exploration Series

In this series, we focus to develop students' creativity and innovation mind-set through exploration on latest technologies: Artificial Intelligence (AI), Augmented/ Virtual Reality (VAR), Unmanned Aerial Vehicle (UAV) and thinking skills: Design Thinking, System Thinking.

3.2.1 Artificial Inelegance (AI) Workshop

Target students: age above 15
Duration: 2 hours
Main Concepts: (1) History and application of AI (2) Basic concept of machine learning

In this workshop, students will learn the history and the latest trend and applications of the AI. We will use a self-developed interactive system (Figure 7) to demonstrate the difficult concept in a fun way. This system will take a photo of the students and then apply the style of a painting to that photo. This demonstrates the deep learning application: neural style transfer (Gatys, L.A., Ecker, A.S., & Bethge, M., 2015). Moreover, students can learn different famous painting from the system.

Figure 7: Self-developed system: AI Artistic Photo Booth for a demonstration concept of deep learning.

3.2.2 STEM x Design Thinking Workshop

Target students: age above 15
Duration: 3 hours
Main Concepts: (1) Concept of design thinking (2) 3D modelling

As an engineer, design thinking is a critical skill for them to solve real-life problems. In this workshop, students will explore the basic concept of design thinking, and will focus on the prototyping stage with hands-on and minds-on experience for them.

Students will learn 3D modelling skill and then design a table for the future office environment. They will make use of simple material: foam board, paper, etc… to make their prototype (Figure 8).

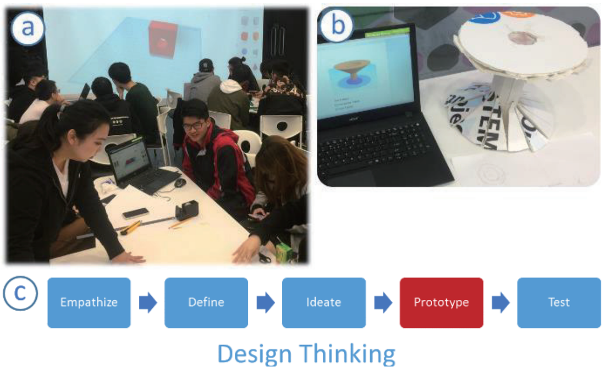


Figure 8: (a) Students using simple material to build their prototype. (b) Computer 3D model and prototype (table for future office) build by students (c) Design thinking process.

3.3 Foundation Series

In this series, our focus is providing solid foundation knowledge of STEM subjects to our students. Topics including algebras, calculus, probability, force and motion, coding. In order to motivate student learning, our centre self-developed interactive learning tools which uses the concept of gamification (Deterding, Sebastian & Dixon, Dan & Khaled, Rilla & Nacke, Lennart, 2011).

For the workshops in the Foundation series, students learn the basic concept and then playing interactive games instead of doing exercise. Figure 9 show two games developed by our centre for learning function, compass/true bearing.

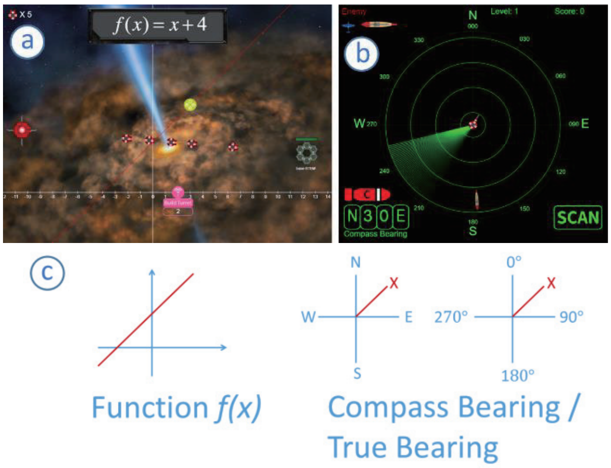


Figure 9: (a) Tower defend type game for learning function f(x). (b) Game for learning compass/true bearing. (c) Main concepts of the two games.

4. Results and Discussion

We found that the workshops of Maker series are the most popular one as students could gain hands-on experience to build their product. Exploration series encouraged students to learn more on STEM-related technology. As the foundation series provide basic knowledge on STEM subject, we found that the number of students joins our foundation series increase a lot before the test/examination period.

We randomly selected 360 workshop participants to do a survey on our three series of innovative STEM workshops (Appendix 1). The overall results were positive, the score was over 4.4 (out of 5) on the following aspects: fun, interactive and stimulated for their STEM learning (Table 1). Also, after finished the STEM workshops, 90% of students were willing to attend the advanced class of the workshops they attended to learn more (Table 2).

Table 1: Survey results of Q2, Q13 and Q14.

Question	**Score** **Score (1 to 5)**
Q2. The workshop activities stimulated my STEM learning.	4.41
Q13. The workshop was interactive	4.44
Q14. The workshop was fun	4.43

Table 2: Survey result of Q8.

Question	**Result (%)**
Q8. Will you join the advanced class of this workshop?	Yes – 90% Neural – 8% No – 2%

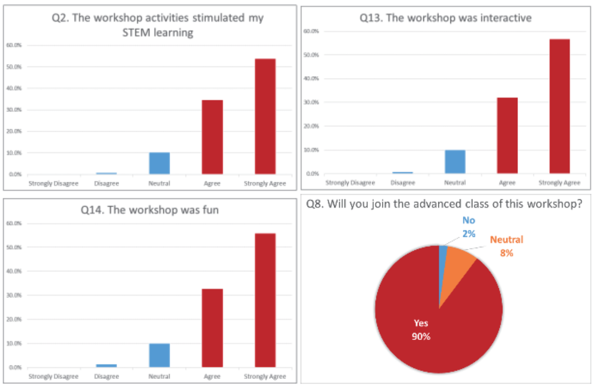


Figure 10: Survey results of Q2, Q13, Q14 and Q8

Finally, the innovative STEM workshops are not to replace traditional curriculum, instead, its main purpose is to arouse students' interest in STEM, enhance and enrich their STEM knowledge. Also, it provides an opportunity for them to integrate multidisciplinary knowledge.

5. Conclusions

STEM education is the foundation for engineering education, therefore three series (Maker, Exploration, Foundation) of innovative STEM workshops were developed by VTC STEM Education Centre to nurture smart people for the emerging STEM careers.

Maker series arouses students' interest in STEM and developing their problem-solving skills. Exploration series opens the mind of students and develop their innovative mind. Foundation series provides a solid knowledge of STEM subjects to students.

In this paper, we propose 4 core elements to design a STEM workshop to reveal the theory/concept through an innovative way. Through the case studies session, we demonstrate how to implement those 4 design elements into our three series of innovative STEM workshops.

Acknowledgements

The authors would like to thanks the VTC STEM Education Centre for providing them with the opportunity to design and run the innovative STEM workshops.

References

Despain, W. & Acosta, K. (2013). *100 principles of game design*. Berkeley, Calif: New Riders.

Deterding, Sebastian & Dixon, Dan & Khaled, Rilla & Nacke, Lennart. (2011). *From Game Design Elements to Gamefulness: Defining Gamification*. Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, MindTrek 2011. 11. 9-15. 10.1145/2181037.2181040.

Gatys, L.A., Ecker, A.S., & Bethge, M. (2015). *A Neural Algorithm of Artistic Style*. ArXiv, abs/1508.06576.

Goleman, D. & Senge, P. (2014). *The triple focus: a new approach to education*. Florence, MA: More Than Sound.

張輝誠 (2015).學・思・達-張輝誠的翻轉實踐.親子天下

葉丙成 (2015).為未來而教：葉丙成的 BTS 教育新思維.親子天下

Appendix 1: Survey Result

Question	**Result** **Score (1 to 5)**
Q1. This workshop lived up to my expectations.	4.45
Q2. The workshop activities stimulated my STEM learning.	4.41
Q3. I will recommend this workshop to my classmates/friends	Yes 89% Neural 10% No 1%
Q4. Progress of the workshop	4.48
Q5. The instructor conducts the workshop effectively	4.59
Q6. The workshop was well organized	4.54
Q7. The instructor was familiar with STEM knowledge	4.63
Q8. Will you join the advanced class of this workshop?	Yes 90% Neural 8% No 2%
Q9. The workshop duration	Suitable 83% Too short 13% Too long 4%
Q10. The workshop level	Elementary 64% Intermediate 31% Advanced 5%
Q11. Teaching facilities	4.35
Q12. Learning and Teaching Material	4.37
Q13. The workshop was interactive	4.44
Q14. The workshop was fun	4.43
Q15. Overall rating	4.50

LEARNER-CENTRIC BLENDED LEARNING PLAN FOR AN ENGINEERING MODULE

F.T.L. Teoh *, a

[a] School of Chemical and Life Sciences, Nanyang Polytechnic, Singapore
* Florence_Teoh@nyp.edu.sg

Abstract

The design of a blended learning plan entails many considerations, with learners being the key stakeholder. Without conscious consideration, the tendency is to allow technology to dictate the direction of the lesson plan. This paper presents the merits and positive results of a blended learning plan designed with a learner-centric approach, for a 2nd year chemical technology diploma.

Three key facets of blended learning design; (1) learner needs, (2) eLearning resources and (3) learning objectives, were considered in relation to one another. In considering learner needs, the LX Canvas was used to consolidate learner profiles, learning objectives, available resources and environment constraints.

Referencing current literature, quality eLearning resources was defined to be activities that are interactive, contextual, provide self-paced learning, encourages collaboration and provide instant feedback to formative assessment. Based on this definition, a survey of current eLearning landscape led to a categorisation and filtering of eLearning activities. Using inputs from the LX canvas, a set of relevant activities that met our learners' needs and capitalised on our schools' resources were arrived at. These included the use of video tools like 'EDpuzzle' and 'Articulate Storyline', collaborative tools like 'InteDashboard', 'Flipgrid' and 'Perusall' and an augmented reality app, 'HP Reveal'.

The last step of the blended learning design involved mapping these eLearning activities to module objectives. This mapping exercise ensured a variety of activities were utilised for the appropriate module objectives, across different topics and different delivery modes.

The result was a learner-centric blended learning experience that included a variety of eLearning activities targeted at fulfilling the module learning objectives. Feedback gathered from the first batch of students indicate that 86% view the eLearning activities as beneficial to their learning.

Keywords: *blended learning, learner-centric, LXD canvas, technology, collaborative, interactive, relevant, engaging, effective, curation.*

Introduction

This paper summarises the work done to implement blended learning in a second-year chemical engineering module. An institution-wide initiative in 2017 to implement blended learning for selected modules led to the formation of a professional learning community (PLC) for blended learning developers within Nanyang Polytechnic (NYP). The work summarised in this paper originated from working in this PLC.

Blended learning: Blended learning encourages deeper understanding of content and better engagement of learners and is potentially transformative to the education landscape. It combines traditional face-to-face (F2F) teaching with technology-aided learning (eLearning) such that the benefits of both teaching methods can be exploited.

In an increasingly electronic world, it is critical to ensure that the benefits of online information repositories, online communication and collaboration channels as well as immersive technologies are fully harnessed. Technology complements traditional teaching methods, by deepening knowledge acquisition through use of the extensive online resources, increasing practice, providing immediate feedback and enabling distance learning. Additionally, adoption of technology in teaching permits the use of varied presentation modes, which helps cater to the different learning styles of learners (Uvalic-Trumbic & Sir John, 2012).

The ability to properly blend the online resources and technologies with F2F teaching to support deep and meaningful learning will define the success of higher education in the 21st century (Garrison & Kanuka, 2004).

Learner Centric Design: Recognising that learners are a key stakeholder in any learning plan, this blended learning design was developed with learner experience and engagement as a key design criteria. Being learner-centric is deemed to be the next level of education challenge, beyond mere cost efficiency and delivery of objectives (Soloway, Guzdial, & Hay, 1994). It is also recognised that quality in eLearning does not only depend on good technology, but also on the learner experience and the learning community (Ulf Daniel, 2001).

Design Process: The three key considerations in any design process are typically the User, Objective and Resources. In the context of blended learning design, these translate to be the Learner, Module Learning Outcomes and eLearning Tools. Without conscious consideration, the tendency is to allow technology to dictate the direction of the lesson plan. To fully exploit the benefits of blended learning, technology employment has to be deliberately designed, introduced and moderated, to prevent technology from taking the lead. In designing the blended learning plan for this module, effort was made to balance all three design inputs. This was done by first considering the learner's needs, then shortlisting available technology based on relevance and quality criteria.

The results of these two exercises were a list of strategies for learner centric design and a shortlist of eLearning activities. These were then considered in the context of the module learning objectives, to ensure even distribution of different activity types across different topics and timeline. This was done by mapping the learning outcomes to the blended learning activities.

The resulting blended learning plan was implemented from the second semester of 2017 and the results are summarised in this paper.

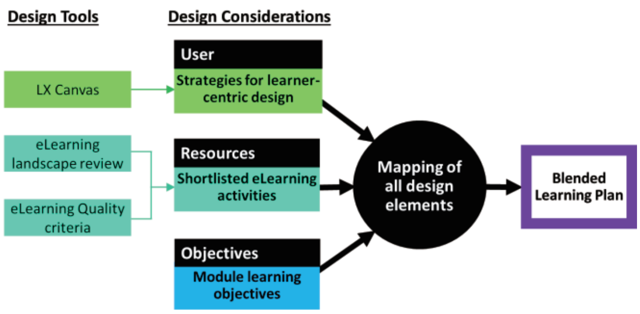


Figure 1 - Blended learning plan design process

Methods & Pedagogy

1. LX Canvas for Consideration of Learners' Needs

Learners are the key stakeholders in any learning design, addressing their needs and motivation is essential to facilitate deep learning and understanding. There are several models for learner-centric design. In the planning of blended learning for this module, the Learning Experience Design (LXD) model (Floor, 2007) was used to consider the learners' needs. The LX canvas used in LXD is a structured platform for addressing learner's needs, presenting all the key considerations in a learning plan design (Figure. 2). It was developed by Niels Floor and focuses on designing the best-possible learning experience for the learner, that is "positive, personal and profound" (Floor, 2015).

The LX canvas was used in a 3-steps approach. Figure 3 shows the semi-completed canvas after steps 1 and 2 were done.

Step 1 : Consideration of Factors Influencing Learning Experience

Learning outcomes & objectives

The specific learning objectives of this module are listed on the canvas. The learning objectives for this module include being able to understand the application of different pump types, read pump curves and predict pump performance. The larger objective of the module is to instil greater confidence in learners when operating pumps and compressors in the workplace. It is desired that learners gain deeper insight and knowledge and achieve better industry relevance.

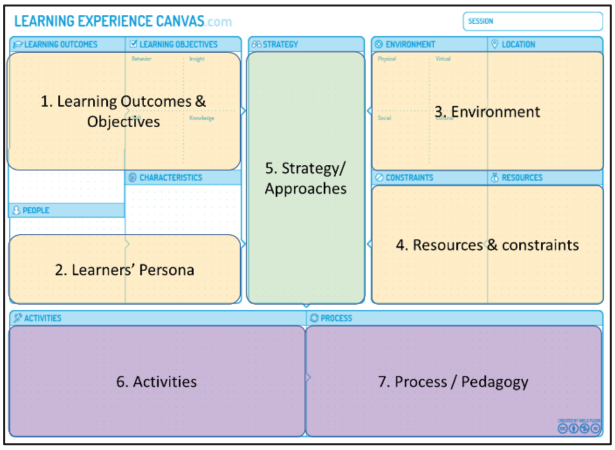


Figure 2 - LX Canvas by Niels Floor

Learners & their characteristics

This section of the canvas involves the crafting of our learners' persona. For this module, learners were 17 to 24 years old and majority have no industrial experience. Youths of this age are savvy with technology, the internet and social media, and prefer watching videos over reading texts. Consideration of these learner aspects led to provision of better visual representation of the equipment being taught using videos or augmented reality. Another characteristic of the learners to be considered is their diversity due to the varied pathways by which they enter polytechnic.

Environment & location

Students are grouped into classes of 20 to 25 for tutorial and laboratory lessons. During mass lectures, 4 to 5 classes or approximately 100 to 120 students, are gathered in a lecture theatre. The environment and available venues are important considerations in the design of learning activities, as certain activities may require more space or furniture that promote collaboration.

Resources & constraints

NYP's key learning resource is the learning management system (LMS) 'Blackboard'. Through this platform, announcements, learning materials, assessment and collaborative activities are delivered. Blackboard's many built-in quiz and collaborative features and add-in video options make it a useful resource for planning learner-centric activities. When choosing the eLearning tools for this blended learning module, consideration was given to whether they were compatible with Blackboard. This is to ensure a seamless learning experience for the learners, so that they do not need to access multiple platforms, and to ensure that the learner identity can be verified. A constraint to address is our learners' long lesson hours, leading to poor attention especially at the end of a long day. In view of this, activities should be engaging to capture the learners' attention.

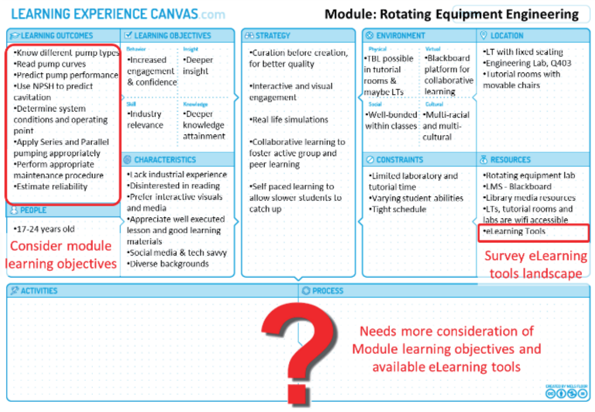


Figure 3 - Semi-completed LX Canvas

Step 2 : Listing of Broad Strategies

Arising from the considerations in Step 1, some broad strategies were listed. How these strategies address the considerations from the LX canvas is listed in Table 1.

Table 1 - Strategies to address LX canvas considerations

Broad strategies	Considerations addressed by strategy
Curation before creation, for better quality learning materials.	Learner persona: • Appreciate good learning materials Resources: • LMS (Blackboard) supports various curated media
Interactive and visual engagement	Learner persona: • Prefer interactive visuals and media
Real life simulation for in-depth learning	Learning objective: • Provide deeper insight • Provide industry relevance Learner persona: • Prefer interactive visuals and media • Lack industrial experience
Collaborative learning to foster active peer learning	Learner persona: • Technically savvy, able to tap on collaborative learning apps Environment: • Tutorial groups of 20-25 pax supports collaborative learning Resources: • LMS (Blackboard) supports collaborative learning
Self-paced on-line learning to cater to different learning abilities and speed of students	Learner persona: • Diverse learner abilities Constraints: • Tight schedule during instructional hours

Step 3 : Planning of Activities & Processes

After considering all influencing factors (Step 1) and determining the strategies (Step 2), the canvas leads us to plan the activities and process in this third and last step. In order to arrive at the detailed activities, more input with regards to the available technology as well as the module objectives was needed. These 2 additional input areas were further explored and are discussed in the next two sections.

2. Research on Technology-Aided Learning

Learning Technology Landscape Review : The wide range of technology-aided learning activities available makes it necessary to review the eLearning landscape. Among the spectrum of activities summarised in Figure 4, the activities within the red box are the relevant ones considered in the following discussion. These include video, collaborative and augemented reality tools.

Understanding the features and limitations of each learning technology is important to choosing the right types of activities to fulfil the different module learning objectives.

The following summarises the key highlights of some of these useful learning technologies.

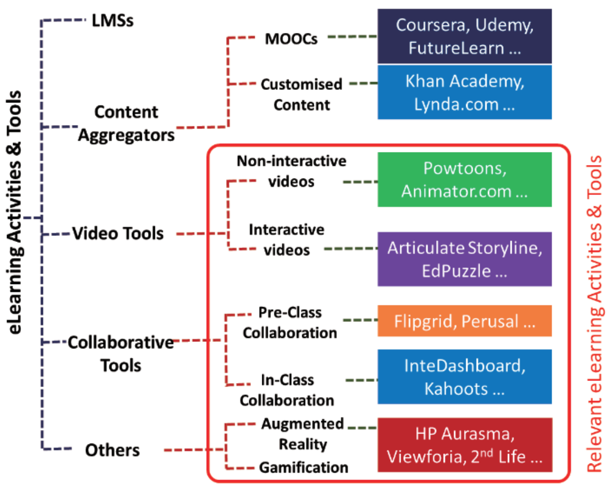


Figure 4 - Learning technology landscape

Video Tools

Videos facilitate deep learning as they allow learners to view a visual explanation of a concept, which may be difficult to explain using pictures. Videos also permit self-paced learning and interactivity. Insertion of comments and quizzes at appropriate timings allows correction of misconception and provides formative assessment. Careful curation of relevant free-to-use videos leads to an increase in quality of eLearning materials. 'EDpuzzle' is an online application that was used to embed videos from existing libraries of good quality educational videos into the LMS. Comments and quizzes were inserted to further contextualise the video delivery. Where relevant videos could not be found online, customised videos were created. 'Articulate Storyline' was used to create interactive videos while 'Powtoons' was used for creation of animated videos.

Collaborative Tools
Collaboration is an important 21st century skills for our learners, and can be supported by technology, through activities that are conducted either online or face-to-face in a classroom. Two online collaboration applications used in this module are 'Perusall' and 'Flipgrid'. 'Perusall' is a collaborative e-book that encourages pre-class reading by turning it into a social activity. Learners read from the online platform and may annotate, comment or ask questions anywhere in the document. Learners benefit from reading and commenting on their peers' interaction with the document. 'Flipgrid' is a media uploading platform that allows learners to share photos and videos of relevant topics, as specified by the instructor. This was used as an introductory activity to encourage learners' participation. 'InteDashboard' is an in-class collaboration tool used in this module. This application facilitated deep learning through individual and team quizzes, followed by an application question that was attempted collaboratively.

Visually Immersive Tools
Youths are naturally lured to visually immersive experiences like Virtual Reality (VR) and Augmented Reality (AR). Besides appealing to their interest, incorporating such visual experiences also adds depth to their learning, helping them visualise equipment and scenarios that are difficult to imagine.

Criteria for Quality in eLearning: With the myriad of eLearning tools, it is necessary to consider these tools against the criteria for quality eLearning, as referenced from current literature. The following presents the findings of recent international research and guidelines.

In the academic paper " eLearning quality : Scale development and validation in Indian context" (Arun Kumar & Deepali, 1999), learners' perspective of qualities of good eLearning is investigated. To the learners, important factors influencing quality of eLearning include collaboration among peers and knowledge sharing, among others.

In "A Guide to Quality in Online Learning" (Uvalic-Trumbic & Sir John, 2012), a set of guidelines published by Academic Partnerships, it was mentioned that the use of different media in online learning catered to the different learning styles of learners. This is important given the diversity among our learners.

In the journal article "Quality in e-Learning, the learner as a key quality assurance category" (Ulf Daniel, 2001), the author combined all important factors of quality assurance measures to arrive at the 'Subjective Quality Model'. This model states the important factors influencing quality in eLearning as communication, cooperation and technology, among others.

Summarizing the literature presented, quality eLearning resources are **interactive**, **contextual**, provide **self-paced learning**, encourages **collaboration**, provides **instant feedback** to **formative assessment** and **varied in modes** to cater to different learning styles.

Based on this criteria, the eLearning activities listed in Table 2 are checked against the quality criteria. In the same table, the broad strategies arrived at by using the LX Canvas are referenced to confirm their relevance.

3. Mapping of Blended Learning Activities to Module Learning Outcomes

To ensure that the selected activities complement each other and do not overwhelm learners with too much technological engagement, it is good to have an overall view of how all the activities will be implemented.

A 'Blended Learning Map' was used to lay out all intended activities and consider them against the module objectives. The purpose of this mapping exercise was to ensure a variety of activities were utilised for the appropriate module objectives, across different topics. The percentage of time spent using different teaching modes (e.g. pre-class, F2F or assessment) is also tracked.

Mapping of the activities to the module topics helped in visualising the flow of activities as the module progresses through the semester, to facilitate the planning and scaffolding of learning. The completed 'Blended Learning Map' is shown in Table 3.

When mapping the activities to the learning objectives, the following were considered:

a. To maintain a variety of blended learning activities across topics.
b. To ensure good distribution of pre-, post- and in-class activities.

Delivery of Blended Lesson and Results

This blended learning plan was implemented from the second semester of 2017, for an average class size of 75 second year students studying for a diploma in chemical engineering. The result was a learner-centric blended learning experience that included a variety of good quality eLearning activities targeted at fulfilling the learner's needs and learning objectives.

Videos to Support Flipped-Learning: 'EDpuzzle' was used to curate videos that explained pump hydraulics concepts well. The built-in features for cropping and adding of subtitles and quizzes were helpful in making the videos more relevant to the students. The videos were embedded in Blackboard to allow students to view them from a familiar platform (Figure 5).

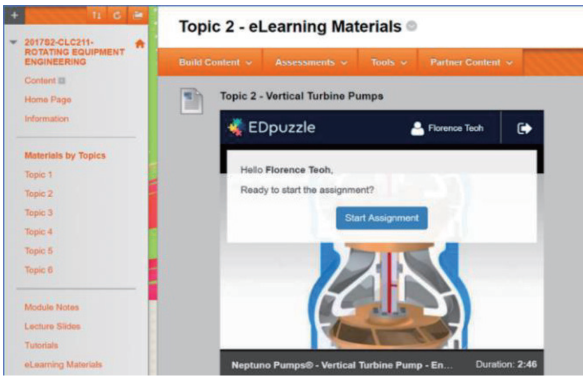


Figure 5 - Embedding of 'EDpuzzle' video in Blackboard

Table 2 - Strategies to address learner experience design considerations

TECHNOLOGY ASSISTED LEARNING ACTIVITIES	CRITERIA FOR QUALITY IN ELEARNING						BROAD STRATEGIES TO ADDRESS LEARNER EXPERIENCE DESIGN CONSIDERATIONS				
	Interactive	Contextual	Self-paced	Collaboration	Feedback	Assessment	1. Curation for better quality learning 2. materials	3. Interactive and visual for better engagement	4. Real life simulation for in-depth learning	5. Collaborative learning to foster active peer learning	6. Self-paced learning to cater to different learning abilities of students
VIDEO TOOLS											
Curated videos:											
EDpuzzle	✓	✓	✓		✓	✓	Curated videos from good quality libraries	Inserted comments add context. Quizzes test understanding			Self-paced viewing of videos
Customized videos:											
Articulate Storyline	✓	✓	✓		✓	✓		Customized interactions. Quizzes test understanding			Self-paced viewing of videos
Powtoons		✓	✓					Animated video			Self-paced viewing of videos
COLLABORATIVE TOOLS											
In-class activities:											
InteDashboard		✓	✓	✓	✓	✓				Team application question & quiz	Self-paced individual quiz
Pre-class activities:											
Flipgrid	✓	✓	✓	✓				Viewing of peers' videos		Sharing of videos & comments	Self-paced uploading of videos
Perusall	✓	✓	✓	✓	✓	✓		Interactive reading platform, permits annotations & comments		Learning from peers' annotations & comments	Self-paced reading
AUGMENTED REALITY											
HP Reveal	✓	✓	✓				Curated videos as overlays		Allows viewing of equipment interior & repeated viewing of worked solutions	Possible tool for gamification and collaborative learning	Self-paced viewing of ARs

Table 3 - Mapping of Learning Activities to Learning Outcomes

BLENDED LEARNING PLAN
MODULE : CLC211 & CLG211

WEEK NO.	TOPIC	MODULE LEARNING OUTCOMES	eLEARNING COMPONENTS								
			PRE / POST CLASS eLEARNING			IN CLASS (F2F) eASSISTED ACTIVITIES			eASSESSMENTS		
			Activity	Hrs	eLearning Tool / Comments	Activity	Hrs	eTool / Comments	Activity	Hrs	eTool / Comments
1	Topic 1 : Rotating Equipment Introduction	1) Define terminology used in hydraulics. 2) Define static head, velocity head and head loss due to friction. 3) Calculate friction head using Darcy Equation.	Interactive Video	2	**Articulate Storyline 2:** interactive video + quizzes						
									BB Quiz #1	0.33	**Blackboard**, self paced individual quiz with immediate feedback
2		Describe the different types of rotating equipment.	Video Sharing	0.5	**Flipgrid** : Video sharing platform						
						In-Class Quiz	0.25	**Kahoots**: 5 quiz questions			
2	Topic 2 : Centrifugal Pu	1) Define basic operating principle of centrifugal pump and its nomenclature. 2) Explain function of seals in centrifugal pumps.							BB eQuiz #2	0.33	**Blackboard**, self paced individual quiz with immediate feedback
3			Interactive Video	0.75	**Articulate Storyline 2**: interactive video + quizzes						
			Curated Video	0.15	**Edpuzzle**: edited videos + quizzes						
						In-Class Quiz	0.25	**Kahoots**: 5 quiz questions			
4	Topic 3 : Centrifgual Pump Performance & Vairables	1) Employ the various types of curves in selection of pumps 2) Identify the parameters affecting the pump performance. 3) Apply the affinity laws to predict pump performance. 4) Recognise the variable components in a system curve. 5) Determine safe pump operation parameters using NPSH calculation.	Animated Video	1	**Powtoons** animation with demonstration on reading of pump curves						
4									BB eQuiz #3	0.33	**Blackboard**, self paced individual quiz with immediate feedback
5			Curated Video	0.15	**Edpuzzle**: edited videos + quizzes						
			Curated Video	1	**Blackboard** videos + quizzes						
						In-Class Quiz	0.25	**Kahoots**: 5 quiz questions			
									BB eQuiz #4	0.33	**Blackboard**, self paced individual quiz with immediate feedback
6	Topic 4 : PD Pumps & REE Accessories	1) Explain function of PD pump and its application. 2) Demonstrate importance of mechanical seals functionality. 3) Differentiate different types of mechanical seal designs.	Interactive Video	1	**Articulate Storyline 2** interactive video + quizzes						
			Pre-Class Reading	0.5	**Perusall** Collaborative reading	Team Based Learning	1.5	**Blackboard + MS Excel**			
7			Curated Video	1	**Edpuzzle**: edited videos with tailored quizzes						
						In-Class Quiz	0.25	**Kahoots:** 5 quiz questions			
8		1) Discuss the various types of couplings used in the industry. 2) State the implications of misalignment. 3) Various types of mixer entry design arrangements used in the industry.							BB eQuiz #5	0.33	**Blackboard**, self paced individual quiz with immediate feedback
13	Topic 5 : Air Compressor	1) State the basic thermodynamic principles involving the gas laws 2) Classify the various type of compressors used in industry by design.							BB eQuiz #6	0.33	**Blackboard**, self paced individual quiz with immediate feedback
14			Curated Video	1	**Office Mix**: videos + quizzes						
									BB eQuiz #7	0.33	**Blackboard**, self paced individual quiz with immediate feedback
						In-Class Quiz	0.25	**Kahoots**: 5 quiz questions			
15	Topic 6 : Maintenance & Reliability	1) Discuss various types of maintenance programs used in industries. 2) Define terminologies used in equipment reliability. 3) Understand causes of rotating equipment failures.	Pre-Class Reading	0.5	**Perusall** Collaborative reading	Team Based Learning	1.5	**Blackboard + MS Excel**			
15									BB eQuiz #8	0.33	**Blackboard**, self paced individual quiz with immediate feedback
16		Demonstrate the importance of various piping plans used in the industry to improve on mechanical seal reliability.				AR Lab	1	Aurasma, identification of Mechanical Seal Piping Plans			
16		1) Capturing vibration data for reliability programs. 2) Terminology used in vibration analysis 3) Vibration measuring techniques. 4) Troubleshoot possible causes of vibration. 5) Prepare technical report summarising vibration data and discussing causes of vibration measurement inaccuracy.				In-Class Quiz	0.25	**Kahoots:** 5 quiz questions	BB eQuiz #9	0.33	**Blackboard**, self paced individual quiz with immediate feedback
Total Blended Learning Hours = 18 hrs				**9.6**			**6**			**3**	

'Articulate Storyline' was used to create four interactive video lessons (**Error! Reference source not found.** 6). These lessons permit the students to interact through sliders and drag-and-drop functions. Students can manage their own learning pace and direction through content markers at the top, bottom or side of the video. Quizzes were also inserted to check the students' learning.

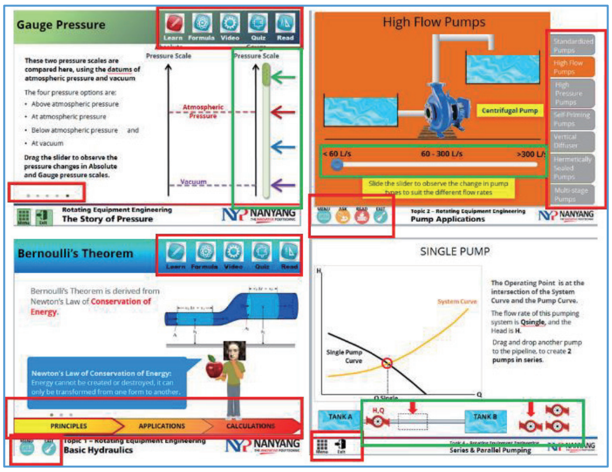


Figure 6 - Interactive 'Articulate Storyline' videos

Collaborative Activities to Promote Peer Learning: 'Perusall' was used to encourage reading of technical documents that students would usually find too boring to read. Students made comments and asked questions, which were viewed by their peers. Through this social reading platform, students were encouraged to read and learn collaboratively (Figure 7). 'InteDashboard' was used to facilitate collaborative. Students took a quiz related to a topic individually at first, then as a group. The responses were recorded using this application (Figure 88), which showed the number of attempts and wrong answers before arriving at the correct answers. This facilitated the identification of students with misconceptions and enabled immediate correction.

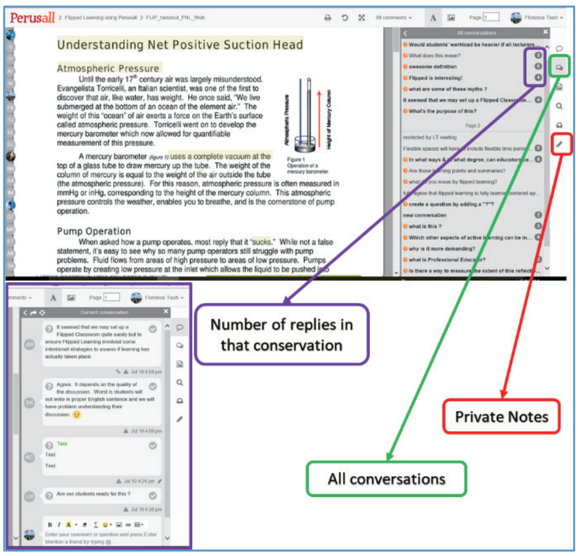


Figure 7 - Use of 'Perusall' app to encourage reading

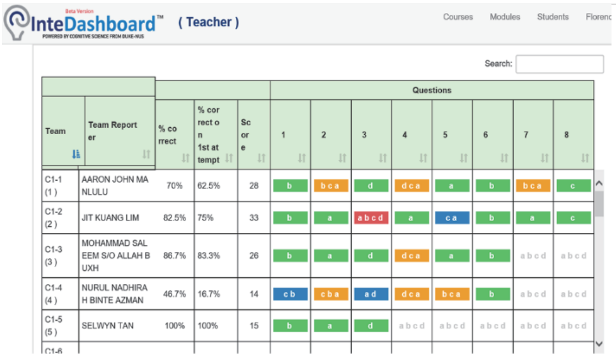


Figure 8 - Summary of students' answers on 'InteDashboard'

AR to Enhance Immersive Experience: An AR app, 'HP Reveal', was used to create media overlays to explain concepts that would otherwise be difficult to describe. The use of AR permitted students to view a repeated visual explanation of how a fluid's vapour pressure can be determined. Students accessed this video by simply scanning the picture of the vapour pressure curve with the 'HP Reveal' app on their mobile phones. This manner of accessing answers is intuitive and visually appealing (Figure 9).

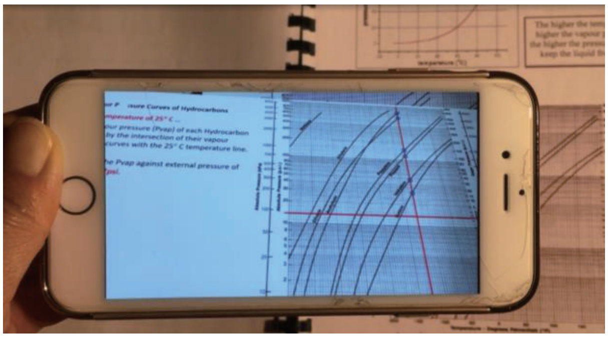


Figure 9 - AR app used to explain fluid vapor pressure

Effect on Students' Academic Results: The blended learning plan was implemented from the second semester of 2017 (2017-S2). Students' results over the 3 semesters before and 3 semesters after blended learning implementation are shown in Figure 10. An analysis of variance (ANOVA) was performed to determine the statistical significance of differences in results, before and after blended learning implementation (Table 4).

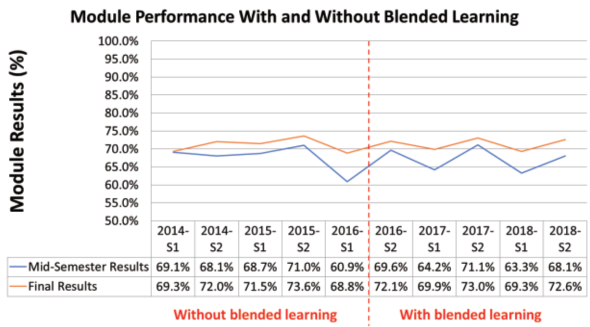


Figure 10 - Module Performance from 2016-S1 to 2018-S2

There is an increase in both the mid-semester results, from an average of 64.9% to 67.5%, as well as the final results, from 70.3% to 71.6%, after blended learning was implemented (Table 4). However, as the ANOVA p-value is larger than the significance level of 0.05 used for testing, it is concluded that the apparent increase in results is not statistically significant. A more representative analysis would be conducted after results from more semesters are available.

Table 4 - Statistical Analysis of Students' Results

Comparison of Mid-Semester Results

	Without blended learning			With blended learning		
Semester	2016-S1	2016-S2	2017-S1	2017-S2	2018-S1	2018-S2
Mid-semester results	60.9%	69.6%	64.2%	71.1%	63.3%	68.1%
Average	64.9%			67.5%		
Std Deviation	4.4%			3.9%		
Anlaysis of Variance (ANOVA):	p-value =	0.4876				

Comparison of Final Results

	Without blended learning			With blended learning		
Semester	2016-S1	2016-S2	2017-S1	2017-S2	2018-S1	2018-S2
Final Results	68.8%	72.1%	69.9%	73.0%	69.3%	72.6%
Average	70.3%			71.6%		
Std Deviation	1.7%			2.0%		
Anlaysis of Variance (ANOVA):	p-value =	0.4199				

Effect on Students' Engagement: Feedback gathered from the first batch of students are shown in Figure 11. Using the percentage of students who rated activities as 'Useful' or 'Very Useful' for their learning as the criteria to judge the activity's effectiveness, it can be seen that quizzes are the most highly rated activities, with a 90% rating. Videos were also favoured among students, with a 91% rating for curated videos and 85% for 'Articulate Storyline' videos. By the same rating criteria, collaborative activities like 'Perusall' and 'InteDashboard' were rated 76% and 82% respectively, while augmented reality activities received an average rating of 75%. Overall, 86% of students rated the activities as beneficial to their learning.

Students commented that the activities helped them remember concepts, made lessons fun and the interaction within groups helped deepen their learning. These are evidence that the activities improved students' understanding of the topics and increased engagement.

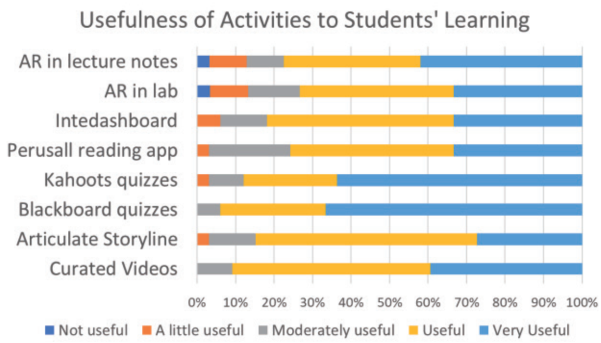


Figure 11 - Student's feedback on blended learning activities

Conclusions

A blended learning plan entails many considerations, with the three key factors being the Learners, the eLearning Resources and the Module Objectives. In the creation of a blended learning plan for a rotating equipment engineering module, the learners' needs were considered first, to arrive at a broad set of strategies that address the learners' needs. The eLearning resources were then considered to arrive at a list of blended learning activities that meet ascertained quality criteria. These activities were mapped to the module's learning objectives to ensure proper flow, scaffolding and matching of activities to learning objectives.

The blended learning plan was implemented since the second semester of 2017. Although the increase in students' academic performance was not statistically significant, the students' feedback showed that the blended learning implementation increased their understanding of the module.

References

Arun Kumar, A., & Deepali, S. (1999). e-Learning quality : Scale development and validation in Indian context. *Knowledge Management & E-Learning : An International Journal*, *4*(4), 500–517.

Floor, N. (2007). Learning Experience Canvas.com.

Floor, N. (2015). Five critical questions.

Garrison, D. R., & Kanuka, H. (2004). Blended learning : Uncovering its transformative potential in higher education. *The Internet and Higher Education*, *7*, 95–105. https://doi.org/10.1016/j.iheduc.2004.02.001

Soloway, E., Guzdial, M., & Hay, K. E. (1994). Learner-Centered Design, The Challenge For HCI In The 21st Century. *Interactions*, 36–44.

Ulf Daniel, E. (2001). Quality in E-learning, the learner as a key quality assurance category. *Vocational Training, European Journal*, (29), 3–15.

Uvalic-Trumbic, S., & Sir John, D. (2012). A Guide to Quality in Online Learning. *Academic Partnerships*.

Creativity experiment incorporating organic light emitting diode fabrication

T Morimune[*,a], K. Fukuda[b] and H. Murakami [b]

[a] Department of Electronic Systems Engineering, National Institute of Technology Kagawa College, Mitoyo, Japan
[b] Technical Education Support Center, National Institute of Technology Kagawa College, Mitoyo, Japan

*E-Mail morimune@es.kagawa-nct.ac.jp

Abstract

The study of electronic component design is indispensable to the engineer education of electronic engineering. In this experiment, even beginners who have not manufactured electronic devices can learn the basics of device manufacturing methods by manufacturing organic devices with simple manufacturing methods and device structures. We also demonstrate that you can cultivate not only theoretical information such as device structure and process but also practical ability such as problem solving ability, planning ability and ability to execute plan through original work making did.

Keywords: *OLED, Education for electronic device, Original work*

Introduction

For students majoring in electronic engineering, it is important to experience the fabrication of electronic devices in order to enhance the understanding and motivation for learning. However, in student experiments based on the conventional method of preparing pre-prepared text, there is no room for incorporating the student's own ideas because the route to the experimental results is decided, and it is felt that it is difficult to convey the fun of manufacturing it has. In addition, in the "thin film circuit" implemented as one theme of the 5th grade experiment in this subject, by incorporating lithography technology and etching technology learned in the lecture, students can clearly understand the learning content by actually experiencing it, and so on. Although there were many time and equipment constraints, there was little room for students to adopt their own ideas. In addition, in the "thin film circuit" implemented as one theme of the 5th grade experiment in this subject, by incorporating lithography technology and etching technology learned in the lecture, students can clearly understand the learning content by actually experiencing it, and so on. Although there were many time and equipment constraints, there was little room for students to adopt their own ideas. Therefore, we planned to introduce this experiment as one theme of the semiannual 15-week 4th grader seminar that has been implemented since 2015

The purpose of this experiment was to fabricate students' original devices using organic devices with short fabrication time and simple structure, which was a problem in conventional semiconductor device fabrication. Among organic devices, organic EL devices, in particular, are sold as a new generation of flat panel displays, and are one of the electronic devices of interest to students. In addition, although characteristic measurement experiments of transistors and solar cells are performed as typical electronic devices, in our experiment, it is possible to intuitively feel the joy when it is produced and operated by making the organic EL by itself. Moreover, in this experiment, it is set to work according to the procedure of 1 task setting, 2 design specifications, 3 designs according to plans, 4 operations verification, 5 each document preparation, and in each operation, I hoped that they could develop the planning ability, the ability to find a solution, the ability to plan and implement continuously, the ability to communicate, problem solving and problem finding, writing ability, presentation ability etc. under constraint conditions. Experiment first plan the final form and use of products using organic devices by brainstorming method (task setting), and submit work schedule and outline design sheet to train more practical plan execution ability we did it. At the beginning of the experiment, the brainstorming method is used to plan the final form and usage of the product using organic devices (task setting), and the work schedule and outline design sheet are submitted to train more practical plan execution ability. It was made to do. Also, after approval of the detailed design sheet and the production sheet, the experiment was started. The contents of work are continuously recorded in the work log, and corrections and redesigns can be made continuously by receiving indications at the time of reporting to the teachers. In this report, we will report the details of the 4th grader seminar classes we have conducted and the usefulness of this experiment.

About organic Light-Emitting-Diode (OLED)

The organic light emitting diode (OLED) is considered to be most suitable for imaging of electronic devices because it has a relatively simple fabrication method and a simple element structure compared to conventional LEDs and fluorescent lamps.

It has a structure in which one or more organic thin films are sandwiched between two electrodes, and the film thickness is about 100 nm. When a voltage is applied, charges (electrons and holes) are respectively injected from both electrodes into the organic layer, and light is emitted by recombining. The types of materials used in OLED are roughly classified into low molecular weight materials and high molecular weight materials, and the former is generally deposited by heating and deposition in vacuum, and the latter is applied by dissolving in a solution and applying it. It can be fabricated. In this experiment, students themselves decided on the existing deposition equipment and manufacturing equipment such as the spin coater apparatus, the manufacturing method, etc. according to the purpose. Moreover, the light emission at the time of voltage application was performed visually by operation confirmation.

Work content and acquisition ability

This experiment was conducted for the fourth grader in technical college, and was conducted for a total of 60 hours, 4 hours / week. A major feature of this experiment is that students can plan and design everything from final product specifications to production methods without text, by incorporating their own ideas and opinions. The amount of money that students can use is up to 30,000 yen, so they can purchase goods through the teacher. Two or three people came together and set themselves to think about the theme and think about their favorite products. Two or three people interested in electronic devices became one set, and they set themselves to think about themes and think about their favorite products. Table 1 summarizes the capabilities obtained outside of the knowledge on electronic device fabrication through the work of this experiment. First of all, it was thought that it was possible to cultivate the planning ability of product development by planning the product development and the schedule management of the whole experiment by setting the problem of the experiment what kind of product the students themselves should make. In addition, I thought that they could learn the ability to find a solution under the conditions, considering the constraints that occur when they make the actual product by creating the design specifications of the product. Furthermore, work is performed according to the schedule plan, but it is necessary to change the schedule, for example, when an unexpected problem occurs during the work. In that case, by continuously replanning, we will solve the problem while always grasping the schedule until the final product can be produced. Through this, we expected to learn the ability to plan and carry out the work continuously and the communication ability. Also, in this experiment, it was obliged to submit reports divided into stages as shown in Table 2 according to the progress of the experiment.

Table 1 Work Content and Acquisition Ability

Work content	Ability to learn
Assignment settings, Schedule creation	Planning ability
Design specification	Ability to find a solution under constraints
Work according to plan	Ability to continuously plan and perform work communication ability
Operation verification	Problem finding, problem solving
Create a document	Writing ability, Presentation ability

Table 2 Various work sheets submitted according to the progress of the experiment

Work sheet	Purpose and contents of entry
Planning sheet	Do the whole scheduling. Fill in the image of the finished product and the constraints to make it.
Outline design sheet	Make a rough design of the finished product.
Detailed design sheet	We will design in more detail and more specifically than the outline design.
Production sheet	Mainly record at the time of creation.
Operation verification sheet	Record the operating status and characteristics of the product.
Problem consideration sheet	If there is a malfunction or failure, the problem occurs failure in any cause summarizes the estimate you are, summarized how the of whether the measures and the results can be solved if.
Final report sheet	Report the final product results.

By preparing these documents, it is possible to create design specifications, predict problems, and make an image of the final product in accordance with the instructor's indications and requests. The experiment report was made every hour to the instructor in charge, and they received comments and suggestions.

Example of experiment

Table 3 shows the experimental themes conducted from 2015 to 2018. These are all the themes of making

OLED, but the points to devise in order to make an original work in each age were largely different. Figures 1 show an example of OLED design in 2015. First, the planning image as shown in Figure 1 was used to write the outline of the completed image, the outline of the product, and the constraints. In 2015, it is a flow to first make a simple surface emitting device and finally make a device in the form of a school badge mark.

Table 3 Experimental themes of each age

year	Experimental theme
2015	Bright school badge by OLED
2016	Matrix LED by OLED
2017	Flexible OLED device
2018	Portable OLED business card

Figure 1 Diagram of planning (2015 example)

Table 4 Summary sheet of constraints during planning (2015 example)

~Constraint condition~ The organic EL device emits light. Display the school emblem mark of Kagawa National College of Technology The intensity of the light emission is such. that it looks clean in the dark room. Drive voltage is undecided. Perform with single color light emission.. Use existing production equipment.. Necessary items within 30,000 yen.
~Main tools and parts~. Organic materials (existing products). ITO substrate (existing product). Tungsten board (existing product). Electrode material (existing product). Resist (existing product). Organic solvent for washing.
~Work content~ Study about OLED. Investigate the production method. Ordering of necessary materials. Device fabrication. Operation check. Examination and improvement of problems Repeat the preparation and evaluation again Challenge to light emission in the form of design.

Table 5 Experiment schedule table created by students

	Month	Day	Schedule
1	Oct.	8	Rough design, study of OLED
2		15	Study of OLED
3		22	Study of OLED
4		29	Study of fabrication method
5	Nov.	5	Interim report
6	Nov.	12	Fabrication of OLED
7		19	Study of fabrication
8		26	Fabrication of OLED1 and confirmation of luminnecence
9	Dec.	3	↓
10		10	
11		17	Fabrication of OLED2 and confirmation of luminnecence
12		24	↓
13	Jan.	7	
14		14	Fabrication of OLED3 and confirmation of luminnecence
15		21	↓
16		28	Check problem consideration sheet
17	Feb.	4	Operation verification
18		11	Preparation of presentation
19		18	Presentation
20		25	Preparation day

Table 4 shows an outline explanation of the planning sheet and constraints. Here, a feasible plan such as a drive voltage, a luminescent color, a size of an element, a shape, etc. will be made specific. Table 5 is an example of a planned schedule created by a student. By thinking about the schedule from the study of OLED to the actual fabrication of the device and the announcement, it is made to think about what kind of knowledge, experimental equipment, articles, etc. are necessary for the purpose.

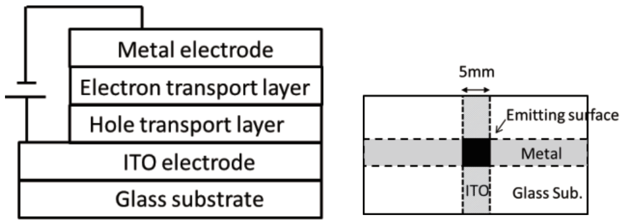
Design project

After the schedule was decided, the design items necessary at the time of production were summarized, and specific drawings were produced. Figure 2 (a) and (b) shows a design example for the 2015 student. First, we will make an OLED device with a simple laminated structure, and then investigate how to use a resist as an insulating film, and think about forming the design of the school badge stepwise. By drawing the cross-sectional view of such an electronic device according to the manufacturing procedure, it is possible to recognize what kind of work is required in actual experiments, so it is possible to understand the explanation during the experiment smoothly.

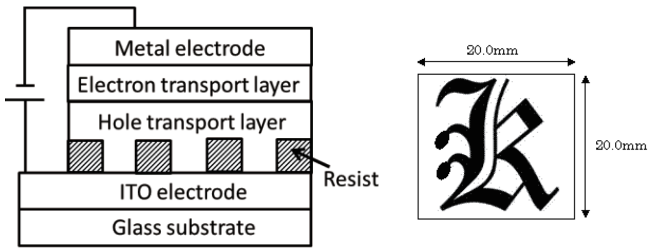
Operation check

In this section, we will describe the results of making the designed element and confirming its operation, and an example of consideration considered by the student. In the first fabrication, fabrication was attempted by changing the film thickness of the resist. It became a light emission surface as shown to Fig.3 (a).

The light emitting surface looks like a collection of point lights. As a result of comparing the film thickness of the resist using two types of 700 nm and 1000 nm, the light of 1000 nm was clearly emitted in a designed form. In the second time, the thickness of the resist was set to 1000 nm, and an attempt was made to reduce the patterning time. As a result, all the produced organic EL did not emit light. It was because the anode and the cathode were conducting. The third was carefully made while considering the time for patterning again. As shown in Fig. 3 (b), a clear contour and surface light emission were obtained, and the dark spots at the first time were reduced.

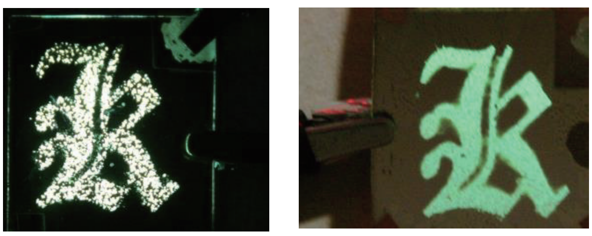


(a) Device structure of OLED using only ITO etching



(b) Device structure of pattered OLED using a resist

Figure 2 Design of OLEDs



(a) First time (b) Third time

Figure 3 Comparison of OLED at the time of operation check

Cause estimation and problem solving

The problem was clarified at the time of operation check, and the cause estimation and the solution method were discussed. We hoped that this would lead to the acquisition of problem solving skills. Here, an example is given of the fact that the above-mentioned 2015 pattern of the luminous design of the school emblem could not be cleaned.

Cause estimation 1: Isn't the difference in film thickness affecting the exposure time?
Measures: It is necessary to change the exposure time according to the difference in film thickness.
Result: At 1000 nm used this time, the shape of the design was clearly shown by setting the exposure time to 4 minutes.

Cause estimation 2: The difference in film thickness may have an influence on development time?
Measures: It is necessary to change the development time according to the difference in film thickness.
Result: The thinner the film, the faster it is developed, and the smaller part is developed to the point where it should not be developed, which affects the shape of the design. Therefore, if it is about 1000 nm, the fine part is also firmly patterned.

By repeating the experiment considering the measures considered to be the cause estimation as described above, I was able to learn the solution method of the problem that the failure is occurring.

Evaluation method

In this experiment, students were evaluated for achievement for the following abilities 1 to 7.

1. Planning ability
2. Ability to find a solution under constraints
3. Ability to continuously plan and implement
4. Communication skills
5. Problem Solving and Problem Finding Ability
6. Writing ability
7. Presentation ability

The degree of achievement was assessed using various sheets, production log diaries, work reports, and presentation evaluation sheets for presentations on the degree of acquisition of these abilities. The degree of achievement of each ability was decided by the instructor who decided the inspection item and participated in the presentation and the instructor in charge of the experiment. In addition, the score of each ability of 1 to 5 and 7 is divided into five stages of very good: 5, good: 4, nomal:3, slightly bad: 2, bad: 1. Only the sentence preparation ability of 6 was evaluated by 100 full marks. Next, the method for evaluating the degree of achievement of each ability will be specifically described. The degree of achievement of the planning ability was evaluated by checking whether the description of items, period, constraints and price of the plan is in the outline design sheet and the planning sheet. The ability to find a solution under constraint conditions was evaluated on the problem consideration sheet whether the problem could be solved under various constraints such as time and price. The achievement items of the ability to plan and implement on a continuous basis were checked and evaluated in the production record diary as to whether or not there was a record that was regularly worked, as whether they worked tirelessly. In addition, as specifics of the evaluation, "Is it working with interest?", "Does the plan be reconsidered according to the work situation?", And "Is it tackling until it achieves?" The achievement items of the communication ability were assigned to share roles and to work together. It is decided that there is a description of the division of roles as an inspection item for that purpose, and it is working in cooperation. The planning sheet and the work report should be left as the basis data for the achievement evaluation. The leader checked and evaluated. Problem solving and problem finding ability were evaluated as to whether problems could be found in the operation verification sheet. The writing ability was evaluated on a 100-point scale whether the problem was understood in the introductory part of the report and whether the method and content of the problem solution could be properly written in this paper. The presentation ability was evaluated by the size of the voice and the ease of understanding whether the presentation time and the question-and-answer session were possible at the presentation about the finished product.

Results and discussion

The evaluation results from 2015 to 2018 are summarized in Fig.7.

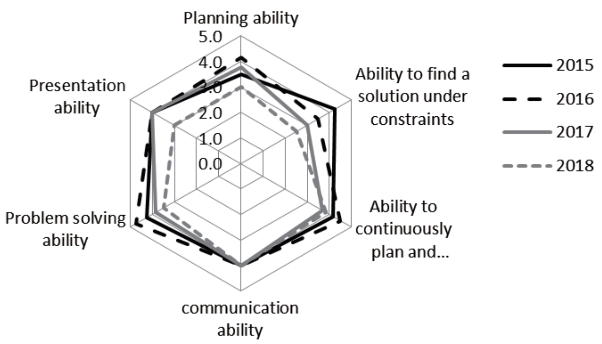


Figure 7 Result of student's achievement evaluation by instructor

From the figure, the average for each year of the target ability was 3.6 points out of 5 points, the ability to find a solution under constraint conditions 3.3 points, the ability to continuously plan and implement 4.0 points, the communication ability 4.0 points , It can be said that the problem solving and problem finding ability 4.1 points and the presentation ability 3.8 points were generally acquired. In addition, the average score of the writing ability was 81 points. Among the evaluations, the ability to plan and carry out continuously was the highest, and the characteristic of this experiment appeared to be able to go through to the end while revising the plan without giving up, which is the most important ability in practice.

Questionnaire results

The impressions of the students who conducted this experiment are summarized below.

- We experimented many times, and we felt a sense of accomplishment because we finally made a glowing element.
- I felt the load at the busy time just before job hunting, but I was able to work on the goal positively.
- I learned how to make electronic parts.
- When I checked the luminescence after making it, I was happy because it was glowing.
- As a result of advancing the experiment from the condition selection, it became possible to emit surface light instead of linear light. It was interesting because we could light up their school badges with OLED. I also felt that the size was bigger than I had thought.

Summary

In this report, we introduced the approach that incorporates the manufacturing of OLED devices of the 4th grader in technical college. In the process of producing students' original OLED devices and applied products using OLED, it was possible to make more practical experiments by solving problems from planning to product development under constraints.

The results of the student questionnaire showed that the students felt a sense of achievement, and that they were able to work positively toward the goal. Also, as a result of evaluating the degree of achievement for each ability, we have learned about all the abilities, and based on these results, we believe that this experiment is useful as a special experiment in Kosen.

References

C. W. Tang & S. A. Van Slyke (1987). Organic electroluminescent diodes. Appl. Phys. Lett., 51, 913-915.

J. H. Burroughes, D. D. C. Bradley, A. R. Brown, R. M. Marks, K. Mackay, R. H. Friend, P. L. Burns, and A. B. Holmes & A. B. Holmes (1990). Light-emitting diodes based on conjugated polymers. Nature, 347, 539-541.

Y. Ohmori, N. Tada, H. Ueta, T. Sawatani, A. Fuji & K. Yoshino (1998).Multicolor organic light emitting device with RGB emission. IEICE Trans. Electron., E81C, no.7, 1041-1044.

H. Kajii, K. Takahashi, Ju-Seung Kim & Y. Ohmori (2006).Study of Transient Electroluminescence Process Using Organic Light-Emitting Diode with Partial Doping Layer. Japan Journal of Applied Physics, 45, no.4B, 3721-3724.

An Innovative Micro-Learning Approach that Addresses Industry Knowledge and Workplace Relevancy for Individuals and Corporates

Noor Faridah A R, Zahiruddin A K M and Phua Kuan Hwee Paul

Temasek Polytechnic/Temasek SkillsFuture Academy, Singapore
Temasek Polytechnic/School of Engineering, Singapore
Temasek Polytechnic/Temasek SkillsFuture Academy, Singapore
faridah@tp.edu.sg
zahir@tp.edu.sg
paulp@tp.edu.sg

Abstract

In April 2018, Temasek Polytechnic (TP), in partnership with a micro-learning platform provider, Gnowbe, launched a massive effort to develop and offer every Singaporean and Permanent Resident one free Micro-Learning Course (MLC) from a library of 63 courses. This paper aims to highlight TP's strategic industry collaboration and micro-learning framework used to spearhead the delivery of a new learning pathway for both individuals and corporates. It elaborates on the critical success factors of this new learning pathway and how it supports the national SkillsFuture movement in Singapore. The project has seen significant take-up rate of over 16,000 MLC registrations since the launch. This paper also highlights the learning experience of the School of Engineering's MLC on "Human Factors in Aviation Maintenance", which aims to refresh the understanding of relationship optimization between aviation personnel and systems to improve safety, efficiency, and well-being at the workplace.

Keywords: *Temasek Polytechnic, Temasek SkillsFuture Academy, SkillsFuture, learning pathways, micro-learning, adult learners, continuing education and training, industry partnership, workplace relevancy, workplace learning*

Introduction

The future of learning is shaped by the rapid technological growth and the proliferation of mobile platforms, paving the new era of mobile first and bite-sized micro-learning. Because of this development, re-thinking about new ways of learning delivery is inevitable to cater to the growing need for busy professionals to stay connected and continuously learn to remain relevant in the industry. In response to this need, Temasek Polytechnic (TP), in partnership with a micro-learning platform provider, Gnowbe, launched a massive effort to offer every Singaporean and Permanent Resident, one free Micro-Learning Course (MLC) from a library of 63 MLCs. This is to encourage the public and working professionals to pursue lifelong learning anytime, anywhere and at their own pace. A detailed listing of the MLCs is provided in Annex 1.

Micro Learning

Micro-learning delivers content to learners in short and bite-sized topics in order to satisfy a specific learning outcome. For example, the MLC 'Motivation on the Move', which is a 4-hour module on the subject on 'motivation', is broken down into various smaller and easily digestible bite-sized mini-lessons known as "Sessions". Learners can complete each of the Sessions in just 10-15 minutes. Learners have the choice to learn what they need to learn. They can also better utilise their spare time by learning anytime and anywhere while commuting or in between tasks (Virvou & Alepis, 2005, as cited in Bruck, Motiwalla & Foerster, 2012). Given its flexibility and cost-effectiveness, micro-learning has been seen to be the new promising way of learning to meet the learning needs of busy working professionals who are expected to upgrade their skills quickly in today's fast-paced and competitive workplace environment (Bahrami, 2015; Bruck, Motiwalla & Foerster, 2012).

Workplace Learning and Work Relevancy

Workplace learning involves the continuous process of improving competence & performance of employees through acquisition of knowledge or skills by formal or informal learning that occurs in the workplace, which may lead to formal qualifications. Given the growing need for greater work relevancy and continuous skills upgrading of employees at the workplace, more and more computer and internet related technologies are required to support the workplace learning designs. This can take the forms of e-learning, mobile micro-learning and blended learning (Cacciattolo, 2015). Though micro-learning delivered on a mobile platform is seen as a promising solution to formulate learning pathways to facilitate career progressions and transitions, yet studies on these areas seem to be lacking. Hence, this paper will provide a new perspective to partly fill this gap.

Aim

This paper aims to highlight TP's strategic industry collaboration and micro-learning framework used to spearhead the delivery of a new learning pathway for both individuals and corporates. It elaborates on the critical success factors of this new learning pathway and how it supports the national SkillsFuture movement in Singapore. The project has seen significant take-up of over 16,000 MLC registrations since the launch in April 2018. In ensuring relevancy, some of the MLCs are also accredited, leading to exemptions in relevant modules offered in TP's part-time Continuing Education & Training (CET) programme.

This paper further discusses a case study centred on the learning experiences of adult learners from the School of Engineering. From this paper, it is hoped that educators, administrators and other organisational and corporate personnel who are interested to implement micro-learning courses into their training curriculum, may obtain helpful ideas to do so. At the same time, the team is also keen to explore possible collaborative projects with other organisations in this area.

Temasek Polytechnic's strategic industry collaboration and micro-learning framework

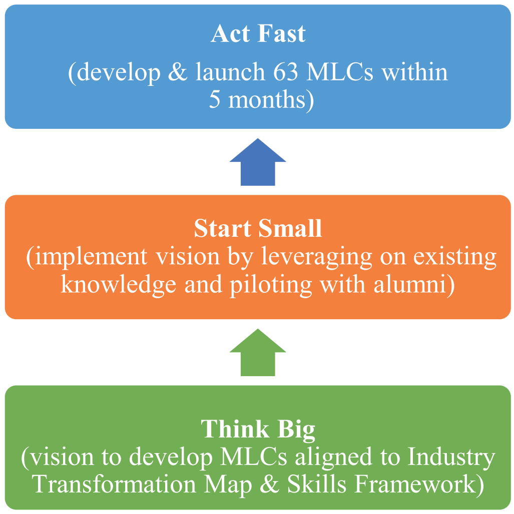
The provision of multiple pathways to success is a call-to-action by Singapore's current Minister for Education, Mr. Ong Ye Kung, as these learning pathways will be critical to drive a culture of innovation throughout the public sector. To do this, Mr Ong urged the public sector to 'think big, start small, act fast' (Yong, 2017). In response to this call-to-action, TP initiated its strategic industry collaboration and micro-learning framework, based on the 'think big, start small and act fast' approach.

The 'think big' strategy started with a vision of the future of learning that is mobile first, bite-sized, scalable and convenient for busy working professionals, individuals and corporates. This strategy involves re-thinking how to transform the future workforce in support of the national SkillsFuture movement and Singapore's journey as a Smart Nation. The intention is to develop and offer micro-learning courses that seek to align to the Industry Transformation Map (ITM) as envisaged by Singapore's Ministry of Industry (MTI) and the Skills Framework outlined by SkillsFuture Singapore (SSG).

This 'think big' vision was implemented using a 'start small' strategy, capitalizing on TPs' domain expertise on content knowledge. This domain knowledge spans across the six ITM clusters covering manufacturing, built environment, trade and connectivity, essential domestic services, modern services and lifestyle. It also spans across the eight categories of the Skills Framework, namely cybersecurity, advanced manufacturing, data analytics, digital media, entrepreneurship, financial services & governance, tech-enabled services and urban solutions (SkillsFuture Singapore and Workforce Singapore, 2018). The 'start small' strategy included collaborating with a short-listed micro-learning platform provider, Gnowbe, to pilot the development of two MLCs and testing them on a random sample of 342 TP's alumni.

Based on the positive feedback received from the pilot phase, the project was rolled-out on a bigger scale using the 'act fast' strategy. This involved the designing, development and launching of 63 standalone and accredited MLCs within 5 months from November 2017 to April 2018. These courses cover topics ranging from personal enrichment to professional development to equip the workforce with future-ready skills that are applicable in various industry sectors.

Figure 1: Temasek Polytechnic's strategic industry collaboration and micro-learning framework



Critical Success Factors of the Innovative Micro-Learning Strategy

Several critical success factors drive the innovative micro-learning strategy in spearheading the delivery of a brand new learning approach for both individuals and corporates.

Strategic Partnership

The strategic partnership with the micro-learning platform vendor, Gnowbe, is the first critical success factor, which propelled the re-skilling and up-skilling of the workforce to a new level. TP combines its strength in domain knowledge expertise across the various disciplines to develop the content of the micro-learning courses, with Gnowbe's state-of-the-art micro-learning platform. This strategic partnership has enabled the launch of 63 MLCs within just 5 months. Gnowbe's easy-to-use curation tool enables TP's domain content experts to curate the courses rapidly. Gnowbe's easy-to-use editorial tools is key in TP's decision-making process when shortlisting for the right partner to collaborate on this project as this reduces the learning curve and lowers the barrier for staff adoption and buy-in to the micro-learning project.

Another consideration is the time to market the MLCs to end-users through a simplified online purchase process. This is facilitated by Gnowbe's readily available online payment gateway, enabling the MLCs to be easily purchased by the public users via TP's and Gnowbe's websites.

Mind-set Change

The second critical success factor is the mind-set change amongst TP domain experts, which enables them to buy-in to design and develop the MLCs. Group training and on-going psycho-educational sessions were conducted to help the curators who are mainly the TP domain experts, to adopt an open and adaptive mind-set to design interactive and engaging MLCs into bite-sized learning format that are suitable for busy working professionals to learn. This is achieved by emphasising the need to identify key contents that are essential to meet the desired *learning outcome,* as compared to developing contents to meet the required *learning duration*.

When curators begin to understand this key emphasis, they readily bought-in to the new approach of micro-learning course design and development. This mind-set change has contributed towards an increased level of ownership amongst curators to produce quality MLCs in time for the launch, hence increasing the success rate of the project. Indeed, having the right mind-set is key for staff to adapt to technological change and embrace future skills such as using micro-learning to transform the landscape of teaching and learning of the workforce (Sim, 2017).

Accreditation

The offering of accredited MLCs is the third critical success factor in the innovative micro-learning framework. Accredited Suite Courses are groups of MLCs that have accreditation value leading to full or partial exemptions of selected modules offered under TP's Diploma or Post-Diploma programmes.

These accredited MLCs allow learners who do not meet minimum entry requirements, to be eligible to apply for selected TP's part-time Continuing Education & Training (CET) programme and offer learners exemption of relevant modules to the CET courses, through Recognition of Prior Learning (RPL). For example, learners who completed the suite of three MLCs under the Managing People Suite Courses will be eligible to apply to the part-time Diploma in Security & Fire Safety Studies or Diploma in Police & Security Studies and be exempted from taking a relevant module.

Marketing Strategy

The fourth critical success factor is the strategic marketing approach linked to Singapore's national SkillsFuture movement. Riding on and in support of the national SkillsFuture movement, a nation-wide publicity drive was carried out to offer a free MLC to every Singaporean for a specific time, thus encouraging the interest for public to sign up to this new way of learning.

Image 1: Launch of the Micro-Learning Courses in April 2018

The team has also sought approval from SSG to allow Singaporeans aged 25 and above to use their SkillsFuture credits to purchase the MLCs. This provided added incentive for Singaporeans to purchase the MLCs using SkillsFuture credits allocated by SSG to encourage life-long learning and skills up grading amongst the population. Together with numerous online and social media publicity campaigns, more than 10,000 MLC registrations were received during the initial launch in April 2018. This included not only those who signed up for the free MLC but also those who purchased additional MLCs.

Methodology

The methodology used in the pilot phase and case study is mainly qualitative in nature. Learners had completed an online survey within the MLCs and the analysis of the survey findings is reported in this paper.

Pilot Phase

During the pilot phase, 342 TP alumni were registered as learners to test two MLCs namely 'Industry 4.0' and 'Introduction to Cybersecurity'. They were selected randomly across different disciplines in the Polytechnic. Out of the 342 registered learners, 210 were active learners of the 2 MLCs.

Case study: Engineering Adult Learners

As an approved Maintenance Training Organisation (MTO) by the Civil Aviation Authority of Singapore (CAAS), TP delivers the subject Human Factors to students from Aerospace Engineering and Aerospace Electronics at the School of Engineering and offers the course to external organisations, including Rolls Royce (RR) and General Electric (GE) Singapore.

"Human Factors" is a compulsory training module under Singapore Airworthiness Requirement (SAR) Part 66 for personnel in the aviation industry including pilots, Air Traffic Controllers (ATC), Licensed Aircraft Engineers (LAE), instructors, assessors, examiners, and personnel responsible for quality and safety. All concerned personnel are also required to undertake the module as a refresher course every two years to maintain their Terms of Reference (TOR). According to the requirement of SAR Part 66, a TOR holder must attend a recurrent training on module M09 Human Factors every two years. This makes the MLC "Human Factors in Aviation Maintenance" a suitable and viable refresher-training course for this group of engineering adult learners to fulfil the TOR required in their profession.

The TP's School of Engineering adopts this new learning approach by endorsing staff TOR holders who missed the scheduled Human Factors' classroom training but completed the MLC "Human Factors in Aviation Maintenance", to have satisfied the SAR147 requirement of TOR. The MLC serves to refresh the understanding of optimizing the relationship between aviation personnel and systems to improve safety, efficiency, and well-being at the workplace.

The MLC has been designed using the model of interactive and practical bite-sized mobile learning. It has 17 Sessions and each Session is enhanced by different engaging learning Actions (activities/tasks) such as reading materials online, listening to podcasts, watching videos, share photos and reflecting on lessons learnt. Learners can also interact with fellow online learners and the curator via the discussion group built-in within the MLC. Learners who completed these learning Actions were awarded e-Certificates. There were 93 registered learners, 52 of them were active learners.

Findings Analysis

Table 1: Participation and Satisfaction of Learning MLCs

	Pilot Phase : TP Alumni *(n=210)**		Case Study : Engineering Adult Learners *(n=52)**
MLC	Industry 4.0 *(n=115)*	Introduction to Cybersecurity *(n=95)*	Human Factors in Aviation Maintenance *(n=52)*
Rating *(Satisfaction)* *[Scale of 1-5: 1-Not Satisfied 5-Highly Satisfied]*	4	4	5
Average Time-Spent *(minutes)*	18	30	53
Average Completion Rate *(%)*	10	17	28

** Active learners of the MLC*

Table 1 summarises learners' satisfaction in learning the MLCs and their participation in terms of time they had invested on learning the contents and the completion rate in terms of finishing the Actions (activities/tasks). The rating of learners' satisfaction is based on a scale of 1 to 5, in which 1 being not satisfied and 5 being highly satisfied. The numbers in brackets show the active learners of the MLCs.

For the MLC "Human Factors in Aviation Maintenance", the engineering adult learners gave a rating of 5, which indicated that they were highly satisfied with the MLC. This high level of satisfaction was manifested in a high completion rate of 28%. This might have been due to the learners' motivation to complete this refresher MLC given its direct relevance to their work. In addition, it also helped in fulfilling the TOR required in their engineering profession.

The case was different for the TP alumni in the pilot phase. They gave an average rating of 4, which indicated that they were very satisfied in learning the MLCs "Industry 4.0" and "Introduction to Cybersecurity" not as highly satisfied as the engineering adult learners. Their completion rates were also lower at 10% and 17% for MLCs "Industry 4.0" and "Introduction to Cybersecurity" respectively. The TP alumni might have learnt the MLCs for various different reasons including for general awareness and acquisition of IT knowledge for the workplace. Both groups of learners spent an average of 33 minutes on learning the 3 MLCs, which could be indicative of their interest to engage with the contents of the MLCs.

Table 2: Positive Feedback and Improvements/Suggestions on MLCs

Pilot Phase : TP Alumni *(n=210)**		Case Study : Engineering Adult Learners *(n=52)**	
Industry 4.0 *(n=115) and* Introduction to Cybersecurity *(n=95)*		Human Factors in Aviation Maintenance *(n=52)*	
Positive Feedback	Improvements / Suggestions	Positive Feedback	Improvements / Suggestions
Convenient and flexible as concepts are taught in bite-size (8)	Include table tools for learners to answer, mini games, diagrams, charts and more examples to illustrate concepts (4)	Very easy to learn and simple to understand (10)	More videos and case studies on real life situation (2)
Easy to learn & navigate and very interactive (7)	More courses on other topics (2)	User-friendly, enjoyable & fun (10)	More quizzes with more questions (2)
Very useful (7)	Reduce questions asked (1)	Very useful (8)	To download in PDF detailed documents (1)
Videos are helpful for learning concepts (4)	Provide clearer images (1)	Good platform for variety of contents (3)	Explanation for wrong quiz answers (1)
Informative, clear and helps to broaden my knowledge and	No need for internet connection (1)	Bite-sized contents make learning manageable &	No need for internet connection (1)

perspective in this fast pacing world (3)		convenient (2)	
Good eye-opener as it dwells on the core topics of Industry 4.0 (3)		Very informative (2)	Regular updates (1)
Good overall coverage of ideas & easy grasp basic knowledge of cybersecurity at own time and pace (3)		Good for recapping concepts (1)	

** Active learners of the MLC*

Table 2 presents the text analysis of learners' positive feedback and suggestions for improvements to the MLCs, when they responded to the online survey within the MLCs. 13 of the 210 active learners of the MLCs "Industry 4.0" and "Introduction to Cybersecurity", and 17 of the 52 engineering adult learners of the MLC "Human Factors in Aviation Maintenance", had provided qualitative feedback in response to these 2 questions: *"What did you like about the program?"* and *"What can we improve on?"* Given in brackets is the number of times each feedback, improvement/ suggestion was provided by the 30 learners. It is to be noted that each learner might have given one or more feedback, improvement/suggestion, which are sorted from the most cited to the least cited.

Pilot phase

The TP alumni learners in the pilot phase cited bite-sized content learning, interactivity, ease of navigation and usefulness as the top 3 most positive experience of learning the MLCs on "Industry 4.0" and "Introduction to Cybersecurity". They also found the contents to be useful for better understanding and broadening of their knowledge and perspective in the fast changing world.

Case study: Engineering Adult Learners

The engineering adult learners in the case study cited user-friendliness, ease and simplicity of understanding of contents and usefulness as the top 3 most positive experience of learning the MLC "Human Factors in Aviation Maintenance." They also found the new learning approach of fulfilling refresher-training requirement, to be manageable and convenient. This was because they were able to incorporate the MLC refresher training within their busy work schedules, with minimal disruptions to their work.

On suggestions for improvements, both set of learners had cited constructive feedback to enhance the MLC contents with more examples, quizzes, videos and case studies on real-life situations. They also suggested adding games, charts, diagrams and table tools to enhance user engagement and learning experience.

Further Research and Next Phase

Overall, the implementation of the innovative micro-learning strategic framework and findings analysis of the pilot phase and case study had provided some insights into the viability of using micro-learning as a new way of learning for individuals and corporates. The findings analysis of the pilot phase had contributed towards the decision of TP's management, to scale up the project to offer 63 MLCs in April 2018. These findings analysis had provided TP with useful insights to understand the different users' expectations and motivation of learning the MLCs. This had guided TP to develop relevant MLCs, some of which had added form of recognition and accreditation. As noted in the case study of the "Human Factors in Aviation Maintenance" MLC, the completion rate is higher as the learners were able to fulfill the TOR requirement of their engineering profession.

While noting the learning points from this paper, there are some limitations that could be addressed. Firstly, the scope of study is limited and not representative of the wider working adult learner and corporate user population. Secondly, the qualitative data collected limits generalization of findings to the wider population.

Further research could be conducted in various areas. The first area could include the usage of MLCs in the workplace to improve work performance especially in measuring the effectiveness of micro-learning in the work environment and personalisation of learners' training needs (Bruck, Motiwalla, and Foerster, 2012; D'Errico, 2016). The second area could include quantitative data collection techniques to give better insights into the impact of the MLC learning on different users at individual and organizational levels. The third area could cover more research into the effectiveness of using micro-learning in enhancing face-to-face training, facilitating on-demand trouble-shooting and problem-solving on-the-job, collaborating and sharing in-the-moment learning experiences (Rossett & Marshall, 2010; D'Errico, 2016).

The next phase of the MLC project is mainly guided by the post-launch developments. Following the MLC launch in April 2018, there has been continuing interests from organisations and corporations on using micro-learning as an alternative learning option for staff training. Some organisations had subscribed to the MLCs for staff training, while others have considered the option to digitise their own in-house training courses by converting parts of their existing face-to-face training into MLCs. In response to this encouraging development, TP developed and offered 36 additional MLCs in May 2019 to the public and corporate users.

Conclusion

Micro-learning has been seen to have promising benefits of being intuitive, engaging, and easily accessible to individuals and corporates. The qualitative findings analysis of the pilot and case study outlined in this paper have highlighted how MLCs have benefited working professionals and adult learners. Indeed, micro-learning will continue to become an integral part of workplace learning to help busy working professionals to stay nimble and relevant in today's rapid industry transformation and increasingly digital work environment.

Acknowledgements

The authors acknowledge Temasek Polytechnic for supporting their research work.

References

Bahrami, R. (2015). *Is Bite-sized learning the way to engage the modern distracted learner?* Retrieved from https://www.trainingindustry.com/articles/learning-technologies/is-bite-size-learning-the-way-to-engage-the-modern-distracted-learner/

Bruck, P, A; Motiwalla, L; and Foerster, F. (2012) *"Mobile Learning with Micro-content: A Framework and Evaluation"BLED 2012 Proceedings."* Retrieved from http://aisel.aisnet.org/bled2012/2

Cacciattolo. K. (2015). 'Defining Workplace Learning'. *European Scientific Journal*. 1, 243-250.

D'Errico, D. (2016). 'Mobile Learning: What's It Good For? Absolutely Everything (That Needs to Be Done Now).' *Workforce Solutions Review*. May 2016, 11-13.

Nalaka, S, E and Rajulu, S.S. (2018). *Micro-learning - A Way to Enhance Learning Pathways.* Retrieved from https://www.als2018.com/pdf/ALS2018%20paper_3.1%20Micro-Learning%20-%20A%20Way%20to%20Enhance%20Learning%20Pathways.pdf

Rossett, A., & Marshall, J. (2010). 'What corporate training professionals think about e-learning: Practitioners' views on the potential of e-learning in the workplace?' *Journal of Asynchronous Learning Networks.* November 2010, 14(2), 19-27.

Sim, R. (Jul 9, 2017). *'PM Lee Hsien Loong outlines ways for governments to help workers, businesses adapt to digitalisation.'* Retrieved from https://www.straitstimes.com/world/pm-lee-hsien-loong-outlines-ways-for-governments-to-help-workers-businesses-adapt-to

SkillsFuture Singapore and Workforce Singapore. (1 Feb, 2018). *'The Education (Training and Adult Education) Industry Transformation Map.'* Retrieved from https://www.ssg-wsg.gov.sg/new-and-announcements/1_Feb_2018_1.html

Yong, C. (Apr 6, 2017). *'Think big, start small, act fast' to drive innovation in civil service, says Ong Ye Kung.'* Retrieved from https://www.straitstimes.com/singapore/think-big-start-small-act-fast-to-drive-innovation-in-civil-service-says-ong-ye-kung

Annex 1
Title Listing of Micro-Learning Courses (MLCs)

Applied Science	Biosafety & Biosecurity Essentials
Applied Science	Fish Feeding Essentials
Applied Science	Biological Containment & Waste Management
Applied Science	Water Quality in Fish Care
Applied Science	Essentials of Fish Health Care
Applied Science	Industrial Wastewater Physical Treatment
Applied Science	Industrial Wastewater Chemical Treatment
Applied Science	Industrial Wastewater Biological Treatment
Applied Science	Upstream Bioprocess Technology (Part 1)
Applied Science	Upstream Bioprocess Technology (Part 2)
Applied Science	Basic Statistics in Uncertainty Estimation
Applied Science	Uncertainty Estimation in Chemical Analyses
Business Management	The MICE Business
Business Management	Guide to MICE Fundamentals
Business Management	MICE Business Strategies Essentials
Business Management	Food & Beverage Management
Business Management	Professional F&B Menu Planning
Business Management	Adopting F&B Technologies
Business Management	Introduction to Brand Strategy
Business Management	Developing a Strategic Brand Blueprint
Business Management	Airline Industry Insights
Business Management	Airline Business Management
Business Management	Basics of Successful Entrepreneurship
Business Management	Visual Merchandising for successful e-commerce
Corporate Finance	Finance for Non-Finance Managers
Corporate Finance	Global Trade
Corporate Finance	Corporate Investment
Corporate Finance	Corporate Risk Management
Engineering	Industry 4.0
Engineering	Human Factors in Aviation Maintenance
Engineering	Sustainable Building Design Principles
Engineering	Sustainable Building Design Process
Engineering	Introduction to Industrial Internet of Things (IIOT)
Engineering	IIOT System Connectivity
Engineering	LabVIEW for Industrial Internet of Things (IIOT)
Engineering	IIOT Smart Sensors and Actuators
Engineering	Fundamentals of Semiconductor Materials
Engineering	Semiconductor p-n Junction and Contacts
Engineering	Semiconductor MOSFET
Engineering	Strategies and Customer Value in Supply Chain Management (SCM-1)
Engineering	Warehousing and Material Handling (SCM-2)
Engineering	Procurement and Integrated Supply Chains (SCM-3)
Engineering	Supply Chain Technology and Risk (SCM-4)
Infocomm Technology	User-Centric Interface Design for Mobile Devices
Infocomm Technology	Visual Logic in User Interface Design
Infocomm Technology	Introduction to Cybersecurity
Infocomm Technology	Introduction to Social Media Analytics
Infocomm Technology	Text Analytics Process
Infocomm Technology	Text Analytics Techniques
Infocomm Technology	Fundamentals of Cloud Architecture
Infocomm Technology	Virtualisation Concepts & Techniques
Infocomm Technology	Embracing Technology in Security Industry
Leadership & People Management	Introduction to Management
Leadership & People Management	Management Planning & Organisation
Leadership & People Management	Leading, Controlling & Corporate Social Responsibility
Leadership & People Management	Planning Power-Packed Oral Presentations

Leadership & People Management	Delivering Power-Packed Oral Presentations
Leadership & People Management	Managing Meaningful Meetings
Leadership & People Management	Talent Acquisition & Management
Leadership & People Management	Employee Grievance, Discipline & Counselling
Leadership & People Management	Motivation & Team Management
Leadership & People Management	Training Needs Analysis@Work
Leadership & People Management	The Secrets of Great Teamwork
Life Skills & Professional Development	食品安全和卫生基础课程
Life Skills & Professional Development	Speak Japanese!
life Skills & Professional Development	Psychology of Ageing
Life Skills & Professional Development	Introduction to Social & Emotional Learning
Life Skills & Professional Development	Motivation on the Move
Life Skills & Professional Development	Counselling on the Go
Life Skills & Professional Development	Portrait Drawing for Beginners
Life Skills & Professional Development	Basic Food Hygiene for Food Handlers (Part 1)
Life Skills & Professional Development	Basic Food Hygiene for Food Handlers (Part 2)
Life Skills & Professional Development	Occupational Safety
Life Skills & Professional Development	CARBs, Friends or Foe
Life Skills & Professional Development	Medication Safety 101
Life Skills & Professional Development	Medical Report - What the Results Mean to You?

Life Skills & Professional Development	Refresher Course in Practical Mathematics
Life Skills & Professional Development	Integrated Circuit (IC) Manufacturing 101
Life Skills & Professional Development	Introduction to LEAN Manufacturing
Life Skills & Professional Development	5 Key Principles of LEAN Manufacturing
Life Skills & Professional Development	6S LEAN Workplace
Life Skills & Professional Development	5S & 7W for Work and Personal Effectiveness
Life Skills & Professional Development	Design Principles for Effective Visual Communication
Life Skills & Professional Development	Accounting Entries for Beginners
Life Skills & Professional Development	7 Important Insights to Attract Customers
Life Skills & Professional Development	Analytics for Hospitality Professionals
Life Skills & Professional Development	Behavioural Insights for Business Decisions
Life Skills & Professional Development	101 of A Winning Business Plan
Life Skills & Professional Development	Merchandising 123 for e-commerce
Life Skills & Professional Development	What Makes Music?
Life Skills & Professional Development	Basic English Language for Non-Native Speakers
Life Skills & Professional Development	Living Well Matters : Embracing Work Life Harmony
Life Skills & Professional Development	Rest Your Stress : Nurturing a Balanced Life
Life Skills & Professional Development	Winner's Work Attitude : Unravelling Your Best Potential
Life Skills & Professional Development	5 Key Principles in Creative Photography
Sales & Customer Services	12 Essentials of Digital Marketing

Sales & Customer Services	Creating Unforgettable Experiences Through Customer Service
Sales & Customer Services	Customer Communication Skills to Drive Service Excellence
Sales & Customer Services	Service Culture - Going Beyond Lip Service

INVESTINGATING NUDGE EFFECTS WITH SPACED REPETITION ON CONTEMPORARY LEARNER'S MOTIVATION AND PERFORMANCE IN LEARNING - DATA COMMUNICATION AND NETWORKING

Y.F. Tang*, Z.H. Huan, S.B. Nai, E. Sim and S.K. Koh

Nanyang Polytechnic/School of Engineering, Singapore

*Tang_Yew_Fei@nyp.edu.sg

Abstract

The current contemporary learner's learning habit is very different due to their exposure to new technology at a young age. They have a lot on their proverbial plates; where having too many things on one's mind made them easily distracted and unable to retain the information. This led to "binge and purge" learning; a common practice whereby students cram for an assessment by consuming subject matter in a large lump (binge) and then spitting it back in the assessment (purge). Due to their proverbial plates being so full, it had led to the students in favouring "binge and purge" learning to achieve academic results but not the knowledge needed for the future. A constant nudging to the students to revise and testing their knowledge throughout lessons could be more appropriate in evaluating these contemporary learner's academic achievement.

In this paper, an initial study was carried out with weekly E-Quizzes to "nudge" the students to study and to find the optimal number of questions to be repeated from their previous lesson; spaced repetition learning is to enhance in students remembering key concepts. The optimal number was the number of cumulative repeated questions that would help the students to remember but will not overwhelm the students with too many questions. The effect size based on Cohen's d and the average marks would be used to evaluate the impact of spaced repetition and the MUSIC survey result conducted at the end of the experiment are then used to evaluate the "nudging effect" in motivating the students in learning networking.

Keywords: *Nudge Theory, Pedagogy for Modern Learners, Spaced Repetition, Sustainable Development, E-learning, Assessment of Learning*

Introduction

It had been observed that more and more contemporary learner cultivates "binge and purge" learning. These students usually use their short-term memory to consume subject matter in a large lump (binge) and reproduced them in the assessment (purge). This memory work would not last and the assessment credentials would be at stake. The ability of a student to remember key concepts is vital for Engineering students; the students are required to remember key concepts for them to innovate and apply to real world situation. Remembering is different from memorizing. Memorizing tends to be short term whereas remembering is not just the process of committing information to memory but also the process of understanding, retaining and recalling the information. That is, the process of remembering requires the student to understand a concept, retain it over a period and then recall the concept when it its needed.

The weekly E-Quizzes will nudge the students to revise what they were taught for the week. The incorporation of spaced repetition learning should enhance the process for students to remember the key concepts for all the taught topics. The "nudging effect" is expected to change the students' behavior and motivate the students to learn; and in the long run, cultivate their interest in engineering when they see an improvement and ability to perform.

Literature Review

Nudge theory is about positive reinforcement and indirect suggestions as ways to influence the behavior and decision making of a human being. Nudging could be a key in influencing students' behavioral and psychological factors when they make education decisions (Jabbar, 2011 and Koch et al., 2015). Evidence had also been examined from field interventions addressing a set of specific behavioral challenges with nudging as a factor (Lavecchia et al, 2016). Empirical evidence for simplifying the transition to higher education had been reviewed (French & Oreopoulos, 2017) and with interventions using new education technology could influence one's behavior (Escueta et al, 2017). In recent empirical work, it was suggested that too much nudging could sometimes backfire from a social welfare perspective (Carroll et al, 2009; Handel, 2013; Damgaard & Gravert, 2018). It is therefore to quantify the result for the circumstances under which nudging may and may not be successful. Empirical studies have also revealed that nudges may have very heterogeneous effects (Allcott, 2011) and as a result it may be desirable to use targeted rather than universal nudges. Furthermore, behavioral interventions may be particularly relevant and effective when individuals face economic or social scarcity because it occupies attention and potentially impedes good decision making (Mullainathan & Shafir, 2013). Therefore, a reasonable degree of "nudging" would be appropriated and influence one's behavioral; to motivate the students to learn.

Spaced repetition is well researched and has shown promising results. Spaced repetition was first introduced in Iowa (Spitzer, 1939) and research had shown manipulation of repetition space could improve the ability to recall information (Melton, 1970 and Landauer & Bjork, 1978). Recent research had also shown positive result with space repetition (Kang, 2016 and Kelley & Whatson, 2013). According to the principle of "spaced repetition", instead of massed learning, remembering and practice of skills is more efficient if each item's practices are spread out over time (Bloom & Shuell, 1981). Concept that is difficult should appear more often and material that is easy, less often, with difficulty defined according to the ease with which the user can remember the material. Incorporation of interleaving between different topics is ideal as it has the potential to stretch the students beyond information retrieval to sense making of newly taught concepts (Brown et al, 2014). The difference between consistent and expanding duration between spacing has found to produce insignificant improvement in retrieval, while more repetitions are found to be more important in producing improvement in retention (Thalheimer, 2006). Spaced learning also has the potential to impacting policy and curriculum planning, since it could produce improved learning outcomes and higher learning per hour compared to conventional teaching methods, back by evidences from neuroscience on rapid memory processes in humans (Kelley & Whatson, 2013). The basis of how the ability of the brain to retain memory decreases over time is based on the forgetting curve of Ebbinghaus as shown in Figure 1.

By deploying spaced repetition in the Data Communication and Networking module, we seek to investigate whether such teaching methodology help students to better remember the technical terms and concept to improve their academic performances in the module.

The MUSIC model of academic motivation (Jones, 2009) is a framework used to measure and engage students in learning. It consists of five categories of teaching strategies derived from research and theory that are critical to students' engagement in academic settings: eMpowerment, Usefulness, Success, Interest, and Caring (MUSIC is an acronym). Empowerment refers to the students' perception of control over their learning. Students who believe they have control over some aspects of their learning tend to be more motivated. Usefulness and Success relate how students believe the topics are relevant and important in helping them succeed respectively. Interest indicates the level where students like and are curious in the topic. The extent of their welfare being looked after and respected is measured by Caring.

Evidence suggests that lecturers who address the MUSIC components are more likely to be successful at motivating their students to engage in learning (Jones, 2013, 2015). By adopting the MUSIC model of academic motivation as a framework in our investigation, we aim to gain insight into impact of spaced repetition on students' motivation.

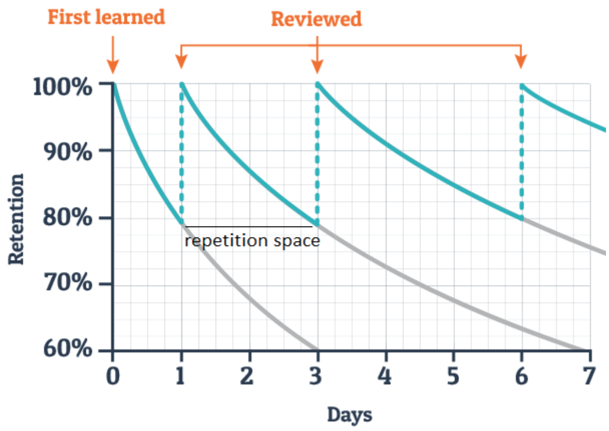


Figure 1. Typical Forgetting Curve for Newly Learned Information (Schneider, 2014)

Methodology

Our study focus is to determine the "nudging effect" and to find the optimal number of questions to repeat in Data Communication and Networking topics and effect of number of allowance attempts. The methodology is shown in Table 1.

"Nudging" in our context is to conduct weekly E-Quizzes on the topics they learnt for the week. The idea is to keep the revision materials to a weekly basis; bit-size and manageable to revise. In having weekly E-Quizzes, hopefully, it will remind them to revise the current material before new materials that will be taught in coming week lessons. The effect of the "nudging effect" will be measured in term of their motivation. Cohen's d would be used to determine the effect size for the comparison between the mean of students' performance in the E-Quizzes of the control group (CG) in the initial study and each of the experimental group's means. Cohen' d suggested that d=0.2 be considered a 'small' effect size, 0.5 represents a 'medium' effect size and 0.8 a 'large' effect size. This means that if two groups' means don't differ by 0.2 standard deviations or more, the difference is trivial, even if it is statistically significant. (Cohen, 1988, 1992). The rational in designing the experiment is to have the experimental control group (EG) to serve as a baseline, Experimental group 1 (E1) is to investigate the effect of having 2 repeat questions, Experimental group 2 (E2) is to investigate the effect of having 3 repeat questions and Experimental group 3 (E3) is to investigate the effect of number of tries.

Table 1. Methodology for initial study

G	SS	Methodology
EG	39	A weekly E-Quizzes based on the lesson conducted for the week. The E-Quiz consisted of 10 multiple choice questions (MCQs) with unlimited tries.
E1	58	Same assessment method as stated in control group but two questions from the previous week/s added to subsequent week/s in a cumulatively manner.
E2	106	Same assessment method as stated in control group but three questions from the previous week/s added to subsequent week/s in a cumulatively manner.
E3	98	Same assessment method as stated in experimental group 2 but the number of tries is restricted to 3.

Legends: Group (G), Sample Size (SS), Experimental Control Group (EG), Experimental Group 1 (E1), Experimental Group 2 (E2), Experimental Group 3 (E3). Remarks: These experiments are conducted with 1st year students doing Data Communication and Network in a networking diploma

MUSIC survey is conducted at the end of the last E-Quiz for all the experimental groups. The MUSIC survey questions are shown in Table 2.

Table 2. MUSIC Survey Questions

Q	**C**	**Question**
1	U	The repeated questions in the after-lab e-quiz was beneficial to me as I could better recall the concepts taught in class.
2	U	In general, the after-lab e-quiz was useful to me as it summarized important concepts taught in class.
3	U	I found the after-lab e-quiz to be useful for other modules in DMIT.
4	U	I will be able to use the knowledge I gained in this module.
5	U	The knowledge I gained in this module is important for my future.
6	S	I was confident that I could succeed in the after-lab e-quiz.
7	S	Throughout the module, I felt that I could be successful on the after-lab e-quiz.
8	S	I felt that I could be successful in meeting the academic challenges in this module.
9	S	I am capable of getting a high grade in this module.
10	I	The after-lab quiz held my attention.
11	I	The after-lab equiz was interesting to me.
12	I	The instructional methods used in this module help my attention.
13	I	I enjoyed the instructional methods used in this module.
14	I	The instructional methods engaged me in the module.
15	I	I enjoyed completing the after-lab equiz.

Legends: Q: Question Number, C: Components, U: Usefulness, S: Success, I: Interest

Results

An improvement in the students' performance in terms of average marks is observed in the experimental groups using spaced repetition learning with unlimited attempts (E1 and E2) and with limited 3 attempts (E3) in the initial study as observed in Figure 2.

In the study, the result tends to contrast to the findings in literature studies that learning has improved through spaced repetition. Based on the results from E0, the study showed that there was no significant difference in the quiz scores between students in CG and E1 (d = 0.29). This could be due to the fact that only 2 questions per topic was repeated. Thus, the effort required by students to recall previously taught topics was negligible and resulted in insignificant improvement in students' academic performance. In comparing CG and E2, the repeated questions were increased from 2 questions to 3 questions. The effect size is medium (d = 0.32), an improvement over the effect size between CG and E1. This suggests that increasing the additional weekly questions from previous topics alone does not significant contribute to a significant improvement in the student's academic performance. In considering not to overwhelm the students with too many questions, E3 is same with E2 but the number of tries was limited to 3 instead of unlimited. The effect size had increased to large (d = 0.67). This suggests that restricting the maximum number of attempts for the quizzes together with suitable number of additional questions from previous topics has moderate impact on students' academic performance.

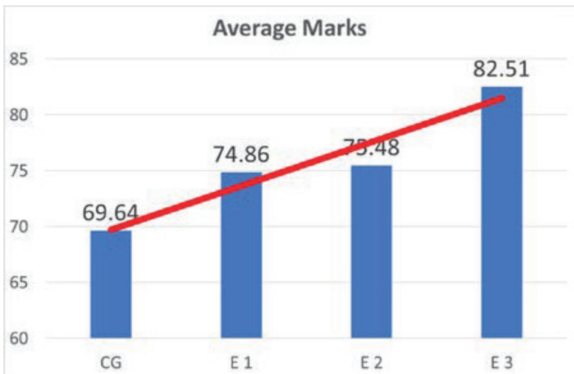


Figure 2. Average marks for initial study

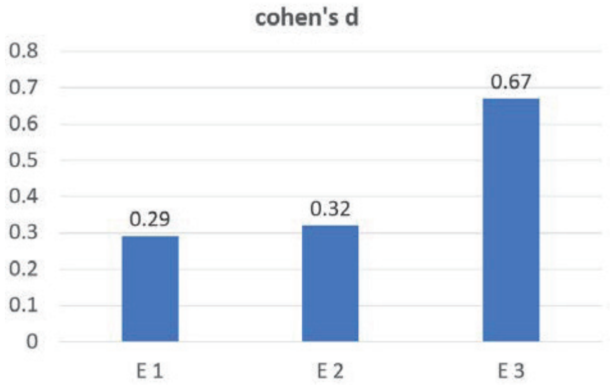


Figure 3. Cohen's d effect size for all experimental groups with respect to the control group

In drilling down further to analyze the performance of academically stronger students (GPA≥3.0) in each of the experimental groups and the control group, the result was shown in Figure 4. Interestingly, we found that the effect size across the experimental groups and control group had significantly increased. This suggested that spaced repetition methodology had a greater influence on the academically stronger students.

Interestingly the results show that with the same assessment methodology used, the average marks and the Cohen's effect size shows the same outcome. This suggested the result could be repeated across the students studying Networking modules.

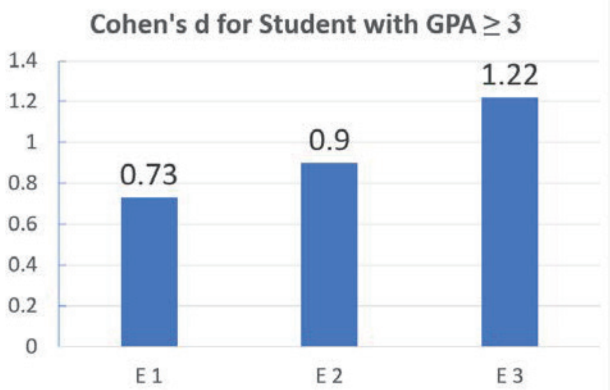


Figure 4. Cohen's d effect size for academic stronger students (GPA≥3)

Students in the experimental groups responded positively to the spaced repetition methodology as shown in Table 3. They generally agreed that the after-lab e-quiz was useful, helpful and interesting and it helped to improve their learning. Students remained interested in the module content and instructional activities which led them to believe they can succeed if they put forth the effort required. The increase in difficulty for the weekly quiz (from unlimited attempts to maximum 3 attempts) did not create any significant impact on students' motivation.

Table 3. MUSIC Survey result taken from each experimental group at the end of the experiment

Component	Average MUSIC Score#		
	E1	**E2**	**E3**
Usefulness	5.24	5.25	4.52
Success	5.17	5.18	4.51
Interest	5.34	5.22	4.63

Likert-type scales: Strongly Agree (Score = 6) Strongly Disagree (Score = 1)

Discussion

The results had shown the effectiveness of using spaced repetition learning in improving students' performance. This is in-line with other studies in virtually every standard experimental learning paradigm, with all sorts of traditional research material (Dempster, 1987a; Hintzman, 1974; Melton, 1970). However, it was interesting to see that spaced repetition was much more effective on students who are academically strong. Although this could be attributed to space effect, where two spaced repetition are about twice as effective as two massed presentations (Hintzman, 1974; Melton, 1970), and the difference between them increases as the frequency of repetition increases (Underwood, 1970). In this investigation, spaced repetition were employed but the repetition frequency was the same for all students and therefore may not have the same influence on the academically weak students as compared to the academically strong students. Students who have a longer knowledge retention period generally performed better academically. This could suggest that some of the academically weak students could have forgotten before the questions were repeated and reviewed, therefore, the spaced repetition impact on academically weak students was limited.

An interesting finding was that the students responded positively showing an improved in motivation for them to learn the concepts in networking despites the increase work required from them. The "nudging effect" in urging the students to revise on a weekly basis had influenced their behavior and motivated them to work.

Conclusions

There is a need to prevent "binge and purge" learning which will not equip the students with the knowledge and skill for the real world. Continuous assessment at a bit-size level in "nudging" our students to study on a regular basis could be the way forward. As our studies show, the "nudging effect" of having weekly E-Quizzes could be more appropriate for students to remember the key concept for their future work. In incorporating spaced repetition learning into the weekly E-Quizzes shows great potential in improving students' academic performance among the academically stronger students. Although, further research is needed in the repetition frequency to see a greater impact on academically weak students for a holistic practical learning system.

Students generally perceive this methodology to be useful, interesting and it helps them to improve their learning. Students' motivation is also not affected by additional effort they must put in to remember the technical terms. In addition, students' performances in the repetition tests provide a useful feedback to students learning progress and facilitate the lecturers to intervene and provide help to students in a timely manner.

Further work to apply the study with other modules on the upper level students would be carried out to validate the findings.

References

Allcott, H. 2011. Social norms and energy conservation. *Journal of Public Economics*, 95(9–10), pp. 1082-1095.

Bloom, K. C., & Shuell, T. J. (1981). Effects of massed and distributed practice on the learning and retention of second-language vocabulary. *The Journal of Educational Research*, 74(4), 245-248.

Brown, P. C., Roediger, H. L., & McDaniel, M. A. (2014). *Make it stick. Harvard University Press*.

Carroll, G. D., Choi, J. J., Laibson, D., Madrian, B. C. & Metrick, A. 2009. Optimal Defaults and Active Decisions. *Quarterly Journal of Economics*, 124(4), 1639-1674.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences Lawrence Earlbaum Associates. Hillsdale*, NJ, 20-26.

Cohen, J (1992). "A power primer". *Psychological Bulletin*. 112 (1): 155–159

Damgaard, M. T. & Gravert, C. 2018. The Hidden Cost of Nudging: Experimental Evidence from Reminders in Fundraising. *Journal of Public Economics*, 157, pp. 15-26.

Dempster, E N. (1987a). Time and the production of classroom learning: Discerning implications from basic research. *Educational Psychologist*, 22, 1-21.

Escueta, M., Quan, V., Nickow, A. J. & Oreopoulos, P. 2017. Education Technology: An Evidence-Based Review. NBER Working Paper No. 23744.

French, R. & Oreopoulos, P. 2017. Behavioral Barriers Transitioning to College. *Labour Economics,* 47, pp. 48-63.

Handel, B. R. 2013. Adverse Selection and Inertia in Health Insurance Markets: When Nudging Hurts. American Economic Review, 103(7), 2643-2682.

Hintzman, D. L. (1974). Theoretical implications of the spacing effect. In R. L. Solso (Ed.), Theories in cognitive psychology." The Loyola Symposium, 77-99

Jabbar, H. 2011. The Behavioral Economics of Education: New Directions for Research. Educational Researcher, 40(9), pp. 446-453.

Jones, B. D. (2009). Motivating students to engage in learning: The MUSIC model of academic motivation. *International Journal of Teaching and Learning in Higher Education*, 21(2), 272-285.

Jones, B. D., & Wilkins, J. L. (2013). Validity evidence for the use of a motivation inventory with middle school students. In Poster presented at the annual meeting of the Society for the Study of Motivation, Washington, DC.

Jones, B. D., & Wilkins, J. (2015). More validity evidence for the use of the MUSIC Model of Academic Motivation Inventory with upper-elementary and middle school students. In Poster presented at the annual meeting of the Eastern Educational Research Association, Sarasota, Florida.

Kang, S. H. (2016). Spaced Repetition Promotes Efficient and Effective Learning: Policy Implications for Instruction. Policy Insights from the Behavioral and Brain Sciences, 3(1), 12-19.

Kelley, P., & Whatson, T. (2013). Making long-term memories in minutes: a spaced learning pattern from memory research in education. Frontiers in human neuroscience, 7, 589.

Koch, A., Nafziger, J. & Nielsen, H. S. 2015. Behavioral Economics of Education. Journal of Economic Behavior & Organization, 115, pp. 3-17.

Landauer, T. K., & Bjork, R. A. (1978). Optimum rehearsal patterns and name learning. In M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), Practical aspects of memory, London: Academic Press, 625–632.

Lavecchia, A. M., Lui, H. & Oreopoulos, P. 2016. Behavioral Economics of Education: Progress and Possibilities. In: E. A. Hanushek, S. Machin & L. Woessmann, eds. Handbook of the Economics of Education Vol. 5. Elsevier, pp. 1-74.

Mullainathan, S. & Shafir, E. 2013. Scarcity: Why Having Too Little Means So Much. Time Books, Henry Holt & Company LLC, New York, NY.

Melton, A. W. (1970). The situation with respect to the spacing of repetitions and memory. *Journal of Verbal Learning and Verbal Behavior*, 9, 596–606.

Schneider, W., Memory development from early childhood through emerging adulthood. Switzerland: Springer (2014).

Spitzer, H. F. (1939). Studies in retention. *Journal of Educational Psychology*, 30, 641–657.

Thalheimer, W. (2006). Spacing learning events over time: What the Research Says. Retrieved November 31, from http://www.work-learning.com/catalog/

Underwood, B. J. (1970). A breakdown of the total-time law in freerecall learning. *Journal of Verbal Learning and Verbal Behavior*, 9, 573-580

The Importance of Face-to-face Discussion – An Attempt to Use "Conceptual Thinking Encouraging Materials" in Elementary Physics Education

Takahiro NIWA*, [a] and Akio KIKUCHI [a]

[a] Department of liberal arts and science education, National Institute of Technology, Hachinohe, College, Hachinohe, Japan

*niwa-g@hachinohe.kosen-ac.jp

Abstract

It is generally admitted that face-to-face discussion remains very important even if ICT for engineering education has developed. Those styles of discussion encourage not only students to be positive but also to improve students' theoretical thinking. This is true to subjects of all kinds including physics, English and so on. In the previous years, the group discussion had been incorporated into the physics classes at NIT, Hachinohe College. It was partially useful, but it had a few problems. One of the most serious problem is low-motivated students' small participation in discussions. Furthermore, low-performing students have little chance to join discussions because low-performing students have no idea how to solve the exercises. In the time of drills or exercises, they just copied their members' answers, not thinking by themselves. One of the reasons can be traced to the problem of the text material. Although the students are divided into several groups, there is no change of texts. The monotonous common questions may have caused students' low motivation, so different types of questions are needed. As the first step of this direction, we provide students drill questions with same formula but different values. In these exercises, the question systems including formula or equations are exactly the same, but the numbers required for the calculation differ depending on each student, so each student have to lead the answer individually. In other words, students cannot "refer" to other students' answers. As the question format is same, the process of getting answers is also common. Through the drills, it was possible to encourage discussion between students in this method. In particular, low-performing students took part in the discussion easier. Consequently, it will be predictable that face-to-face discussion with the random-choice questions is very effective not only in obtaining advanced skills but also getting basic skills. It might be possible to apply the method to other subjects in which students have difficulty in basic skills such as English. As the second step of our research, we are also going to introduce this idea to English classes and develop English learning materials.

Keywords: *Face-to-Face discussion, Physics Education, English Education, Engineering Education, "partially random" questions, learning skills improvement*

Introduction

For engineering education, studying physics, mathematics and fundamental English is important. In these class, we provide not only classroom lectures but also many drill questions, such as handouts. When students solve it, we consider face-to-face discussion is also important too. Those styles help them to understand concepts in each subject and to improve their theoretical thinking skills. In the previous years, we had tried to make classes encouraging them focusing of those aspects (Kada and Niwa, 2016, Niwa and Nakamura, 2017 and Niwa et al. 2018). As those classes proceed in content-based teaching and face-to-face discussion using many drill questions, we have faced an inevitable problem, which was students' cheating. In particular, it has been done by midrange performing students and low-performing students. It is clear that such acts have negative effects on students because it blocks encouraging students' theoretical thinking and face-to-face discussion. In this paper, we introduce drill questions with same formula but different values (hereafter, we call it "new material") and also provide some part of development way of new material and students' impression in trial use in physics class.

Requirements of new material and their solution

How do we prevent the "copy" or cheating? The easiest way is to provide handouts which have completely different drill questions per student. However, such way has three major problems. At first, students can't discuss to solve questions each other in those styles. If we design to encourage face-to-face discussion. Secondly, some students have no idea to solve questions, especially low-preforming students. Thirdly, it is too hard to prepare. We must prepare a huge amount of drill questions in those styles.

In the dealing with such problems, a new material has three requirements; (1) students should share same problems, (2) low-performing students can join face-to-face discussion and can get answers by themselves, and (3) teachers prepare easily. Furthermore, of course, we prevent the cheating. What we especially pay attention to is requirements (2). It shows how the effect of encouraging face-to-face discussion using new material is related to our aims. Requirements (1) and (3) are easy to solve because providing students with same questions requires us minimum preparation for teachers. In drill questions of physics class, numerical calculation question can train theoretical thinking in many cases. By solving questions, students need more deep understanding of process to answers in addition to calculation technique. Because scientific calculator provides calculation values or even technique. This is the reason the process to answer is necessary for students than technique itself. Therefore, we conclude that we prepare questions with same formula but different values to contrast the process with the result.

Example of new material

Figure 1. provides examples of new materials. This example shows question about Newton's 2nd law.

Pattern 1:
3.0 N force applying with 3.0 kg object. Calculate acceleration for object. (Answer. 1.0 m/s^2)

Pattern 2:
4.0 N force applying with 2.0 kg object. Calculate acceleration for object. (Answer. 2.0 m/s^2)

Pattern 3:
2.0 N force applying with 4.0 kg object. Calculate acceleration for object. (Answer. 0.50 m/s^2)

Figure 1. Examples of new materials

Shown in figure 1, we provide questions with different values (red highlights). These share the solution of the same formula,

(acceleration) = (force) / (mass).

Students must reach their answer value by receiving different pattern problems. Although these examples are the simplest question, the drills include more difficult questions: from very fundamental to National Centre Test for University Admissions level.

Development of new materials

Building new materials, we use LaTeX with PGF package. LaTeX is one of the most famous computerized composition systems and especially are used in many scientific fields (Kunuth 1984). PGF is one of LaTeX package (sub program) which use simple scientific calculation and draw the diagram, table, and figures. Functions of original PGF package are limited but if extended package is in use, we can expand PGF functions.

The key function of PGF is "Random". Random function gives Latex random integer within specific range, so we can allocate random number on each question. The examples of allocated questions are shown above; a concept of our script is like the following lines:

(random number) N force applying with (random number) kg object. Calculate acceleration for object.

Highlighted parts give new material from the computer. Based on those number, we can build most of the questions and answers automatically by PGF package although inputting question sentences manually is needed.

Furthermore, we have to adjust another matter by hand. It is a range of "random" number. If outputted numbers are completely random, some questions can't come into existence as drill questions; they are unsolvable or too difficult for students to work on.

Trial use and results

(1) Overview

We did a trial use of new material for 2nd graders in spring and summer semesters in physics classes (40 members class-size). In trial use, we prepare 11 units of the material. Each unit has two fundamental and advanced questions, and each includes both very fundamental questions and National Centre Test for University Admissions level questions, respectively. Table 1. shows contents of the units.

	Unit
1	Composed and relative velocity
2	Free fall and related motion
3	Friction force
4	Equation of motion
5	Universal gravity
6	Hook's law
7	Work and mechanical energy
8	Momentum
9	Uniform circular motion
10	Simple harmonic motion
11	Basics of light

Table 1. Units of new material adopted

(2) Students' reactions in the classes

Students seemed to actively talk with each other and to share their ideas with others during each class while working on each question. Some high-performing students struggle drill questions by themselves, which contributed to their self-learning. In other aspects, some midrange and low-performing students seem to feel too hard to solve. In new material, students only share "process" to attempt drill questions and don't "copy" the answer of another student, and that will be why they feel difficult.

(3) Questionnaire survey for students

In order to investigate effects of new materials quantitatively, we carried out questionnaire survey to 2nd graders. This contains 10 questions concerning new material and 85 students answered it. Ten questions mainly ask students about comparison new materials and conventional materials. Evaluation of each question is scoring with 5 points maximum. Contents of questionnaire survey and their score are shown in Table 2.

	Question	Score
Q1	Are new materials enjoyable for solving questions rather than conventional materials?	3.6
Q2	Do new materials give you many chances to debate actively rather than conventional materials?	4.1
Q3	Do new materials give you many chances to solve questions yourself rather than conventional materials?	3.9
Q4	Do you think do drill questions in new materials easier to solve rather than conventional materials?	2.7
Q5	Do new materials encourage your understanding of physics rather than conventional materials?	3.8
Q6	Are new materials useful for your study?	4.2
Q7	Do you have opportunity to teach other students during classes?	2.6
Q8	Do you have a chance to learn from your friends during classes?	3.6
Q9	Do you have many chances to study only yourself during classes?	2.9
Q10	Do such kind of handout useful for study not only you but also other student?	4.5

Table 2. Questionnaire survey for new materials (80 students, average score)

Moreover, in order to confirm the influence of the student's performance, we divide students into three: low-performing, midrange-performing, and high-performing students based on examination of physics score shown in Table 3. Red, green, and blue highlights represent, high, midrange, and low-performing students' average score.

Discussion

(1) From questionnaire survey results of whole students (Table 2)

All questions' average score exceeds 2.5, students have positive impression to new materials especially Q2, Q6, and Q10 record high average score. These results quantitatively show that new material encourage students' active debate with each other. It can be said that students are more referring each process than copying answers. In addition, from Q6 and Q10 shows students have high motivation against to drill questions too. Furthermore, many students enjoy solving questions from Q1. Q3, Q5 have also high average score. It considers to be use for doing homework, review and etc. According to these facts indicate new material keeps students' high motivation and encourages debate so new materials are very effective for students' leaning.

On the other hand, Q4, Q7, and Q9 have low average score. Those results show that for students to solve questions alone is difficult alone and they need to face-to-face discussion. In new material, they can only share "process to the answer" while omitting final answers.

(2) From questionnaire survey results of each performance of students

	High performance	Midrange performance	Low performance
Q1	3.9	3.2	3.7
Q2	4.5	3.8	4.1
Q3	4.3	3.6	3.7
Q4	2.6	2.7	2.7
Q5	3.9	3.7	3.7
Q6	4.4	4.0	4.1
Q7	2.8	2.5	2.5
Q8	3.7	3.5	3.8
Q9	2.9	3.3	2.7
Q10	4.6	4.5	4.4

Table 3. Questionnaire survey for new materials (Divided into three based on performance, 80 students, average score)

Up to the previous section, we find the new material affects very positive for students' learning. We also learn more details about those effects, where we divide into three groups students by the physics examination score. Table 3. shows results of questionnaire survey of each group. In table 3., we find the answer of low-performing students' score is high (4.1/5.0, yellow-highlighted in table 3.) and it means that low-performing students get many chances to join group discussion. It's one of biggest results for us because it clearly exhibits the new material is easier for low-performing students to join group discussion than conventional materials. Some low-performing students mentioned about new material: "Questions are very difficult, but I think that I enjoy solving questions." These comments unveil new materials encourage low-performing students' motivation and discussion well.

Furthermore, scores of midrange-performing students are very interesting to us. Some scores of them indicate slightly different tendency compared with others (blue-highlighted in table 3.). At first, Q1 and Q2 have low scores, while High- and low-performing students' them are high. Midrange-performing students are less interested in discussion than we expected. On the other hand, Q9's score is higher than the other performance. Although the number of students in our classes may be limited, it might also suggest that midrange-performance students like to solve questions alone. Its reasons have too complex to unveil and need another research, but one of the reasons may be attributed to many 2nd graders' immature skills for discussions and debate.

Moreover, we emphasis the Q7's score for high- and midrange-students and Q9's one for low-performing (green-highlighted), because it is possible to detect all students have "role" during practice; for example, high- and low- performing students behave as "teacher" and "student" respectively. Tendency of "role-playing" has been seen in our previous research in 3rd graders, but present research brings different result. If we propose a hypothesis concerning 2nd graders, we can point out the gap of academic skills and ability of theoretical thinking isn't large yet.

As mentioned above, we discuss effectiveness of new material. This research quantitively makes it clear that the new material is very effective on encourage students' motivation and theoretical thinking. We are going to develop this research in physics classes.

Future Work

(1) Can new material apply other subjects?

Now, we also discuss about a problem of availability of new material in other subjects.

The features of new material are mainly three; (1) all students can share same questions, (2) students only share the process to the answer, (3) low-performing students can join face-to-face discussion and can get answers themselves. They bring students encourage students' motivation and theoretical thinking and all students can join face-to-face discussion easily. The first candidate to apply this method is mathematics, but at present, our question generation system doesn't support symbolic calculation yet, so we can't use the higher-level mathematics which learn in our college, so we apply this method in English as a trial.

Grammar is one of important unit of contents and hold a prominent position to understand English. In Japan, in order to learn English grammar, we usually use word-rearrangement quiz as drill questions in English classes. In word-rearrangement quiz, words which need a sentence arrange randomly, students try to rearrange correct arrangement. Word-rearrangement quiz has common feature same as physics questions; (1) all students can share same grammar, (2) all students can only share "grammar" because if words which need a sentence can reshuffle to other words, we prepare huge number of sentences which have same grammar; thus, we can make drill questions with same "grammar" but different "words". A question generation system for English is completed, so we ready for providing questions. In present, we collect example sentence. We are going to provide drill questions in autumn semester beginning October.

(2) Improvement question generation system

We have achieved encouraging face-to-face discussion and motivation to study in 2nd grader's physics classes. In addition, we have question generation system for English grammar and ready to provide in autumn semester. We are going to improve question generation system in the following points. At first, we develop the symbolic calculation system for mathematics. The reason why this system can't be applied to higher-level mathematics, because we can't symbolic calculation in our system. If we apply this method to mathematics, it will great help to students' theoretical thinking and face-to-face discussion.

One of the future ideas is to use Artificial Intelligence (AI) technique (machine learning algorithm, deep-learning algorithm and etc.) to generate drill questions. Ultimately goal is to build an auto-generated system for drill questions. However, if achieving it, we will need the huge collection of drill questions and their answers and will require prepare huge amount of knowledge about AI.

Conclusions

We developed new materials for physics which have same formula but different values. Using these materials has a merit of encouraging face-to-face discussion among students to solve drill questions. Our conclusions can be summarized in the below

- We develop new materials for physics. These are drill questions with same formula but different values. Aim of using new materials is to encouraging students' face-to-face discussion.
- We did a trial use of new material for 2nd graders in spring and summer semester in 40 physics classes. In trial use, we prepare 11units of the material. Those styles of discussion encourage students not only to be positive but also to improve students' theoretical thinking.
  - In order to investigate effects of new materials quantitatively, we held questionnaire survey about 2nd graders. This contains 10 questions for new material and 85 students answered it. We find all question's average score exceeds 2.5, students have positive impression to new materials.
- To clarify more details of those effects, we divide into three groups of students by the physics examination score. The low-performing students have achieved better results through face-to-face discussion. This research also quantitively makes it clear that the new material is very effective on encourage students' motivation and theoretical thinking

References

Kada, K. and Niwa, T. (2016). A Collaboration of science and literature to foster the logical thinking ability of students to learn engineering, *The 10th International Symposium on Advances in Technology Education*

Niwa, T. and Nakamura, Y. (2017) Quantitative Evaluation of Learning Effect of Peer Instruction in Physics, *The 11th International Symposium on Advances in Technology Education*,

Niwa, T., Nakamura, Y., Kikuchi, A., and Wakasa, T. (2018). How do we make students learn engineering? The importance of organization of classes by capacity according to the characteristics of students, *The 12th International Symposium on Advances in Technology Education*

Knuth, Donald Ervin (1984), The TeXbook, C*omputers and Typesetting, A, Reading, MA*: Addison-Wesley, ISBN 0-201-13448-9

Active Learning Based on Tourism and Culture –Contents Tourism as Teaching Material

Akio Kikuchi[*,a]

[a] Department of Liberal Arts and Engineering Sciences, National Institute of Technology, Hachinohe College, Hachinohe, JAPAN

*akikuchi-g@hachinohe.kosen-ac.jp

Abstract

It is needless to say that Kosen students need a wide of variety of cultural experience or knowledge as they are supposed to be global engineers in their future career. Although various subjects are provided for students of Hachinohe Kosen to study culture, one-sided inputting classes are given. In the fifth year students at Hachinohe Kosen, the attempt of applying tourism for the improvement of students' cultural knowledge was given. This attempt had been incessantly held since the subject was opened to students in 2013 in called 'Tourism and Culture' in which histories of tourism, tourist sites, tourism resources have been treated. In 2019 the class has focused on contents tourism, which is a pattern of tourism which offers tourists to enjoy the sites, places or natural resources related to cultural material including literature, comics, films, and so on. it is assumed that some topics which are familiar to students have the possibility for stimulating and promoting students' motivation for learning cultures. At the same time, it will enable students to learn geography, history, and literature not separately but as a cultural matrix. Based on this idea, TC in 2019 has provided the subjects concerning contents tourism with the assignments to promote an inbound travel plan using the relationship between regions and cultures. Through the activities in TC, it will be shown how the students' motivation will be bettered and contents tourism can be effective material for Kosen students' cultural understanding.

Keywords
Active learning, tourism, contents tourism, teaching material, cultural understanding,

Introduction

The main purpose of this study is to produce the new learning program based on contents tourism for students to study various culture. Contents tourism is a tourism focused on the cultural subjects such as literature, or film comics as the theme of travel. The students are facing the diverse cultures after their graduation as global engineers, but it is not difficult to say that they have enough or energetic motivations for learning various cultures. In addition, the fifth year students of Kosen have another reason for lessening their motivations for learning particularly as they succeed in job hunting. The success made them feel they have no necessity to study.

Tourism and Culture

It has been made clear from my previous research that tourism can be an effective medium for combining the cultural material and stimulating students' motivation to solve their negative attitudes toward the knowledge of history, literature, language, sociology, or other fields of studies. At National Institute of Technology, Hachinohe College, the subject 'Tourism and Culture' (TC) has been opened to the 5th year students as one of the selective subjects since 2013 by the author (except 2014 and 2015), 2016, 2017, 2018, and 2019. Since it started in 2013, 'Tourism and Culture' has been working on lectures on histories of tourism, tourist sites, tourism resources. In 2018, in addition to the other subjects, travel writing was more focused than previous years. Through these activities, the students are expected to not only come to know about historical situations in the time of the beginning of Meiji period but also try to think about inbound tourism through the text. In 2019, the contents tourism has been focused. Why? Contents tourism is a pattern of tourism which offers tourists to enjoy the sites, places or natural resources related to cultural material including literature, comics, films, and so on. As the examples of contents tourism are found in Aomori Prefecture like Tsugaru Area as a native place for a famous novelist called Dazai Osamu (1909-1948), and a comic called *Flying Witch* in Hirosaki, the contents tourism is not distant from the students' surroundings. Although the content tourism is not old idea, not a few arguments have been made concerning that topic. Nevertheless, it is difficult to find the attempt to use it for educational purpose. Admittingly, the choice of topics will be less effective, but it is assumed that some topics which are familiar to students have the possibility for stimulating and promoting students' motivation for learning cultures. At the same time, it will enable students to learn geography, history, and literature not separately but as a cultural matrix. Based on this idea, TC in 2019 has provided the subjects concerning contents tourism with the assignments to promote an inbound travel plan using the relationship between regions and cultures.

Results and Discussion

The class has more than ninety students, so its class size is difficult for active learning but in one activity students are divided into 24 groups for making presentations on the new museum as a cultural facility in Aomori Prefecture. Students are required to give papers in advance concerning their own ideas about the museum. In each group, most of which is made up of 4 students, members discussed their ideas and use each elements for making their group plans for presentations. Although discussions were made in Japanese, presentations were given in English.

Tourism and Culture Presentation 1

GROUP

Class:	No:	Name:
Class:	No:	Name:
Class:	No:	Name:
Class:	No:	Name:
Class:	No:	Name:

Discuss your plans about the new museum in Aomori Prefecture. Clarify the merit and demerits of each plan. And make a better plan using each idea. ※Each group is supposed to give a 3-minute presentation in June 12 (and June 19),

The leader of each group should submit presentation data to the supervisor: akikuchi-g@hachinohe.kosen-ac.jp。

1. It does not violate the natural environment
2. It should bring benefit for the local community.
3. It should contribute to the conservation of the natural or cultural tradition of the local societies,

Figure 1. Presentations on the museum

In other assignments, students are required to choose one of the travel writings concerning Aomori, explore the historical background of the text, and pick up the description of the local areas as the local promotion.

Special Lecture on Tourism and Culture Work Sheet No. 10

Class; No;	Name;
Date; / /2019	Subject; Travel Writing 実習

[1] 青森を訪れた旅行記を一つ選びなさい。

作者：

タイトル：

年代：

[2] 上記の旅行記について、書かれた当時の日本の歴史状況について、簡単に説明しなさい。

[3] 上記の旅行記について、訪れている地域描写の中で、地域をうまく描き出していると思われる個所を一パラグラフ（一パラグラフ以上でもよい）抜き出しなさい。

[4] [3]で抜き出した個所をもとに、その地域を端的に表すフレーズを作りなさい。媒体言語は問わないが、日本語以外の場合は和訳をつけること。

Tourism and Culture Report	
1	Name one of the travel writing texts whose setting is Aomori
	Author:
	Title:
	Year:
2	Explain the historical background of the text briefly
3	Describe the good expression of the local areas from the text
4	Make a short phrase from the description

Figure 2. Report on the travel writing

Through these activities, students are expected to learn the information of the region or areas in addition to cultures. In order to examine the students' consciousness, the following questionnaire will be given concerning the ideas on culture, history, geography, and so on.

2019 Tourism and Culture questionnaire

Class: No: Name:

Please mark each answer.

(1) Are you interested in knowing the culture of your area?
1 Yes, very much 2 Yes 3 Neutral 4 Not 5 Strongly Not
(2) Are you interested in knowing the culture of other areas?
1 Yes, very much 2 Yes 3 Neutral 4 Not 5 Strongly Not
(3) Are you interested in literature?
1 Yes, very much 2 Yes 3 Neutral 4 Not 5 Strongly Not
(4) Are you interested in history?
1 Yes, very much 2 Yes 3 Neutral 4 Not 5 Strongly Not
(5) Are you interested in geography?
1 Yes, very much 2 Yes 3 Neutral 4 Not 5 Strongly Not
(6) Do you know well about your hometown?
1 Yes, very much 2 Yes 3 Neutral 4 No t 5 Strongly Not
(7) Are you interested in enriching your knowledge on the culture of various areas including their history, geography, literature?
1 Yes, very much 2 Yes 3 Neutral 4 Not 5 Strongly Not
(8) Are you interested in travel or tourism?
1 Yes, very much 2 Yes 3 Neutral 4 Not 5 Strongly Not
(9) Are you interested in reading?
1 Yes, very much 2 Yes 3 Neutral 4 Not 5 Strongly Not
(10) How do you often read books?
1 More than five in a month 2 Four 3 Three 4 Two 5 One (Or none)
(11) Are you interested in contents tourism?
1 Yes, very much 2 Yes 3 Neutral 4 Not 5 Strongly Not
(12) Are you interested in visiting somewhere for contents tourism?
1 Yes, very much 2 Yes 3 Neutral 4 Not 5 Strongly Not

Thank you very much for cooperation.

Figure 3. The questionnaire on the students' attitude toward culture understanding

The result of this questionnaire will be introduced in the presentation.

Conclusions

The research will show how much the contens tourism can be effective as the teaching material for cultural understanding by evaluating the change of students' motivation for learning cultures in 2019 class of Tourism and Culture. Through the activities concerning the contents tourism in Aomori Prefecture, students have been working on the relationship between regions and culture. It will be more effective to connect the students' learning activities to the direct contibution to the local communities. Through this cycle, students will get more confident in their own learning, which will be another future subject of this study.

References

Bird, I. L. (2000) *Unbeaten Tracks in Japan.* 1880. San Francisco: Traveler's Tales.

Booth, A.. (1995) *Looking for the Lost: Journeys Through a Vanishing Japan.* New York: Kodansha USA.

Gruenwald, D. A., G. A. Smith, ed. (2008). *Place-Based Education in the Global Age.* New York and London: Psychology Press, 2008.

Hulme, P., and T. Youngs, ed. (2002) *The Cambridge Companion to Travel Writing*. Cambridge: Cambridge UP.

Kikuchi, A.. (2016). The Possibility of Tourism Studies for Engineering Students: An Attempt of 'Tourism and Culture' for 5th Year Students in 2016 year, *School Bulletin of National Institute of Technology, Hachinohe College* 51, 149-50

Urry, J.. (1990) *The Tourist Gaze: Leisure and Travel in Contemporary Societies*. Los Angels: Sage.

Youngs, T.. (2013). *The Cambridge Introduction to Travel Writing*. Cambridge: Cambridge UP

Introduction of the "integral engineering class" at Tsuruoka KOSEN: Background, Design, and Future Direction

R. Shomura*, M. Tanaka, K. Watanabe, S. Takahashi, H. Arafune, S. Hoshina, and T. Morinaga

National Institute of Technology (KOSEN), Tsuruoka College, Japan

* shomura@tsuruoka-nct.ac.jp

Abstract

The following skills are considered essential for engineers to successfully contribute toward society: (1) creativity - the ability to discover and solve issues; (2) initiative - presentation skills and self-expression; (3) team-building - cooperation, collaboration, and leadership; and (4) communication - active listening, dialog, and discussion. At Turuoka KOSEN, we have started a unique approach which we call the "integral engineering class" based on active learning designed to develop these abilities. In this paper, we discuss our efforts by focusing particularly on activities that contribute toward the development of initiative and leadership, which we consider to be areas of weakness among our students. Furthermore, we explore the effectiveness of the program and approaches to improve the course via student questionnaires.

In the integral engineering class, a wide variety of project-based learning (PBL)-type groupwork activities are combined with the teaching and learning of basic knowledge that engineers require throughout the first four years of the program. Toward this end, there is a joint PBL class for second- and fourth-year students in which the latter participate as facilitators in the former's group discussions. In particular, the fourth-year students support the second-year students' groupwork by supplementing the latter's knowledge and experience which makes it possible for them to engage in more in-depth discussions. Furthermore, the experience of team building and leadership is expected to help the fourth-year students to develop independence.

The effect of the joint class was investigated via student questionnaire surveys consisting of self-evaluation and mutual assessment. A preliminary analysis of the questionnaire results suggests certain positive effects of the program on "deep discussion" while at the same time, pointing toward the need for further "leadership education." We plan to continue improving the integral engineering class based on the questionnaire results.

Keywords: *KOSEN, Integral engineering class, Active learning, PBL, Initiative, Leadership*

Introduction

The "integral engineering class" is being conducted at Tsuruoka KOSEN as a cross-disciplinary class that students from all courses in our department from the first to the fourth year can attend. The main purpose is to educate "generic skills" in engineering within four years, and we are making various new attempts based on active learning to achieve this. The integral engineering class consists of introductory classes on engineering knowledge conducted in the form of lectures and project-based learning (PBL) classes in which teams work on issues (Figure 1). Students receive lectures on engineering ethics, intellectual property, entrepreneurship, and career plans, and they acquire the basic knowledge necessary to become an engineer after four years of study. For these lectures, we invite experts who are active in the front lines of research to become instructors. This is a major goal not only to impart technical knowledge, but also to cultivate the minds of the students to help them become engineers. Afterward, small groups discuss each lecture and establish knowledge from it that was received passively. The important aspect is to cultivate "understanding skills" and "thinking skills" through deep discussion about one theme and to encourage the students to establish their own ideas.

Intensive PBL lessons are given for each grade using various themes. By performing groupwork with several people in the group, the students share the experience of "providing results efficiently in a team"; learn about team building; and comprehensively develop the ability to find, think, and present. Furthermore, a major goal is to foster initiative and communication through the groupwork. As mentioned previously, the focus of the integral engineering class is on the improvement of generic skills required in the real world, such as initiative, communication, and teamwork, through active learning.

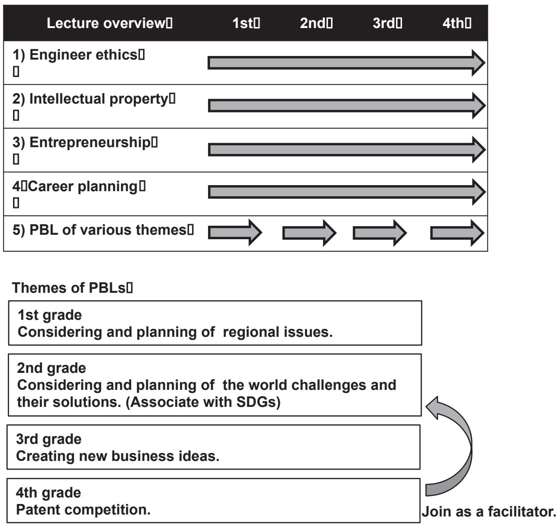


Figure 1. Content of the integral engineering class.

Materials and Methods

In the integral engineering class, a wide variety of PBL-type groupwork activities are combined with the teaching and learning of basic knowledge required for engineers throughout the first four years of the program. Especially, there is a joint PBL class for second- and fourth-year students in which the latter participate as facilitators in the former's group discussions. In detail, the fourth-year students support the second-year students' groupwork by supplementing their knowledge and experience, which makes it is possible for the latter to engage in more in-depth discussions. Furthermore, we expect that the experience of team building and leadership will lead to the development of initiative among the fourth-year students. Groupwork that mixes different grades has been introduced in other KOSENs and universities as well, but what is characteristic in our approach is that second-year students present ideas while the fourth-year students facilitate them by leading the groupwork and drawing out and summarizing the second-year students' ideas. By clarifying the roles in this way, we expect that they will better understand the work and role they should carry out and improve the quality of their team output, which thus contributes toward leadership education.

On the specific occasion for this study, two fourth-year student facilitators were assigned to second-year student groups consisting of eight people per group, and groupwork was conducted. The theme of the groupwork was sustainable development goals (SDGs), and the second-year students watched a DVD on global environmental issues related to SDGs before the groupwork. The fourth-year students had taken the class two years ago and had participated in the groupwork on the premise that there was prior knowledge. The output of the groupwork comprised issues to be solved and the solutions to them, at the end of which the second-year students presented their ideas. To verify the effect of this approach, we conducted questionnaire surveys to each of the second-year and fourth-year students.

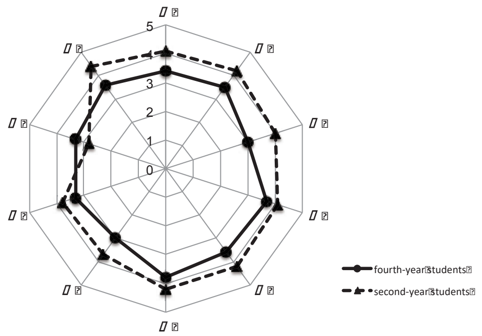
Results and Discussion

The questionnaires comprised a total of 10 questions on groupwork in general (questions Ⅰ to Ⅴ), mutual evaluation (Ⅵ to Ⅷ), and on the facilitator (Ⅸ to Ⅹ) as shown in Table 1. The answers comprised a scale of 1(not good) to 5 (good). The questionnaire results are reported as the average score for the second-year and fourth-year students for each question, as shown in Figure 2. The second-year students attained relatively high scores with regard to Ⅲ (How active was your team?) and Ⅶ (How many questions did have your team member?) whereas the fourth-year students had lower scores in comparison. This suggests that the second-year students' initiative was lower from the perspective of the fourth-year students. In particular, the scores were significantly different for Ⅸ (How easy was the facilitation?). For this question only, the score for the second-year students was lower than for the fourth-year students. From this result, although fourth-year students had received training on facilitation in advance, we think that a longer period of training is necessary.

However, when looking at the overall results, the scores were generally higher for the second-year students than in the fourth-year students, although the trend was similar. In particular, the following questions attained high scores high for both sets of students: Ⅰ (Did you share the theme with your team?), Ⅱ (How was the atmosphere?), Ⅳ (Did you give and receive diverse opinions?), Ⅴ (Finally, were the team's ideas summarized?), Ⅵ (Did your facilitator (or second-year students) listen actively?), and Ⅹ (Was the facilitator neutral position?). Subsequently, we consider that from the results obtained from the process and output of the groupwork, our learning approach is effective.

Table 1. Questions

Ⅰ	Did you share the theme with your team?
Ⅱ	How was the atmosphere?
Ⅲ	How active was your team?
Ⅳ	Did you give and receive diverse opinions?
Ⅴ	Finally, were the team's ideas summarized?
Ⅵ	Did your facilitator (or second-year students) listen actively?
Ⅶ	How many questions did have your team member?
Ⅷ	Could your facilitator (or second-year students) organize the ideas themselves?
Ⅸ	How easy was the facilitation?
Ⅹ	Was the facilitator neutral position?



fourth-year students (average score)	3.4	3.5	3	3.7	3.6	3.8	3	3.3	3.3	3.6
second-year students (average score)	4.1	4.2	4	4.1	4.2	4.2	3.7	3.8	2.8	4.4

Figure 2. Questionnaire results.

Conclusions

As part of the "integrated engineering class", we conducted a joint PBL class in which the fourth-year students participated as facilitators for the second-year students' groupwork, and verified the effectiveness of this approach. From the questionnaire results, especially from the questions concerning the groupwork process and output, the scores for both sets of students were high and the effectiveness of this class was evident. On the other hand, weaknesses such as a lack of initiative by the second-year students and a lack of facilitation skills in the fourth-year students were also noted. We will provide feedback on these results and use them to improve the integrated engineering class approach.

Acknowledgements

We would like to thank all teachers at Tsuruoka KOSEN for their cooperation.

INTEGRATING PYTHON PROGRAMMING INTO CURRICULUM FOR SPECIALIST DIPLOMA COURSES IN DATA SCIENCE.

U-L. Tang*,a

[a] Singapore Polytechnic/School of Mathematics and Science, Lead(Projects), Singapore, Singapore
*tang_u_liang@sp.edu.sg

Abstract

The Python programming language invented by Guido Rossum in 1991 has become synonymous with data analytics. Many courses offered as adult continuous training courses or conversion diplomas contain at least one module on how to use Python for data science. However, this module is usually taught as a *programming* module separate from a data analytics context. The theory of data science is usually taught in other modules which may or may not use Python in their curriculum.

The purpose of this paper is to examine these three reasons for integrating Python into a data analytics curriculum and to test out the hypothesis that integrating a course in data science with Python programming will produce better outcomes in terms of mastery, motivation and student satisfaction in the course. In particular we were interested to compare this new approach with a prior approach of teaching data analytics without the use of Python programming.

In carrying out this study, we will integrate Python into the teaching of data analytics for the second run of the module, conduct a post-assessment review and collect student feedback. We will analyse the feedback and compare it with feedback obtained from a previous run. This paper will discuss the results of our approach and gives recommendations for future runs.

Keywords: *Python, computer aided instruction, data science, data analytics, adult education, andragogy*

Introduction

Data science and data mining is undoubtedly one of the most discussed and hyped discipline in today's discourse.

A report from LinkedIn (Lewis 2019) reveals that data science and related disciplines are within the top 30 most in-demand hard skills for 2018. In Singapore, a data analysts can expect an average pay of SGD 6k per month. It was estimated from the same that Python programming skills would increase earnings by 15% on average. (Payscale.com)

Clearly this shows the industry importance of data science and Python programming. It is because of industry demand that the School of Mathematics and Science, Singapore Polytechnic has been active in offering adult continuous education training (CET) courses to meet demand of such skills.

While there is no one set definition of "data science" as an academic discipline, we can glean several important characteristics of data science and analytics that are particularly important for training in data science:

(1) Multidisciplinary approach, (2) Industry focused, (3) Data driven, (4) Deep understanding of business use cases and implementation.

Andragogy for data science and analytics

CET course design in SP is based upon the four principles of andragogy by Knowles (1984) (1) Involvement in planning and evaluation of instruction, (2) Experiential learning, (3) Relevance to their jobs and (4) problem centered instead of content centered.

These principles are general, but helpful when applied in particular to data science training. In particular, a course in data analytics would then encompass the need to (1) explain the reasons for choosing a particular models over others, (2) instruction revolves around working with real datasets from various domains instead of simulated ones, (3) Cater to various learner backgrounds e.g. some students are from management who want exposure, others are looking to acquire hard skills for a career switch. (4) Opportunity to work with data and complete assignments without direct supervision from the instructor.

Software usage is very much an integral part of teaching data science. This is because in dealing with big data, it is impossible to perform the calculations "by hand" on datasets which have tens of thousands of rows. Thus the need for good software to support teaching and learning.

In this regard, we have data mining software like RapidMiner, Statgraphics, Minitab, KNIME and TIBCO Statistica and others which have a suite of tools designed to make data analysis and modelling a point and click affair. At an enterprise level, we have a tools like IBM Data Science Experience (DSX), IBM Watson Studio, Alteryx, Dataiku and others which promises to integrate and streamline the training and deployment of enterprise predictive models for the organization. KNIME was chosen as the data mining tool in our course.

A normal data science class would consist of teaching of some common and well known algorithms for generating predictive models and then a lab work where software is used to generate said models from example datasets.

One of problems we found with this approach course based on feedback received from students is the apparent disconnect between the theoretical content of the course and the practical aspects of the course.

Students' feedback that they could not relate what was learnt in the classroom to their workplace needs.

In order to meet these concerns from the students, we undertook to implement several improvements to the course to bring it further in line with Knowles principles'.

One was to introduce Python based laboratory work to complement training in data science.

History of Python programming

Python was created in 1989 by Guido von Rossum in CWI in Netherlands as a successor to ABC (a programming language which was intended for teaching and prototyping). It was not until 1991 that the first release was published as v0.9.0. Ever since, it has enjoyed surging popularity not only among data scientists but the general developer community. As of July 2019, Python is ranked number 3 on the TIOBE index behind Java and C. (https://www.tiobe.com/tiobe-index/)

Why has Python enjoyed such growth over the years? We identify three main reasons:

(a) Productivity

As an interpreted language, Python can run code with a time consuming "build" or compilation step. In other words, a data scientist can execute code immediately. So a user can type a block of code, run it and check the output. Coding with Python becomes a quick iterative process with no compilation downtime.

This is of great utility to the data scientist as data science is inherently exploratory. Which means it is not a linear but non-linear process with backtracking, re running segments of code, trying out new computations on the fly. It is no wonder that Python has become the language of choice when doing data science.

(b) Expressivity

Python is also a very expressive language. Expressivity in a programming language is defined to be the ability of a language to express a solution to a problem in the closest way to the original problem, in a clear, natural, intuitive and concise way and in terms of other solved sub problems.

Python checks all the boxes in this regard. A convention used in Python is use descriptive variable names. In this way, Python code becomes almost self documenting. Indeed, one of the reason for its popularity amongst data scientists is that Python libraries like Pandas used extensively in data analysis and manipulation have an almost declarative API that encourages the developer to think about the final shape of the data instead of the steps taken to shape the data.

(c) The ecosystem and community

The Python community is also a burgeoning one. Stack Overflow, a community site for troubleshooting support recently reported that Python is one of the most questioned languages on the site beating Javascript.

In general, the community support for Python encourages beginners to start with Python as they know that there is active support for the language. Besides Stack Overflow, other community sites like Dev.To and Medium have many tutorials and how-to instructions for doing things like reading data from a file, building machine learning models with SciKit Learn all the way to building simple web applications.

It is not an exaggeration to say that one could learn Python without ever needing to take a formal course in programming or computer science. This is not to say that there are not online courses available to learn Python. Both Udemy and Coursera, giants in the MOOC space offer many courses in Python ranging from topics from data analytics, visualization, programming and web development.

Pedagogical uses of Python programming

Python has been used for teaching and learning ever since its creation. von Rossum writes,

It all started with ABC, a wonderful teaching language that I had helped create in the early eighties. It was an incredibly elegant and powerful language, aimed at non-professional programmers. Despite all its elegance and power and the availability of a free implementation, ABC never became popular in the Unix/C world. I can only speculate about the reasons, but here's a likely one: the dif- ficulty of adding new "primitive" operations to ABC. It was a mon- olithic, "closed system," with only the most basic I/O operations: read a string from the console, write a string to the console. I deci- ded not to repeat this mistake in Python.

–quoted from Tollervey (2015)

Python has been used extensively by many faculty for teaching of programming as first language. Miller (2004) writes

"In order to communicate with a computer a programmer must use a language. Although there are many computer languages from which to choose, there are few designed with the beginning programmer in mind."

For this reason, many have used Python to teach concepts in computer science like Object-Oriented Programming with Python. Such experiences are document in this paper by Goldwasser and Letscher (2008) which use Python to introduce students to OOP before moving them to languages like Java and C++. One important reason for using Python was features like (1) dynamic typing (2) a consistent object model and (3) no need to declare variable visibility (private, static, public) which takes away much of the initial cognitive burden of learning programming. What we note is that by taking away much of the burden of ensuring correct typing and variable visibility, the learner focuses on the logic of problem solving and using programming syntax to express the solution.

Miller also notes that,

scientific computer simulations are not just the working out of mathematical equations, but rather, the execution of algorithms that may model physical *phenomena that cannot be represented by equations. And it is the conceptualization and embodiment in code of those algorithms that will more and more constitute the life of the mind of future scientists.*

For this reason we are encouraged to use Python in an integrated way to teach data mining. As data mining involves steps in data manipulation, cleansing and modelling, students have to think very explicitly about their process when forced to code. Such explicit representation of thinking help improves reasoning and high-level conceptualization of the data mining / problem solving process.

Yet we note that not all students in an adult class are programming literate. Thus, our approach in integrating programming, even one as beginner friendly as Python, into a lesson cannot be one where students are expected to code. Due to varying levels of comfort, we have opted to use a tool that can display code, execute it and display output of modelling. The only required level of interaction from the student is to execute the script of block of code.

This led us to the adoption of IPython notebooks to deliver lesson content. IPython notebooks can be run locally via Jupyter Notebooks, a REPL environment developed by Project Jupyter. Jupyter notebooks can be tried out on a browser (https://jupyter.org/try). Service providers like Azure and Google also offer Jupyter Notebooks which are hosted on the cloud. Our choice of provider and implementation is detailed the next section.

Materials and methods

In view of andragogical requirements-in particular experiential learning and job relevance-we adopted Python as a programming language supplement to our data science training.

For implementation in the CET course, we prepared several IPython (Interactive Python) notebooks which could be run in a REPL (Repeat-Eval-Print-Loop) environment. One of the more well known REPL environments for Python is the Jupyter Notebook environment distributed by Anaconda, inc. However, we note that this requires installation of the entire Python stack on students own personal device which leads to a host of configuration issues.

Both Google (https://colab.research.google.com/notebooks/welcome.ipynb) and Microsoft (https://notebooks.azure.com/) provide free deployments of a Python REPL environment which can run IPython notebooks. These run on the cloud and students are able access this service via a browser without the need of any local Python installation. We chose to go with Google Colaboratory because of (1) Integrated forms (2) 25GB free temporary space for files (3) Integration with GitHub and Google Drive.

We prepared IPython notebooks which revolved around several important concepts in data science: (1) Bias and variance in models, (2) K nearest neighbors' algorithm (3) Polynomial regression.

During a session, students would work through the notebook. Each notebook was prepared with sections of code and the student need only execute the said cell and get the output. Several discussion questions had been prepared and students' used the output from the code blocks as prompts for further reflection and class wide discussion.

A survey was carried out among the students to ascertain their response and feedback to this particular form of teaching.

Discussion of results

An anonymous survey was carried out asking these four questions (1): Did you pass the mid semestral test? (2) I believe programming is an essential part of learning data mining (3) The Google Colaboratory Lab work has been helpful in helping me gain deeper knowledge of data mining (4) Any other feedback.

What is interesting to note that more than half (76% of respondents) agreed that programming skills were important in a data science course. This agrees with industry wide assessment that Python programming is an essential technical skill for a data analyst. (KDnuggets, retrieved 17 July 2019).

Their response to whether implementation in Google Colaboratory was successful was slightly more mixed with a majority of respondents neutral towards its helpfulness. As the student interaction with the Python material was essentially passive, it was not surprising.

This suggests that future implementations of Python coding in a data science course may require more coding input from students if it is to make a difference to the student experience.

Future improvements

There is a fear that introducing programming into a data science course may introduce an unnecessary level of difficulty for a learner who may have prior training in programming. Yet, based on student feedback, industry practise and the usage of Python in data science, we feel that Python should be an integral part of the curriculum.

There are two extremes which should be avoided: (1) A course which descends into a *programming* course for data scientists and another extreme (2) in which the course becomes nothing more than an introduction to data science and fails to impart any hard skills to students.

We suggest the following improvements to implementing an integrated approach to data science and programming. (1) Illustration of important concepts in data science and data analysis using Python programming as a computational and/or visualization tool. This envisions using Python as lecturer's teaching aid and does not require participation from the learner. (2) Python based lab work integrated into every lesson instead of selected topics to underline its importance as a tool for data science. (3) Assessments which require minimal programming to complete in order to give students practise with the language and exposure to its usage in a data analytics workflow.

Conclusion

In this short study, we have implemented elements of Python coding into the curriculum of a CET module in data science and studied student responses.

We found that students agreed that programming was important to data science but felt that the material did not fully help them appreciate its importance. Further improvements to this teaching method was suggested in line with established principles of andragogy.

References

Goldwasser, M.H., Letscher, D. *Teaching an Object Oriented CS1-with Python.* Proceedings of the 13th Annual Conference on Innovation and Technology in Computer Science (ITiCSE), Madrid, Spain Jun. 30-Jul. 2, 2008, pp. 42-46.

KDnuggets, *9 Must-have skills you need to become a Data Scientist updated.* Retrieved from https://www.kdnuggets.com/2018/05/simplilearn-9-must-have-skills-data-scientist.html

Knowles, M. (1975). *Self-Directed Learning*. Chicago: Follet.

Knowles, M. (1984). *The Adult Learner: A Neglected Species (3rd Ed.)*. Houston, TX: Gulf Publishing.

Lewis, G. *The most In-Demand Hard and Soft Skills of 2019.* Retrieved from https://business.linkedin.com/talent-solutions/blog/trends-and-research/2018/the-most-in-demand-hard-and-soft-skills-of-2018.

Miller, J.A. (2004) *Promoting computer literacy through programming Python.* Thesis, University of Michigan.

Payscale.com. Retrieved from https://www.payscale.com/research/SG/Job=Data_Analyst/Salary

Tollervey, N.H (2015) *Python in Education*. O'Reilly Media, Inc.

Curriculum Design based on Universal Maritime Education

A. Futamura[*,a], S. Kubota[b], A. Yabugami[c], K. Yamada[d], H. Murata[e], N. Yuda[a] and T. Murakami[a]

[a] National Institute of Technology (KOSEN), Yuge College, Maritime Technology Department, Japan
[b] National Institute of Technology (KOSEN), Toba College, Maritime Technology Department, Japan
[c] National Institute of Technology (KOSEN), Hiroshima College, Maritime Technology Department, Japan
[d] National Institute of Technology (KOSEN), Toyama College, Maritime Technology Department, Japan
[e] National Institute of Technology (KOSEN), Oshima College, Shipping Technology Department, Japan

*E-Mail futamura@ship.yuge.ac.jp

Abstract

We aimed to make a universal curriculum cooperated with the five maritime colleges for the development of future world-class seafarers. In the late years, the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (STCW) was revised for the innovation in the marine transportation. Specifically, seafarers decided to need new techniques such as ECDIS (Electronic Chart Display System), BRM (Bridge Resource Management) and ERM (Engine Resource Management). In this way, the ability required for seafarers was greatly advanced. We, the five maritime colleges, had to meet the needs of the shipping industry. Thus, we considered a new curriculum for the training of future seafarers. As the first step, we used the results of company questionnaires to understand the important skills required of seafarers. In the second step, we examined the efficiency of the current curriculum in order to add credits of new skill subjects. Finally, we discussed what kinds of teaching methods are good for new skill subjects, and we carried out the experimental class for new skill subjects. As a result of first step, it was revealed that communicative competence, problem discovery power, sense of responsibility, teamwork power, abilities for carrier design and patience were important skills for seafarers. Second, we were able to streamline the current curriculum to add new skill subjects. As a result of the third step, we proposed an active learning style with mixed grade groups as a new skill subjects teaching method. Therefore, we created a table of each grade credits and an example of timetable for mixed grade groups classes. In the experimental class by the mixed grade group, some students had an opportunity to organize their thoughts and their problem discovery power and communicative competence were improved. In conclusion, we made a universal curriculum cooperated with the five maritime colleges. We found that mixed grade group classes were very effective to learn new skill subjects. We propose the creation of a timetable that allows classes to be implemented by mixed grade groups.

Keywords: *curriculum design, five maritime colleges, seafarers, new skills, active learning, mixed grade group*

Introduction

The marine transportation is important transportation means for Japan surrounded in the sea. In the late years, the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (STCW) was revised for the innovation in the marine transportation. Specifically, seafarers decided to need new techniques such as ECDIS (Electronic Chart Display System), BRM (Bridge Resource Management) and ERM (Engine Resource Management). In this way, the ability required for seafarers is greatly advanced. We, the five maritime colleges, have to meet the needs of the shipping industry.

Then, 6 years ago, we, the five maritime colleges started a project to develop a high quality maritime education system by forming a team with Japanese Shipowners Association, Japan Maritime Officers Association, All Japan Seamen's Union, and International Mariners Management Association of Japan, which are stakeholders, in order to raise advanced seafarers required by the marine transportation industry. This project aims to present the knowledge and skills that future seafarers should have.

Based on the findings obtained from this project, we were able to assume three career models of students after graduation. They are marine jobs, land jobs, and university advancement. In addition, it was possible to clarify the abilities to be acquired for each of these three career models (Yamamoto et al., 2018). At the same time, it was also revealed that the current curriculums of our maritime colleges were not designed to enable students to acquire the communication and other skills required for these career models. In other words, in order to train future seafarers, it is necessary to establish a new curriculum.

Therefore, this study aims to establish a new curriculum for training seafarers who can surely acquire these skills and knowledge.

Methods

(1) Survey of knowledge and skills required of seafarers

In developing a new curriculum, it is important to identify the knowledge and skills required for seafarers. In the project mentioned above, an enterprise questionnaire survey was conducted in 2016, and answers were obtained from 38 companies, and knowledge and skills necessary for seafarers were clarified. This study will incorporate the results of this questionnaire into a new curriculum.

(2) New Curriculum Policies

Based on the knowledge of the past projects, we have summarized the three types of knowledge and skills that need to be strengthened in order to develop future seafarers (Figure 1). One is strengthening English skills. It is an essential ability to work as an ocean-going seafarer. English ability is necessary for wireless phones even in Japan. The second is human resources development as seafarers. The communication skills, teamwork skills, sense of responsibility, and self-management skills are the capabilities necessary to carry out the business with the companion in the narrow ship for the long term. The third is fostering the ability to establish learning basic and specialized academic abilities. In the maritime industry, technological innovation related to ICT continues, and human resources capable of flexibly dealing with technological innovation are required. Therefore, it is necessary to foster students with basic and professional academic abilities.

(3) Efficiency of the current curriculum and new skill credits

We, the five maritime colleges, serve as both a higher education institution and a training institute for seafarer. Therefore, in addition to the regular engineering curriculum of higher education institutions, license related subjects should be taught. In recent years, the number of subjects related to license has increased due to the revision of the law. Therefore, it is very difficult in terms of time to add classes of all the newly required abilities to the current curriculum. Therefore, we propose to improve the efficiency of the current curriculum by clarifying the scope of teaching using the model curriculum common to the five maritime colleges. Credits generated by the efficiency improvement of the current curriculum will be added as new skill credits. The purpose of the new skill credit is to develop three reinforcing skills (Figure 1). Therefore, these units will develop the strengthening English skills, human resources as seafarers, and the ability to establish learning.

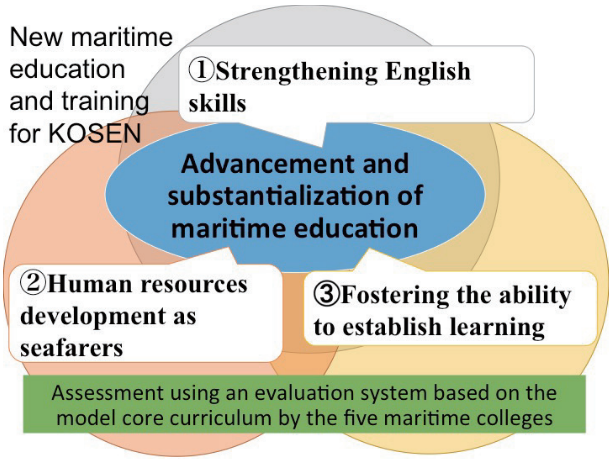


Figure1 Three policies of new curriculum

Results

(1) Knowledge and skills required for seafarers through corporate questionnaires

We describe the knowledge and skills required at the time of entry and the results of those required levels as revealed in the company questionnaire. The required level is based on the level of achievement defined in KOSEN model core curriculum (Table 1). First, the level of basic and professional academic ability at the time of entering the company was the level 3. It was proven that these were equal to the level required in present technical college graduation. In the meantime, the skill required in the society was the level 3, and especially, communication ability and problem finding ability were regarded as important. The skill on the human power was the level 4, and especially, the enterprise regarded sense of responsibility, teamwork, career design ability and patience as important. Next, it was proven that information collection, utilization, transmission skill, logical thinking skill, self-management skill, and ability to get used to the sea were also required. From this fact, it became clear that especially, the high level of the skill concerning the human power was required.

(2) Result of streamlining the current curriculum

In order to examine the efficiency improvement of the current curriculum, we organized 147 credits of graduation from the Maritime Department. First of all, 147 credits can be divided into 75 credits or more for general subjects and 62 credits or more for special subjects. Specialty credits include 43 credits (Navigator course) or 39 credits (Engineer course), which are necessary for seafarer training. In this study, the maximum number of credits required for seafarer training was 43.

We found that in the current curriculum, 43 seafarers training credits were distributed among more than 62 credits of specialized subjects. Therefore, we decided to consolidate the dispersed training credits as much as possible (Figure 2). And, the special subject was decided to be 72 credits. As a result, 10 credits out of 72 credits of specialized subjects were created as new skill credits (Figure 2), excluding necessary credits such as seafarers training credits and graduation research credits.

Table1 Level of achievement defined in KOSEN model core curriculum

Level 1	Having the ability to recall
Level 2	Having the ability to understand the meaning of important concepts and methods and use them as needed
Level 3	Having the ability to use knowledge or theory or information to solve applied cases or problems
Level 4	Having the ability to identify, focus, organize, and reason why elements are related to complex problems
Level 5	Capable of being judged on the basis of standards or norms
Level 6	It has the ability to reassemble elements and reorganize elements to organize the whole.

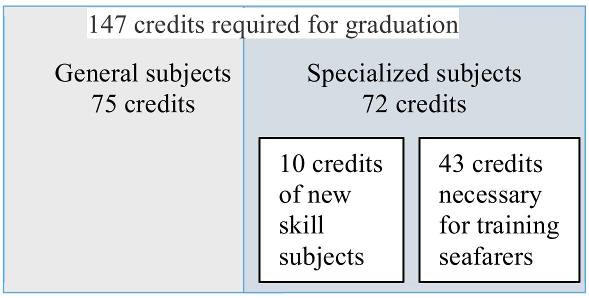


Figure 2 Diagram of efficiency improvement of current curriculum

(3) The credits table for each subject and subjects of new skills

We were able to add 10 new skill credits by streamlining the current curriculum. In this section, we presented the credits table for each subject in the new common curriculum of the five maritime colleges (Table 2). 147 units of graduation credits consisted of 72 units of specialized subjects and 75 units of general subjects. Specialized subjects were classified by purpose, including 43 credits required for training seafarers, 6 credits for graduation research, 10 credits for new skill, 4 credits for mixed class of departments, and others. Subjects of new skill credits were named "Exercise of Career design and presentation".

Table 2 The credits table for each subject in the new common curriculum. "N" and "E" mean navigator and engineer Courses.

[Course and Grade] Name of the subject	Credit
[NE1] Basic training	2
[NE1] General engineering overview	2
[NE1] Information literacy	1
[NE1] Exercise of career design and Presentation 1	2
[NE1] Practical training on a training ship 1	1
[NE2] Exercise of career design and Presentation 2	2
[NE2] Fundamental mechanics	2
[NE2] Information processing	1
[NE2] Electricity and electrons	2
[NE2] Practical training on a training ship 2	1
[NE2] Experiment and Practice 1	2
[NE3] Ship engineering	1
[NE3] Maritime law	1
[NE3] Exercise of career design and Presentation 3	2
[NE5] Applied mathematics	2
[N3] Navigation, operation, and laws 1	9
[N3] Practical training on a training ship 3	1
[N3] Experiment and practice 2	3
[N3] License training 1	1
[N4] Experiment and practice 3	2
[N4] Navigation, operation, and laws 2	8
[N4] License training 2	2
[N5] Practical training on a training ship 4	2
[N5] Navigation, operation, and laws 3	8
[N5] Graduate study	6
[N5] License training 3	2
[E3] Engine and works 1	9
[E3] Practical training on a training ship 3	1
[E3] Experiment and practice 2	3
[E3] Free subject 1	1
[E4] Experiment and practice 3	2
[E4] Engine and works 2	8
[E4] Free subject 2	2
[E5] Practical training on a training ship 4	2
[E5] Engine and works 3	8
[E5] Graduate study	6
[E5] Free subject 3	2
[NE4] Exercise of career design and Presentation 4	2
[NE5] Exercise of career design and Presentation 5	2
[NE4] Elective subject 1	2
[NE5] Elective subject 2	4

Discussion

The purpose of the new skills course "Exercise of career design and presentation" is to develop the 3 reinforcing skills mentioned above (Figure 1). For this purpose, we considered a mixed class by active learning. The purpose of this class is to ensure the acquisition of knowledge and skills by communicating the knowledge and skills that students have learned to other students in different grades. For this reason, in order to make it possible to conduct mixed grade classes, we arranged “Exercises of career design and Presentation” for each grade (Table 2). In addition, we created an example of a timetable for placing “Exercises of career design and presentation” at the same time (Table 3).

Table 3 Example of a timetable

Course and Grade	Thursday			
		10:30 – 12:00	13:00 – 14:30	14:40 – 16:10
NE1		Mathematics	**Exercise of career design and presentation 1**	
NE2		Society	**Exercise of career design and presentation 2**	
N3		Navigation, operation, and laws 1	**Exercise of career design and presentation 3**	English
E3		Engine and works 1		
N4		Navigation, operation, and laws 2	**Exercise of career design and presentation 4**	Health and physical education
E4		Engine and works 2		
N5		Navigation, operation, and laws 3	**Exercise of career design and presentation 5**	Graduate study
E5		Engine and works 3		Graduate study

In addition, we conducted an experimental class related to this class (Photo 1). In the experimental class, a few students in the fifth grade taught a few students in the first grade how to write the career design note of the maritime department based on their college experience. The career design notebook of the maritime department is a notebook in which students of the maritime department write down the knowledge, skills and experience they have acquired on the campus in order to help them achieve their career goals by the time they graduate (Figure 3). This book was created in our project. At the beginning of the class, some 5th graders explained to 1st graders the purpose of the notebook and how to write it. The fifth grade students talked about their future career vision, club activities, and their experience in qualifying. Next, first graders asked about their experience in training large training vessels. First graders had the opportunity to see examples of students achieving their career goals.

Photo 1 Scenes of the experimental class

Figure 3 The career design notebook

graduation from the Maritime Department. First of all, 147 credits can be divided into 75 credits or more for general subjects and 62 credits or more for special subjects. Specialty credits include 43 credits (Navigator course) or 39 credits (Engineer course), which are necessary for seafarer training. In this study, the maximum number of credits required for seafarer training was 43.

We found that in the current curriculum, 43 seafarers training credits were distributed among more than 62 credits of specialized subjects. Therefore, we decided to consolidate the dispersed training credits as much as possible (Figure 2). And, the special subject was decided to be 72 credits. As a result, 10 credits out of 72 credits of specialized subjects were created as new skill credits (Figure 2), excluding necessary credits such as seafarers training credits and graduation research credits.

Table1 Level of achievement defined in KOSEN model core curriculum

Level 1	Having the ability to recall
Level 2	Having the ability to understand the meaning of important concepts and methods and use them as needed
Level 3	Having the ability to use knowledge or theory or information to solve applied cases or problems
Level 4	Having the ability to identify, focus, organize, and reason why elements are related to complex problems
Level 5	Capable of being judged on the basis of standards or norms
Level 6	It has the ability to reassemble elements and reorganize elements to organize the whole.

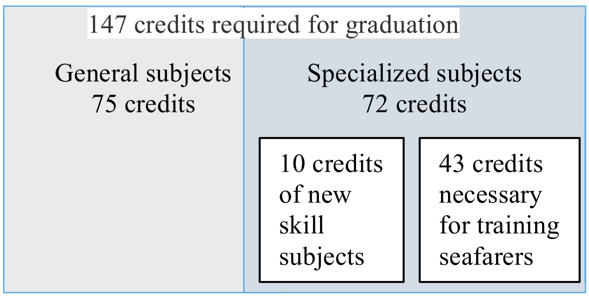


Figure 2 Diagram of efficiency improvement of current curriculum

(3) The credits table for each subject and subjects of new skills

We were able to add 10 new skill credits by streamlining the current curriculum. In this section, we presented the credits table for each subject in the new common curriculum of the five maritime colleges (Table 2). 147 units of graduation credits consisted of 72 units of specialized subjects and 75 units of general subjects. Specialized subjects were classified by purpose, including 43 credits required for training seafarers, 6 credits for graduation research, 10 credits for new skill, 4 credits for mixed class of departments, and others. Subjects of new skill credits were named "Exercise of Career design and presentation".

Table 2 The credits table for each subject in the new common curriculum. "N" and "E" mean navigator and engineer Courses.

[Course and Grade] Name of the subject	Credit
[NE1] Basic training	2
[NE1] General engineering overview	2
[NE1] Information literacy	1
[NE1] Exercise of career design and Presentation 1	2
[NE1] Practical training on a training ship 1	1
[NE2] Exercise of career design and Presentation 2	2
[NE2] Fundamental mechanics	2
[NE2] Information processing	1
[NE2] Electricity and electrons	2
[NE2] Practical training on a training ship 2	1
[NE2] Experiment and Practice 1	2
[NE3] Ship engineering	1
[NE3] Maritime law	1
[NE3] Exercise of career design and Presentation 3	2
[NE5] Applied mathematics	2
[N3] Navigation, operation, and laws 1	9
[N3] Practical training on a training ship 3	1
[N3] Experiment and practice 2	3
[N3] License training 1	1
[N4] Experiment and practice 3	2
[N4] Navigation, operation, and laws 2	8
[N4] License training 2	2
[N5] Practical training on a training ship 4	2
[N5] Navigation, operation, and laws 3	8
[N5] Graduate study	6
[N5] License training 3	2
[E3] Engine and works 1	9
[E3] Practical training on a training ship 3	1
[E3] Experiment and practice 2	3
[E3] Free subject 1	1
[E4] Experiment and practice 3	2
[E4] Engine and works 2	8
[E4] Free subject 2	2
[E5] Practical training on a training ship 4	2
[E5] Engine and works 3	8
[E5] Graduate study	6
[E5] Free subject 3	2
[NE4] Exercise of career design and Presentation 4	2
[NE5] Exercise of career design and Presentation 5	2
[NE4] Elective subject 1	2
[NE5] Elective subject 2	4

DEVELOPMENT OF A TASK-BASED ONLINE SELF-LEARNING SYSTEM USING LMS

Yoshiyuki Usuda*

General Education (Humanities), NIT, Hakodate College, Hakodate, Japan

*usuda@hakodate-ct.ac.jp

Abstract

The purpose of this study is to introduce the development of an online self-learning system in which EFL (English as a Foreign Language) learners will engage themselves in listening activities and language focus activities with the help of the idea of Task-Based Language Teaching (TBLT), and to discuss how the system can benefit the learners. The online self-learning system, which works as Learning Management System (LMS), was designed based on the flow of Task-Based Language Teaching (Ellis, 2003). Input-based tasks (Ellis, 2003) were chosen, considering the L2 competence of the participants. They were required to work on activities in two phases in the LMS. The first one was the main-task phase (listening activity) which stimulates learners' prediction, and the second was the post-task phase which requires them to learn linguistic features from the transcripts of the skits and to practice pronunciation. The participants were 199 Kosen students, and they worked on the tasks online outside of school for several weeks. The results of the questionnaire survey of the students showed that the tasks and system were regarded favourably. They rated the self-learning system on ten-point scale evaluation (1. very poor---10. Excellent). The average was 7.96, which was higher than we had expected. However, their free comments included its inconveniences and disadvantages. We found that the online self-learning system leaves much room for improvement of functions of the system and more creative activities.

Keywords: *Online self-learning system, LMS, listening tasks, prediction, main-task phase, post-task phase*

Introduction

Task-Based Language Teaching can be viewed as an approach for developing four language skills (Ellis, 2003). It involves input-based tasks as well as output based tasks. In input-based tasks, learners listen to input and process the input to accomplish a communicative outcome. Teachers can devise input-based tasks to cause learners to pay attention to new words and guess the meanings of them from the context.

An input-based task is usually designed in a classroom where the input is coming from the teacher and the students are required to process the input to achieve the goal. The author explored designs of input-based tasks that can give learners opportunities to do tasks and learn vocabulary and linguistic features outside of the classroom. One possible way is e-Learning using LMS. Learners work on an input-based task, or a listening task, and learn linguistic features after the task. We must take into an account, however, that there is a drawback in designing input-based tasks on LMS. It is impossible for learners to produce language orally if they so wish because they have to do the tasks online. Even if they have something to ask about the input, they cannot interact with the teacher or classmates. Nevertheless, the author regards doing input-based tasks online as effective to learners in that they have opportunities to learn linguistic features.

In addition to introducing the input-based tasks incorporated into LMS, this study addresses a research question: How effective is the task-based online self-learning system for the learners?

Tasks and ICT

Tasks in ESL (English as a Second Language) settings have been highly evaluated by not only practitioners but also researchers of SLA (Second Language Acquisition), and activities are normally considered to be interactive (Ellis, 2003). However, it is occasionally said that introducing such reciprocal tasks to EFL settings is difficult, especially in classrooms where learners' speaking level is low. Prabhu (1987) argued that it was difficult for beginner learners to use the L2 productively, so input-based tasks should initially be introduced.

According to Ellis (2003), a task can involve both productive language skills (speaking and writing) and receptive language skills (listening and reading). It must satisfy four criteria for tasks: (1) the primary focus is on meaning, (2) there is some kind of gap, (3) learners rely mainly on their own linguistic and non-linguistic resources, (4) there is a clearly defined communicative outcome. In input-based tasks, for example, learners are required to listen to spoken texts and then perform some action. They must comprehend meanings by making use of their own linguistic and non-linguistic resources (i.e, context, world-knowledge and gestures). So, when introducing a task-based approach to teaching, input-based tasks would be easier than output-based tasks that force learners to speak and interact with others.

It is generally difficult to create environments in which learners are exposed to the L2 outside of school in EFL settings, where there is no need to use the L2. Unless they are really motivated and autonomous, learners are not likely to expose themselves to the L2 voluntarily although they could have access to a great deal of input material on the Internet.

The author thinks ICT such as computers and mobile devices can provide L2 learners with opportunities to not only expose themselves to L2 input but also work on input-based tasks that can arouse their interest through LMS (Learning Management System) or applications.

Online Self-learning System

In order to provide students with L2 input outside the classroom, the author designed an LMS in which they can work on input-based listening tasks and post-task activities online by themselves so that they will be able to learn linguistic features and also to practice pronunciation as often as they like outside of school. Based on the design, an e-learning system (LMS) was created by an ICT solutions company. We use skits as listening material for tasks so that learners can listen to conversations where they learn useful words, phrases and structures they can use in their L2 conversations.

The system has two phases. The first phase includes prediction tasks. Learners are required to predict the place where a conversation they are listening to is taking place, the number of people who are talking, and the season or month, etc. Prediction is a natural cognitive process that naturally occurs in using language. Learners are required to employ it in order to carry out the task. The second phase is the post-task activities based on the transcript of the skit they have just listened to. The phase consists of three parts: learning useful words, phrases and structures; practicing pronunciation; making a list of words that they want to learn. Through these post-task activities, they are encouraged to extend necessary language knowledge and improve their L2 pronunciation.

Method

Participants

The participants in the present study comprised 199 Japanese students at a national institute of technology in Japan (Kosen). Their age is 15 or 16. They entered the institute in April, 2019. These students belonged to five different classes, each of which had been almost equalized in their academic proficiency before the new school term began. According to the survey conducted in April, about 42% of the students do not like English, and about 60% feel they are not good at English. 65% would like to improve their listening skill. About 80% of them think they would use English when they get employed in the future. Most of them regard English as a necessary tool for their future career.

Procedure

The participants were provided with assignments on the e-learning system in May. They were required to do main-tasks that are focused mainly on prediction and comprehension and then activities that are focused on language features and vocabulary in the post-tasks phase.

The main-tasks are all listening tasks that can stimulate learners' imagination and prediction, such as "Where is this conversation taking place? (Figure 1)" or "Listen to the first half of a skit and sort the latter half of it. (Figure 2)" The students inevitably have to concentrate on the meaning of the conversation they are listening to.

The next phase is working on activities in which the participants not only learn new vocabulary and structures but also practice pronunciation through the transcript of the conversation (Figure 3). Then, they are expected to make a list of words for themselves (Figure 4). They pick up any words from the transcript of conversation that they find useful. This is for promoting the students' vocabulary acquisition.

The participants were first taught how to work on the activities of the e-learning during a class, and then told to do it on their own computers or mobile devices outside classroom hours. They tackled 14 sets of tasks in four weeks.

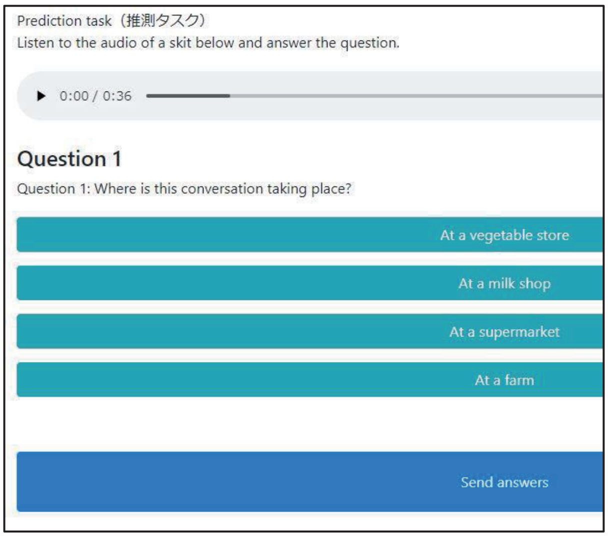


Figure 1. Prediction (main-task)

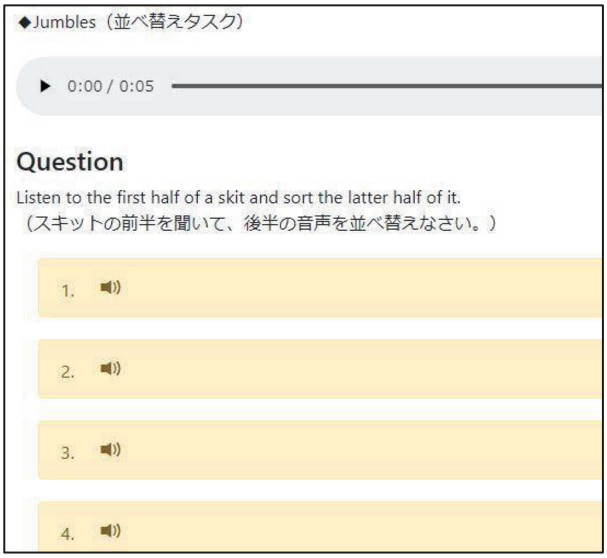


Figure 2. Jumble (main-task)

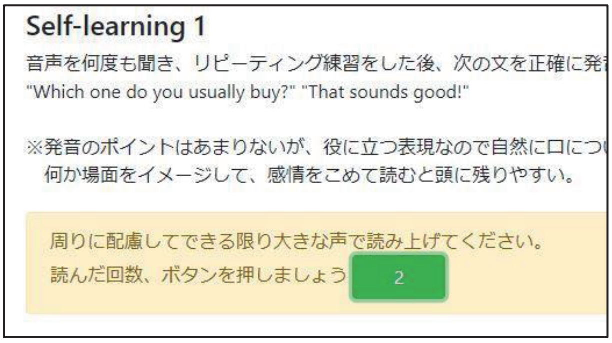


Figure 3. Pronunciation practice (in the post-task phase)
Note. Listen to the audio and read aloud the transcript ten times or more. Click the button as many times as you read out loud.

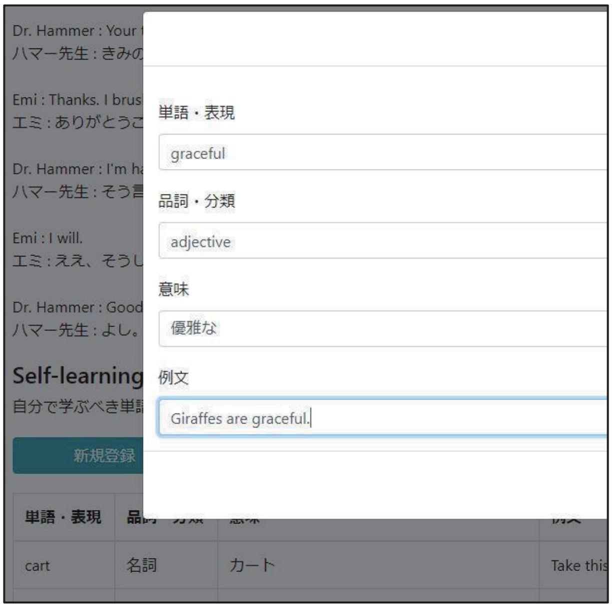


Figure 4. Vocabulary list making (in the post-task phase)
Note. Check words you do not know.

Questionnaire

In order to check how they felt the tasks and activities they worked on and the LMS they used, a questionnaire was conducted four weeks after its introduction. The questionnaire consists of some questions about the tasks and activities and free descriptions about the impression of them and the LMS.

Results and Discussion

Table 1 shows the participants' difficulty in working on the tasks in the first phase. Most of them felt the tasks had a little or moderate difficulty. Many of them expressed the listening tasks (prediction) were helpful, interesting and inspiring. Some comments are: "I think doing prediction tasks is a good opportunity to improve my listening skill", "It is very interesting to predict the situation from a conversation, and it could lead me to guess the meanings of unfamiliar words", "Prediction tasks really makes me concentrate on listening and try to understand what the people are saying."

However, some of them felt there was a difficulty gap among the listening tasks; the system was not conveniently designed for smartphones; the system had some functions that were difficult to use.

Table 1. *The Percentage of Respondents to the Prediction Task Difficulty*

difficult	a bit difficult	neither	a bit easy	easy
6%	42%	47%	2%	0%

Note. Question: Were the tasks difficult for you?

Table 2 shows how the participants liked learning useful language from the conversation transcripts in the post-task phase. About 60% felt the level of difficulty was moderate, and 30% a little difficult. Their comments included: it gave me a good learning opportunity; there should be more questions; hints should be added; some questions were too easy; most of the questions were nice and easy to work on, etc. No serious problems were founded in their descriptions.

Table 2 *The Participants' Impressions of Learning Useful Language in the Post-task Phase*

difficult	a bit difficult	neither	a bit easy	easy
5%	30%	57%	6%	0%

Note. Question: How did you like activities in the post task phase after the prediction task?

Table 3 shows how the participants liked practicing pronunciation and making a list of words in the post-task phase. Both of the activities were regarded as moderate or good. Overall, pronunciation practice on the LMS was helpful and seemed to be unique. Some of the participants do not think practicing pronunciation on the LMS is useful because they are not confident whether they are pronouncing correctly. So, functions which correct learners' mispronunciation or evaluate their pronunciation would motivate them more.

As for the vocabulary list making activity, 76% of the participants considered it good. Checking the meanings of words they do not know on the spot and making their own vocabulary list seems to be useful. The free descriptions, however, included bad comments as well as good ones: editing function is necessary; it is time-consuming; it is not attractive; it is a bother to look the list over again. To relieve these complaints, technical improvement and creative ways of making vocabulary lists would be necessary.

Table 3. *The Participants' Impressions of Practicing Pronunciation and Making a Vocabulary List in the Post-task Phase*

	very good	a bit good	OK	a bit pointless	pointless
Q1	20%	37%	22%	15%	8%
Q2	33%	43%	17%	3%	1%

Note. Q1: How did you like practicing pronunciation in the post-task phase? Q2: How did you like making a list of words they want to learn in the post-task phase?

The participants rated the task-based online self-learning system (LMS) on a scale of 1 to 10. The average was 7.96 excluding 3 non-respondents. Table 4 shows 72.3% of the participants rated it 8 and higher. They evaluated the system more highly than we had expected.

Table 4. *Evaluation of the System by the Participants*

	1	2	3	4	5	6	7	8	9	10	NR
N	5	1	5	0	1	11	31	61	45	35	3
%	2.6	0.5	2.6	0	0.5	5.6	5.9	31.3	23.1	17.9	

Note. 10 point scale. NR=non-respondents. *N*=199

The free descriptions of functions to be equipped with in the LMS include: "The system should have the function to control the speed of the audio", "If there's a chat function, I'd be much motivated", "The function that scores my pronunciation would be helpful", "I'd like to talk with classmates in English in this e-Learning system", "I want to edit what I wrote in the vocabulary list", "I want to see the percentages of correct answers", "The forum function would be helpful", "Anime illustrations would motivate me", "It should have more fun activities like listening to songs and watching movies." Those comments would really helpful to improve the e-learning system.

From the result of the survey, the students found the system was refreshing and helpful and learned linguistic features although there are drawbacks in the contents of the tasks and activities and also some of the functions of the system. As for the answer to the research question, there was no objective data to prove the effectiveness of the system, but it gave favourable impressions to the students. The author considers that this system would be more beneficial to the students through technical improvement and more inspiring tasks and activities.

Conclusion

The present study introduced the development of the online self-learning system using LMS for the first-year students at a Kosen in Japan, and discussed based on the survey what impressions the system gave to them and how effective it was for them. Although the system had advantages and disadvantages, the students found it refreshing and helpful, and learned language through working on post-task activities.

Further study and experiments should be conducted and more efficient functions should be equipped with the system in order to make the task-based online self-learning system using LMS more user-friendly and motivating to learners. Furthermore, creating effective input-based tasks to be incorporated into the system is requisite.

Acknowledgements

This research is partially supported by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Grant-in-Aid for Scientific Research (C), No. 16K04731.

References

Dörnyei, Z. (2009). *The psychology of second language acquisition*. Oxford: Oxford University Press.

Ellis, R. (2003). *Task-based language learning and teaching*. Oxford: Oxford University Press.

Ellis, R. (2018). *Reflections on Task-Based Language Teaching*. Multilingual Matters.

Ellis, R and Shintani, N. (2004). *Exploring language pedagogy through second language acquisition research*. New York: Routlege.

Ellis, R., Tanaka, Y. and Yamazaki, A. (1994). Classroom interaction, comprehension and the acquisition of word meanings. *Language Learning* 44: pp.449-91.

Leaver, B and Willis, J (Eds.). (2004). T*ask-based Instruction in Foreign Language Education*. Georgetown University Press, Washington, D.C.

Loschky, L. (1994). Comprehensible input and second language acquisition: What is the relationship? *Studies in Second Language Acquisition* 16: pp.303-23.

Long, M. H. (1985). A role for instruction in second language acquisition: task-based language teaching. In Hyltenstam, K., & Pienemann, M. (Eds.), *Modeling and assessing second language development* (pp.77-99). Clevedon, Avon, UK: Multilingual Matters.

Nunan, D. (2004). *Task-Based Language Teaching*. Cambridge: Cambridge, UK University Press.

Pica, T., Kanagy, R., and Falodun, J. (1993). Choosing and using communication tasks for second language instruction and research. In G. Crookes & S. Gass (Eds.), *Tasks and Language Learning: Integrating Theory and Practice* (pp. 9-34). Clevedon, UK: Multilingual Matters.

Pica, T., Young, R. and Daughty, C. (1987). The impact of interaction on comprehension. *TESOS Quarterly* 21: pp.737-758.

Purhabu, N. S. (1987). *Second Language Pedagogy*. Oxford: Oxford University Press.

Skehan, P. (1998). *A cognitive approach to language learning*. Oxford: Oxford University Press.

Shintani, N. (2016). *Input-based Tasks in Foreign Language Instruction for Young Learners*. Philadelphia: John Benjamins Publishing Company

Willis, J. (1996). *A Framework for Task-based Learning*. Harlow: Longman.

Willis, D. and Willis, J. (2007). *Doing Task-based Teaching*. Oxford: Oxford University Press.

Teaching AI to Advance Sustainable Development Goals

Peter Leong[*,a] and Danny Lee [#,b]

[a] Singapore Polytechnic, School of Computing, Singapore
[b] Singapore Polytechnic, School of EEE, Singapore

*peterleong@sp.edu.sg; #dannylee@sp.edu.sg

Abstract

Artificial Intelligence (AI) has seen rapid growth around the world in recent years. In 2017, the United Nations (UN) International Telecommunications Union (ITU) organized a summit entitled "AI for Good Global Summit". The summit refocused AI on sustainable development and assisting global efforts to eliminate poverty and hunger, and to protect the environment. It provided a platform to foster understanding of emerging AI technologies and how they can apply to the UN Sustainable Development Goals (SDGs). Some of the breakthroughs include using AI to map poverty and to aid in disaster relief using satellite imagery. There are also new opportunities for AI to help achieve Universal Health Coverage.

There is also a large gap between the demand for AI talent and the supply of trained AI technical specialists around the world. In order to realize the potential benefits of AI for global good, there is a pressing need to improve and increase the AI talent pool. Singapore has launched a national AI strategy in 2017 with the creation of AI Singapore. Part of the strategy involves a multi-pronged approach to develop AI talent at different levels. At the Singapore Polytechnic, we have started several programs to teach AI. In 2018, we launched a continuing education course for teaching AI and data science to working adults; an eight month long Specialist Diploma in Data Science (Artificial Intelligence). The course is open to all students with a technical background or have demonstrated sufficient competency in mathematics and statistics. This is to encourage more diversity and not restrict entry to only students from the Infocomm sector who already have some knowledge of programming or computer science. Applied AI is a cross-disciplinary field that involves domain knowledge from economics, marketing, finance, cybersecurity and engineering. For our younger full-time students, there is a campus-wide free elective for students as an Introduction to AI. In our Computing curriculum, there are also more specialized modules such as Machine Learning and Deep Learning. The paper describes our experience in teaching AI at the polytechnic level.

Keywords: *Teaching Artificial Intelligence, Sustainable Development, AI in Education*

Introduction

In AI for Good Summit (ITU, 2017) report, Artificial Intelligence (AI) has been identified as key technology for enabling the realization of the United Nations Sustainable Development Goals (SDGs). Artificial Intelligence (AI) will be central to the achievement of the Sustainable Development Goals (SDGs) and could help solve humanity's grand challenges by capitalizing on the unprecedented quantities of data now generated on sentient behaviour, human health, commerce, communications, migration and more.

The United Nationals Sustainable Development Goals (SDGs) are a set of 17 human and economic development goals that provide a guide for development that does not prioritize short term gains over medium- and long-term benefits for the future. The 17 Sustainable Development Goals (SDGs) are the world's best plan to build a better world for people and our planet by 2030. Adopted by all United Nations Member States in 2015, the SDGs are a call for action by all countries - poor, rich and middle-income - to promote prosperity while protecting the environment. They recognize that ending poverty must go hand-in-hand with strategies that build economic growth and address a range of social needs including education, health, equality and job opportunities, while tackling climate change and working to preserve our ocean and forests.

AI has been identified as an enabler for the 17 SDGs. Of these we wish to focus on sustainable development goal 4 "Quality Education" — Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. Of the many targets, one of them is "By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship". AI is also one of the key Information and Communications Technology (ICT) skills that would be in great demand around the world in 2030.

There is also a large gap between the demand for AI talent and the supply of trained AI technical specialists around the world. In order to realize the potential benefits of AI for global good, there is a pressing need to improve and increase the AI talent pool. Singapore has launched a national AI strategy in 2017 with the creation of AI Singapore. Part of the strategy involves a multi-pronged approach to develop AI talent at different levels. At the Singapore Polytechnic, we have started several programs to teach AI. The paper describes our experience in teaching AI at the polytechnic level.

AI in Continuing Education

At the Singapore Polytechnic, we have started several programs to teach AI. In 2018, we launched a continuing education course for teaching AI and data science to working adults; an eight-month long Specialist Diploma in Data Science (Artificial Intelligence).

The course is open to all students with a technical background or have demonstrated sufficient competency in mathematics and statistics. This is to encourage more diversity and not restrict entry to only students from the Infocomm sector who already have some knowledge of programming or computer science.

Applied AI is a cross-disciplinary field that involves domain knowledge from economics, marketing, finance, cybersecurity and engineering. For our younger full-time students, there is a campus-wide free elective for students as an Introduction to AI. In our Computing curriculum, there are also more specialized modules such as Machine Learning and Deep Learning.

The total learning hours for the course is 270 hours: 2 foundational modules 60 hours each and 2 advanced modules 75 hours each. We use a blended learning approach to deliver the course with a mix of E-learning and face-to-face contact time with the instructors. The ratio for e-learning time : face-to-face time is 1:3 for the foundational modules and 2:3 for the advanced modules.

We have found that the blended approach is effective in teaching AI compared with a purely online approach because of the large amount of time devoted to hands-on practical labs in the course. The best way to learn and hone practical AI programming skills is to actually work with actual running code. Our focus at the polytechnic level is practical skills-based education instead of focusing on the theory of AI and machine learning. The students are much more engaged with the content and they also have the opportunity to learn from their peers.

However, the blended learning approach does take more resources than a pure online approach. And to give each student the necessary amount of attention, our instructor to student ratio is kept to no more than 1:20. We have found that with the diverse intake of students it is quite a challenge for one instructor to help with the hands-on exercises for 20 students.

Students also bring along their own laptops for performing the practical tasks. Instructors often find themselves bogged down with debugging software installation related problems because of the different operating systems and make of laptops that the students use. We are in the process of investigating how to streamline this by using virtual environments or containers such as docker.

The Specialist Diploma in Data Science (SDDS) (Artificial Intelligence) is conducted as part of series of four stackable Data Science Diplomas. Data Science is actually a wide area and it is not possible to cover the entire range of expertise within the time of one single specialist diploma, which has a maximum time of 270 hours stipulated by the education ministry. The four specialist diplomas are: i) SDDS (Artificial Intelligence), ii) SDDS (BigData and Streaming Analytics), iii) SDDS (Data Analytics) and iv) SDDS (Predictive Analytics).

Table 1 SDDS Modules

SDDS (Artificial Intelligence)	
PDC1	Python Programming for Data Science
PDC1	Statistics for Data Science
PDC2	Applied Machine Learning
PDC2	AI Human Interface
SDDS (BigData & Streaming Analytics)	
PDC1	Python Programming for Data Science
PDC1	Statistics for Data Science
PDC2	Big Data Platforms
PDC2	Streaming Analytics
SDDS (Data Analytics)	
PDC1	Python Programming for Data Science
PDC1	Statistics for Data Science
PDC2	Data Mining Techniques
PDC2	Applied Statistical Methods
SDDS (Predictive Analytics)	
PDC1	Python Programming for Data Science
PDC1	Statistics for Data Science
PDC2	Introduction to Statistical Modelling
PDC2	Generalised Modelling and Forecasting
PDC1 *PDC2*	*Professional Development Certificate 1* *Professional Development Certificate 2* *PDC1 are foundational modules (Common modules for all the 4 SDDS)* *PDC2 are advanced modules*

The four stackable Data Science Diplomas have a common set of foundational modules in PDC1 (first semester). They are stackable because of the common PDC1. Once a student completes PDC1 and PDC2 for one SDDS, he or she will be awarded one specialist diploma. If he or she, takes the PDC2 or another SDDS, without retaking the common modules, he or she will be awarded a second SDDS. They can take all the SDDS within 2.5 years.

The field of AI is evolving rapidly with new algorithms being developed. There are also fresh concerns revolving around data privacy and ethical use of AI. One of the challenges faced is when to refresh the material to include newer topics without also making the course too difficult for novices who may join the course from other knowledge domains in order to transition from other industries into the AI economy.

AI in Polytechnic Education

For our younger students, who are in the same age range as Kosen students, we are launching a new full-time diploma — Diploma in Applied AI and Analytics (DAAA) in 2020. This new diploma builds on the work and experience that we have already gathered from offering the Continuing Education programs. This new diploma helps to address a gap in the industry where there are no associate or junior AI engineer level qualified staff. The graduates can also opt to join into one of the bachelor programs in AI from one of the Singapore universities.

Defining the curriculum for the new diploma course involved many dialogues with industry ranging from large enterprises to start-up companies. The potential employees of the graduates also come from varied industries such as e-commerce, fintech, cybersecurity, healthcare services, telecom, software application development and cybersecurity. The needs from the different companies do vary considerably, but we were able to distill some of the common layers of knowledge that need to be instilled into the students.

At the foundational layer, students need to be grounded in the development processes, computation, programming and mathematics. General skills such as communications skills and critical thinking also need to be taught. For the second year, students will be exposed to the more specialized AI modules such as machine learning and deep learning. In their final year, they will be on internship and they will also be working on a capstone project.

Table 2 Curriculum for DAAA

Foundational		
	Mathematics	MA
	Statistics for Data Science	MA
	Python for Data Science	CS
	Software Development	CS
Advanced		
	Data Visualization	DS
	Data Engineering	DS
	Algorithms and Data Structures	AI
	Mathematics for AI	MA
	DevOps and Automation for AI	DS
	Machine Learning	AI
	Deep Learning	AI
	Practical AI	AI
Industry & Project		
	Capstone Project	CS
	Industry Internship	IN
	Industry Symposium	IN
	Career Guidance	IN
	AI = Artificial Intelligence *CS = Computer Science* *DS = Data Science / Analytics* *IN = Industry* *MA = Math*	

In the industry symposium, issues surrounding the ethical use of AI and data privacy would be covered. The Singapore government has also issued a Model Framework on the AI Governance (PDPC, 2019). In addition, the Monetary Authority of Singapore has also published a report on the FEAT principles for use of AI (MAS, 2018).

Students also cover subjects that are part of their general education such as communication skills, writing skills and critical thinking as part of their overall education in the Singapore Polytechnic.

Results and Discussion

The AI Continuing Education had a successful run in the first year. We had more than 60 students in the first batch of students. The attrition rate was less than 5%. However, because of resource constraints we could not run classes for the remaining 40 applications who could not be admitted into the first class. At the time of the launch, we were the first polytechnic in Singapore to offer a specialist diploma in artificial intelligence. Since then, the other 4 polytechnics in Singapore have also started offering AI continuing education courses. In spite of that, we still enjoy a healthy subscription rate in our AI courses.

After consultation with industry and in view of the evolving Digital Industry in Singapore, we had planned and eventually started a new Diploma in Applied AI and Analytics for our full-time O-level graduates. This new diploma will be receiving its first batch of student in 2020. We are optimistic that it will be well received and it will help to fill the talent gap in AI in Singapore.

Applications of AI in Competition

Most people first encounter the concept of Artificial Intelligence (AI) from science fiction: C3P0 and the many other robots from the Star Wars franchise; the titular robots and Skynet from the Terminator movies; or HAL 9000 from Arthur C. Clarke’s Space Odyssey novels, to name a few. This short list illustrates that AI refers to technologies that try to emulate human intelligence, and are not necessarily physical robots. It would be better to think of AIs as ‘smart’ software rather than smart robots.

In reality, AIs are currently only tools that can be programmed for specific purposes which are quickly becoming a ubiquitous technology. The lines between what is and isn’t AI are blurring. For example, Intelligent Virtual Assistants (IVA) like Amazon’s Alexa and Apple’s Siri are considered AIs because of how similar they are to fictional portrayals. However, what makes them AIs are not their functions, but rather, how they function. IVAs use Natural language processing (NLP), a subfield of AI, to understand verbal commands to perform simple tasks such as sending a text message or setting a reminder without the user having to physically interact with the device. IVAs are much akin to automation tools or mere remote controllers; the user is still entirely responsible for the decision-making process.

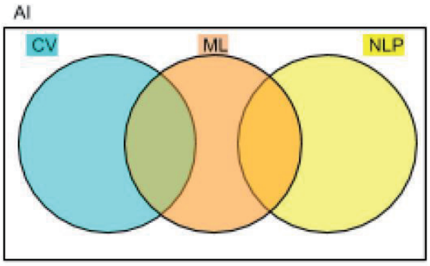


Figure 1: Relationship between AI subfields

Computer Vision (CV) is another subfield of AI, focusing on the digital interpretation and processing of visual information. OpenCV, an open source programming library, also has functions for Machine Learning. Image data is represented by matrices, upon which mathematical functions can be applied to differentiate, group or filter data points. This makes implementing ML on CV tasks highly intuitive.

ML is more than just computer programme because it has the ability to learn how to perform a task without clear instructions. Google Translate uses Optical Character Recognition (OCR) technology which basically only detects individual letters and words to convert text in images into a digitally compatible format. Since a word in different languages don't always have a one-to-one relationship depending on the context of the sentence, translation requires an understanding of both languages. Google Neural Machine Translation is used for the actual translation between languages. It uses an Artificial Neural Network (ANN) which generally has a set of functions that output into each other in a certain order to process information quite similar to how a biological brain functions.

An ANN learns how to perform its given task through training. Training data is input to an ANN which is processed in various ways by the individual functions to produce a particular behaviour or manipulation of the input data. For an ANN to learn, the training data must be annotated in some way, whether through another data processing function or user input. Data annotation can be as precise as where the object is in a labelled image or simply in an unlabeled image. Training an ANN with labelled data is known as supervised learning and unsupervised learning uses unlabeled data. With datasets of equal size, supervised learning may produce more accurate results, but since labelling the data is tedious, unsupervised learning may be more efficient. Semi-supervised learning which typically uses a smaller labelled dataset and a larger unlabeled dataset, can give the best of both worlds.

In the case of Google Translate, the processing can be thought of as one learns another language, it shows better results in term of greater fluency in translations of words in that language. Google Translate allows users to indicate if a translation is accurate and offers alternative translations that when selected, help improve future translations. This is an example of reinforcement learning.

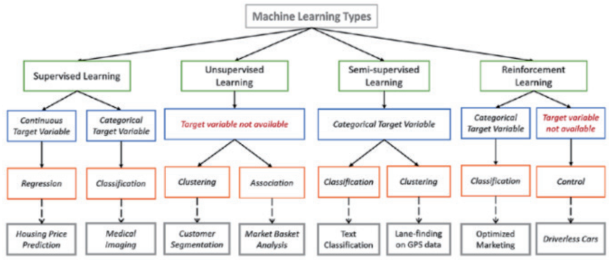


Figure 2: Types of Machine Learning

Unmanned Aerial Vehicles (UAVs) can make use of Artificial Intelligence (AI) for target detection and making decisions while in flight. Navigation between GPS waypoints has been achieved without AI but an UAV can perform a pre-set flight using Attitude and Heading Reference System (AHRS) data. In the absence of GPS (i.e., indoors), a more robust navigation system is needed for flights since the margin for error is narrower. The use of Simultaneous Localization and Mapping (SLAM) systems can provide 2D or even 3D spatial information to an autopilot system, enhancing navigational adaptability. SLAM systems require relatively greater computational power, and are set up alongside or in place of the autopilot system, rather than simply plugging in an additional sensor. With a more powerful computer, the capacity for even higher complexity computation increases.

Recreational and professional applications of UAVs almost always incorporate a vision system using video and photography for surveillance and/or inspection which primarily rely on a camera. With the camera system on-board the flying machine, Computer Vision and Machine Learning can be implemented to automate some of the tasks such as to detect, identify and localize objects. One of the examples is AI facilitated drone inspection system for building façade. The conventional practice of building façade inspection is tedious and costly. To make it worse, modern high-rise buildings have complex shapes and curvatures which it makes building façade inspection very challenging. Therefore drone technology and AI-based image processing technology can be integrated together to achieve faster, safer and more seamless building facade inspection workflow.

In School of Electrical and Electronic Engineering, students take part in Singapore Amazing Flying Machine Competition (SAFMC) annually. Singapore Amazing Flying Machine Competition (SAFMC) is an exciting and unique event organised by DSO National Laboratories and Science Centre Singapore, and supported by Ministry of Defence (MINDEF). It is opened to all schools and students who want to explore the science behind flight and create their very own flying machines. Students working on their capstone project and choose to take part in SAFMC to benchmark their engineering excellence at national level. There is a fully autonomous category D2 in SAFMC where participants have to develop and build their flying machine to tackle tasks such as to take-off, navigate the flying machine to avoid obstacles, detect and identify objects, make decisions during flight, release payload at designated spots and land. This is impossible for an UAV with just a GPS-based autopilot system. Navigation of the competition setup uses SLAM for obstacle avoidance and CV for specific objects recognition. The team has to work on the CV algorithms for detecting and recognizing regular shapes and colors. The focus is more on the UAVs ability to navigate and perform the tasks after recognizing and/or localizing the objects.

In 2019, a team of three Year 3 students from Diploma in Aerospace Electronics (DASE) and Diploma in Computer Engineering (DCPE) participated in the fully-autonomous category D2 at Singapore Amazing Flying Machine Competition (SAFMC) 2019. They applied CV in their flying machine to tackle some of the tasks required in the competition so to accomplish the mission.

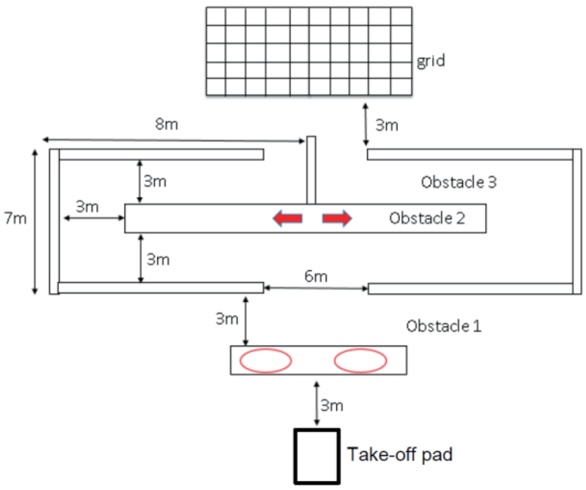


Figure 3: SAMFC 2019 Category D2 Competition Setup

The competition setup for Category D2 is as shown in Figure 3. The aircraft is to carry a total of 5 x 13-15g payload which will be dropped on the required square at the grid. The team has applied CV in their programme for the following tasks such that the flying machine will be able to navigate the lighted window, correct direction and able to release the payload on the lighted grid. The tasks to accomplish are as follows:

- Lighted window - There will be 2 x 1.5m diameter circular windows surrounded with red LED lights. One window will be lighted up after the aircraft takes off, the aircraft will have to fly through the lighted window
- Directional change - 2 red LED arrows will be hung on the wall, pointing to opposite directions. The arrow will be a transparent acrylic case with the LED light in it. After completing the first obstacle, one of the two arrows will light up, the aircraft will have to fly in the direction of the lighted arrow.
- The Grid - A red square will be turned on to indicate the location to release one payload at a time. Only when the payload successfully lands within the square, then the next square will be lighted up red. The previous red light will remain on. There will be a total of 5 lighted red squares. When the flying machine runs out of payloads, a square will be lighted GREEN so it can perform a precision landing on that GREEN square.

This competition requires a very high technical level in the areas of CV and also the ability to integrate it well with the existing guidance, navigation and control system on the flying machine.

Figure 4: Team photo with Senior Minister of State, Ministry of Defence Mr Heng Chee How at SAFMC 2019 Prize Presentation Ceremony

The team won the 1st runner-up at the SAFMC 2019 category D2. This is made possible with the CV algorithm and reflecting the application of AI in a competition like SAFMC.

Acknowledgements

The authors wish to acknowledge the support provided by the management of the School of Computing and School of EEE, Singapore Polytechnic for doing the research work and/or taking part in the Singapore Amazing Flying Machine Competition.

Conclusions

The United Nations 17 Sustainable Development Goals (SDGs) provide a set of guides to benefit human prosperity without sacrificing the environment. AI has been identified as a key enabler to achieve these SDGs. Of the various SDGs, SDG 4 on Quality Education is a focus of work reported in this paper. AI is a transformer in many industries and a vital ICT skill for students to be trained in by 2030.

In the Singapore Polytechnic, we have successfully launched Continuing Education course (for adult learners). The Specialist Diploma in Data Science (Artificial Intelligence) has more than 80 graduates in the first year of offering the course. Graduates from the program are able to continue their studies in modular master level programs. The projected number in the second year is 100. In addition, we also run short master classes of 1 to 2 days for adult learners to pick up specialized skills in AI.

For our younger students, who are in the same age range as Kosen students, we are launching a new full-time diploma — Diploma in Applied AI and Analytics (DAAA) in 2020. This new diploma builds on the work and experience that we have already gathered from offering the Continuing Education programs. This new diploma helps to address a gap in the industry where there are no associate or junior AI engineer level qualified staff. The graduates can also opt to join into one of the bachelor programs in AI from one of the Singapore universities.

In addition, we have also seen how EEE students can make use of AI technologies such as CV in their capstone to take part in SAFMC 2019. Though the students do not have prior knowledge and experience in their curriculum, they are able to pick up technologies and implement them well. As School of EEE moves towards Self-Directed Learning model, this strengthens our confidence that our students are capable learn on their own if they have the intrinsic motivations and passion for engineering.

References

@gidishperber. (2019). A gentle introduction to OCR - Towards Data Science. Retrieved from https://towardsdatascience.com/a-gentle-introduction-to-ocr-ee1469a201aa

Are Airplane Autopilot Systems the Same as Self-Driving Car AI? (2017). Retrieved from https://www.aitrends.com/ai-insider/airplane-autopilot-systems-self-driving-car-ai/

Castrejon, L., Kundu, K., Urtasun, R., & Fidler, S. (2017). Annotating object instances with a polygon-rnn. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 5230-5238). Retrieved from https://arxiv.org/pdf/1704.05548.pdf

du Boulay, B. (2016). Artificial Intelligence as an Effective Classroom Assistant. *IEEE Intelligent Systems*, 31(6), 76-81.

Dale, R. (2016). The return of the chatbots. *Natural Language Engineering*, 22(5), 811-817.

Goel, A., Creeden, B. Kumble, M., Shetty, S., & Salunke, S. (2015). Using Watson for Enhancing Human-Computer Co-Creativity. In *Proceedings of the AAAI 2015 Fall Symposium on Cognitive Assistance*, Arlington, Virginia.

Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep learning (online version with additional materials)*. Retrieved from http://www.deeplearningbook.org/

Is Object Detection a Done Deal? (n.d.). Retrieved from https://hackernoon.com/is-object-detection-a-done-deal-59a7be913fd2

International Telecommunication Union (ITU) (2017). *AI for Good Global Summit*. Retrieved from https://aiforgood.itu.int/

Microsoft (2017b). *Bot Framework*. Retrieved from https://dev.botframework.com/

Microsoft (2017c). *QnA Maker*. Retrieved from http://qnamaker.ai/

McTear, M., Callejas, Z., & Griol, D. (2016). *The conversational interface: talking to smart devices*. Springer.

Machine Learning Frameworks. (2018). Retrieved from https://en.proft.me/2018/06/21/machine-learning-frameworks/

Monetary Authority of SIngapore (MAS). (2018). *Principles to Promote Fairness, Ethics, Accountability and Transparency (FEAT) in the Use of Artificial Intelligence and Data Analytics in Singapore's Financial Sector*. Retrieved from https://www.mas.gov.sg/publications/monographs-or-information-paper/2018/FEAT

Personal Data Protection Commission (PDPC) Singapore. (2019). A Proposed Model AI Governance Framework. Retrieved from https://www.pdpc.gov.sg/Resources/Model-AI-Gov

Robitzski, D. (2018). You have no idea what artificial intelligence really does. Retrieved from https://futurism.com/artificial-intelligence-hype

Russell, S., & Norvig, P. (2009) *Artificial Intelligence: A Modern Approach. 3rd edition*. Prentice Hall.

United Nations. (2019). *Sustainable Development Knowledge Platform*. Retrieved from https://sustainabledevelopment.un.org/

Yu, D., & Deng, L. (2014). *Automatic speech recognition: A deep learning approach*. Springer.

THE BIG PICTURE OF QUALITY ENHANCEMENT @TUAS

J. Kontio

Turku University of Applied Sciences/Faculty of Engineering and Business, Turku, Finland

juha.kontio@turkuamk.fi

Abstract

Turku University of Applied Sciences (TUAS) used several years Balanced Scorecard model for management and quality enhancement purposes. In 2017, the university decided to look alternative frameworks for quality enhancement and finally decided to move to EFQM Excellence Model. This model provides an holistic view of the organization. The EFQM Excellence Model is a practical, non-prescriptive framework. The EFQM Excellence Model allows Managers / Leaders to understand the cause and effect relationships between what their organisation does and the results it achieves. While this model focuses mostly on the organization and its features, there are other tools to complement the whole quality enhancements of Turku University of Applied Sciences. One of these tools – Corporate Spirit employee survey – is focusing on understanding the organisation from the employee perspective. This survey and its target-oriented processing supports the achievement of the organisation's strategic targets and profitability of operations. The aim is to strengthen the engagement of the personnel, which facilitates both the development of the personnel experience and success of the organisation. The students' perspective to quality enhancement comes from the Student Barometer. It is an annual survey measuring the overall satisfaction of students. Furthermore is provides open information on all kind of study related issues. There are several other tools in use on students experience too such as course level feedback, module feedback, student representatives and feedback days. Finally, focusing quality enhancement on our main operation – education – we are actively using the CDIO approach and the CDIO self-evaluation. In this paper, the overall quality enhancement system at Turku University of Applied Sciences will be described and analysed. The analysis is done from the viewpoint of one faculty, namely the Faculty of Engineering and Business. The different main tools in QE will be explained as well. The paper shows connections between the different elements and provides ideas for other conference delegates to learn from our experiences.

Keywords: *Quality Enhancement, EQFM Excellence Model, CDIO approach, Engineering education*

Introduction

Quality is a constant and important topic in higher education agenda. In Europe, since 2000 there has been a joint initiative to strengthen quality in higher education. This initiative is called European Association for Quality Assurance in Higher Education (ENQA, 2019). The ENQA contributes to the maintenance and enhancement of the quality of European higher education, and acts as a major driving force for the development of quality assurance across all the Bologna Process signatory countries (ENQA, 2019). The ENQA collaboration provides a common framework for quality assurance systems in European higher education - The Standards and Guidelines for Quality Assurance in the EHEA (ESG) (ENQA, 2015). Quality assurance in higher education can be defined as *the collections of policies, procedures, systems and practices internal or external to the organisation designed to achieve, maintain and enhance quality* (Harvey, 2019). As the definition shows we can see there at least two main purposes for quality assurance: to ensure that stated standards are reached and to fulfil the accountability duty (Williams, 2016). The accountability duty has been discussed by several authors (Amaral, 2007; Filippakou & Tapper, 2008; Houston, 2008).

In Finland, the legislation defines that universities and universities of applied sciences have to participate in external evaluation of their activities and quality systems on regular basis. The main authority responsible of doing these evaluations is The Finnish Education Evaluation Centre (FINHEEC, 2019a). They have conducted quality audits of higher education institutions in Finland since 2005. The purpose of these audits is for example to evaluate whether the quality work in the HEI meets the European quality assurance standards and assess whether the quality system produces relevant information for the continuous development of operations (FINHEEC, 2019b). The purpose shows that FINHEEC is not only focusing on quality assurance, but encouraging quality enhancement as well. This is an important point from the perspective of a Higher Education Institute: quality assurance is not enough rather you have to have procedures for quality enhancement in place too.

Quality enhancement is defined in (Harvey, 2019) as *a) the enhancement of individual learners; the augmentation or improvement of learners' attributes, knowledge, ability, skills and potential and b) the improvement in the quality of an institution or programme of study.* This definition provides two areas to focus: individual learner and programme of study. Gray, Patil and Codner (2009) stated that the ultimate test of an institution's quality is the success of its students, which leads us again to quality enhancement. From the perspective of a higher education institute, there are several different approaches to quality assurance. Most of the HEIs use a combination of these depending on their internal strategies and traditions, as well as national requirements (Bennedsen et al., 2018). Gray and Patil (2009) presented a conceptual canvas to think about different approaches to quality assurance and quality enhancement (Figure 1).

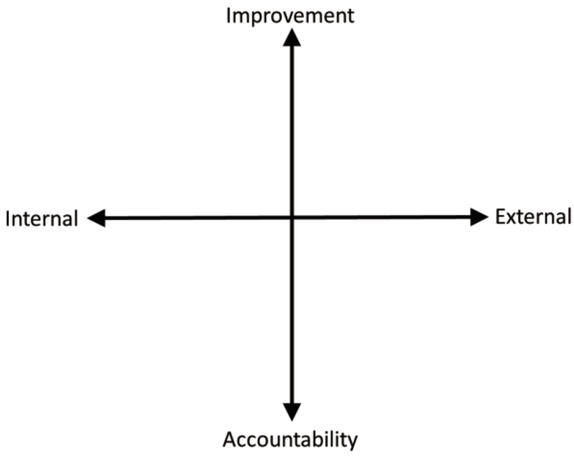


Figure 1. Quality assurance and enhancement canvas.

The audit of Finnish Education Evaluation Centre seems to focus on the right side of the above canvas. In this paper we introduce the quality assurance and enhancement activities and procedures happening in the Turku University of Applied Sciences and focus especially activities at the Faculty of Engineering and Business. We start with describing the research and continue explaining the results. At the end the results are discussed and conclusions are provided.

Research approach

The research approach used in this paper was a single case study research. Case research aims for an in-depth understanding of the context of a phenomenon (Cavaye, 1996). This research methodology was selected, because the goal of the research is not to achieve statistical generalisation rather analytic generalisation (Yin, 1994). Methodologically this is a descriptive case study research. A descriptive case study presents a complete description of a phenomenon within its context (Yin, 2002). The unit of analysis is the quality assurance and enhancement in Turku University of Applied Sciences at the Faculty of Engineering and Business.

The Finnish higher education system is made up of two parallel sectors (Figure 2): Universities and Universities of Applied Sciences. The basic purpose of Universities is to perform scientific research and to provide higher education connected with it. The Universities of Applied Sciences are usually regional higher education institutions providing higher professional education with a close connection to working life.

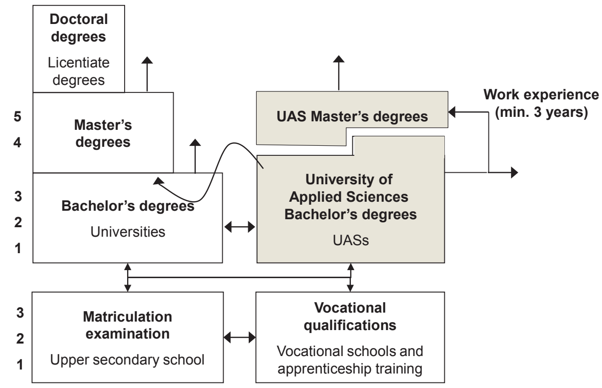


Figure 2. Finnish Education System.

Turku University of Applied Sciences (TUAS) is an inspiring community of 10,000 members – an innovative and multidisciplinary higher education institution, which creates international competitiveness and well-being for Southwest Finland. Our graduates are practice-oriented professionals with top competencies. Turku University of Applied Sciences has three faculties of which the Faculty of Engineering and Business is the biggest with 5800 students. In the field of applied research, Turku University of Applied Sciences represents the top tier in the country. TUAS coordinates or acts as a partner in over 200 RDI projects yearly. Studies at TUAS are working life-oriented, combining theoretical studies with professional skills.

The data for this paper consists of documentation, reports, intranet sites and process guidelines relating to quality assurance and quality enhancement at TUAS.

QE model @School of Engineering and Business

The quality assurance system of Turku University of Applied Sciences is made of a collection of policies, procedures, systems and practices to achieve, maintain and enhance quality. The quality assurance system of TUAS is based on the ENQA framework and national higher education policy including FINEEC's audit model guidelines and focus areas. A central tool for all TUAS activities is the agreement with the Ministry of Education and Culture (Ministry of Education and Culture, 2019) and strategy of TUAS (Turku University of Applied Sciences, 2019b). The agreement with the Ministry of Education and Culture define the fields of education provided at TUAS as well as the agreed goals of graduates in these fields. The strategy reflects our situation in the national higher education landscape as well as in the local economic state of affairs. The strategy paints our goals and defines the key focus areas guiding our activities in the following years.

The strategy is turned into annual action plans in university, faculty and school levels. The plans reflects developments from previous year and sets goals for next year both in numbers as in concrete actions. The annual plan is strongly connected with the strategy and with the budget as well. The plans set numeric goals such as the number of graduates and number of publications. These annual plans are followed quarterly according to PDCA cycle and additional actions are taken to support reaching the goals. This action plan process is one natural element of our quality enhancement and constant development.

Since 2017 EFQM Excellence Model (EFQM, 2019) has been the general framework for quality enhancement at TUAS. This model provides a holistic view of the organization's strengths and development areas (Figure 3).

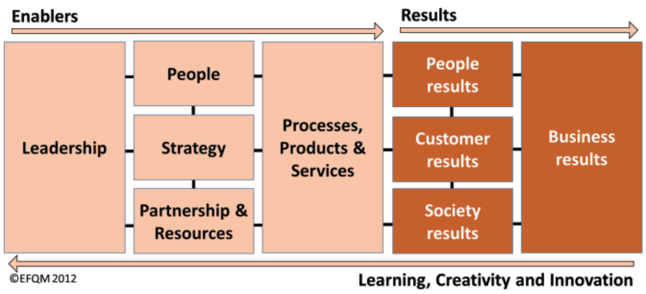


Figure 3. EFQM Excellence Model.

The EFQM Excellence Model is a practical, non-prescriptive framework. The EFQM Excellence Model allows Managers / Leaders to understand the cause and effect relationships between what their organisation does and the results it achieves. EFQM Excellence model is used to self-evaluate how well the goals set in the strategy are progressing, how our activities and procedures support reaching those goals, how we could improve our activities and procedures to reach the goals. This self-evaluation process provides a common platform to discuss quality enhancement and built common understanding of our university. The EFQM model evaluates both things that enable success and well as results. At TUAS, EFQM self-evaluation precedes the annual action plan preparation. In the self-evaluation process, all nine elements of the model are evaluated. The strengths as well as possible development steps are documented for each element. For example, a strength in Leadership is that we have reacted well with the funding model changes and a development step is that we receive up-to-date and reliable information from our teaching and learning. The EFQM self-evaluation results act as input while the action plans are prepared.

While the EFQM Excellence Model focuses mostly on the organization and its features, there are other tools to complement the whole quality enhancements of TUAS. One of these tools – Corporate Spirit employee survey (Corporate Spirit Oy, 2019) – is focusing on understanding the organisation from the employee perspective. This survey and its target-oriented processing supports the achievement of the organisation's strategic targets and profitability of operations. The aim is to strengthen the engagement of the personnel, which facilitates both the development of the personnel experience and success of the organisation. The 2019 survey had 50 standard questions, 15 tailored for TUAS questions, 3 open-ended questions as well as necessary background data questions. There are three levels (own work, unit, whole organization) and three perspectives (commitment, leadership, performance). These make a 3 * 3 table with different areas of interest as shown in Figure 4. The data from the standard question provides input for these nine areas of interest. This data is statistically analysed with the data of previous years. The results show changes and trends compared to the previous years. The results can be compared to the whole university, another faculty, another school or even another unit. The analysis provide main findings, show main strengths and key areas to be improved. As a summary of all results the PeoplePower rating is generated. It shows the overall result of the unit in analysis compared to the benchmark.

	Commitment	Leadership	Performance
Own work	Job motivation	Empowerment	Prerequisities
Unit	Communication & involvement	Managerial work	Agility and Effectiveness
Whole organization	Employer image	Leadership culture	Operative culture

Figure 4. Corporate Spirit areas of interest.

The results of the Corporate Spirit survey are discussed in all levels of the university. Should there be results that need immediate reaction a plan to work on these is initiated. Otherwise, these results give input to the annual action plan preparation too.

Both the EQFM Excellence Model and Corporate Spirit survey attach to the main activity of a university, the education. However, education is not their only focus and for ensuring quality enhancement on teaching and learning too, we are using the CDIO approach (CDIO, 2019) together with Innovation Pedagogy (Turku University of Applied Sciences, 2019a). The overall idea of the CDIO approach is to support engineering education development and educate students who have deep working knowledge of technical fundamentals, who can lead creation and operation of new products, processes and systems as well as who understand the importance and impact of research and technical development on society (Crawley, Malmqvist, Östlund, & Brodeur, 2007). Important tools in this task are the 12 CDIO Standards. The standards act as guiding principles for the design and development of a degree programme. Focusing on development in the areas defined by the standards will lead to improved learning results, students learning more and students having a better experience at their HEIs. The standards address issues related to what to teach and how to teach, but also issues related to teaching staff new skills. One of the standards focuses on how to evaluate the current quality and standard of the degree programmes thus providing tools for CDIO self-evaluation. (Kontio et al., 2012) In CDIO self-evaluation the program is evaluated using the 12 CDIO standards, which we can group following:

- Programme goals and design
  - Std. 1 – The Context
  - Std. 2 – Learning Outcomes
  - Std. 3 – Integrated Curriculum
- Learning experiences
  - Std. 4 – Introduction to Engineering
  - Std. 5 – Design-Implementation Experiences
  - Std. 6 – Engineering Workspaces
- Teaching and learning methods
  - Std. 7 – Integrated Learning Experiences
  - Std. 8 – Active Learning
  - Std. 11 –Learning Assessment
- Continuous development
  - Std. 9 – Enhancement of Faculty Skills Competence
  - Std. 10 – Enhancement of Faculty Teaching Competence
  - Std. 12 – Programme Evaluation

For each standard the current situation is described, a rubric score is given and ideas for continuous improvement are registered. The self-evaluation is repeated on regular basis, usually once in two to three years. The improvement ideas provide input for the action plans from teaching and learning perspective.

The students' role in quality enhancement is essential too. There are several possibilities for students to engage in development and quality enhancement. We have long tradition to engage students as Kontio and Tuohi (2011) describe. There are basic course feedback systems, groups discussions, feedback days, graduate feedback surveys, work placement feedback, ad hoc feedback possibilities as well as possibilities to work in faculty level development group. In addition, there is a tool called Student Barometer. It is an annual survey measuring the overall satisfaction of students. The overall satisfaction is shown per faculty and per study year. The trend is available as well. In addition to this simple overall measure, the student Barometer provides open information on all kind of study related issues. It gives information on student services, tutoring, study progress, assessment, learning environment and student wellbeing for example. The data of the student barometer is processed in each faculty and school. The data provides valuable additional information on the teaching and learning and its' support services. The data provides input to action plans, but also to quicker actions to improve the learning experience.

Discussion

This paper presented quality assurance and quality enhancement processes and activities in Turku University of Applied Sciences. The presented case was from the Faculty of Engineering and Business. The CDIO self-evaluation is only used in this faculty at TUAS. Otherwise the descriptions apply to whole TUAS.

The quality assurance and quality enhancement at TUAS has several dimensions. Behind everything is the European higher education agenda and the recommendations raising from it. The national level regulation in Finland acknowledges the agreed principles of the European Higher Education Area (EHEA). However, the Finnish auditing system varies from many other European systems. In Finland, the main auditing authority is FINEEC and focus of their audits is in the quality assurance system of the higher education institute, not in individual programs. However, FINEEC provides nowadays a possibility to audit programs too with the European Accredited Engineer (EUR-ACE) label, which is administered by European Network for Accreditation of Engineering Education (ENAEE, 2019).

The big picture of TUAS quality assurance and quality enhancement is in the Figure 5.

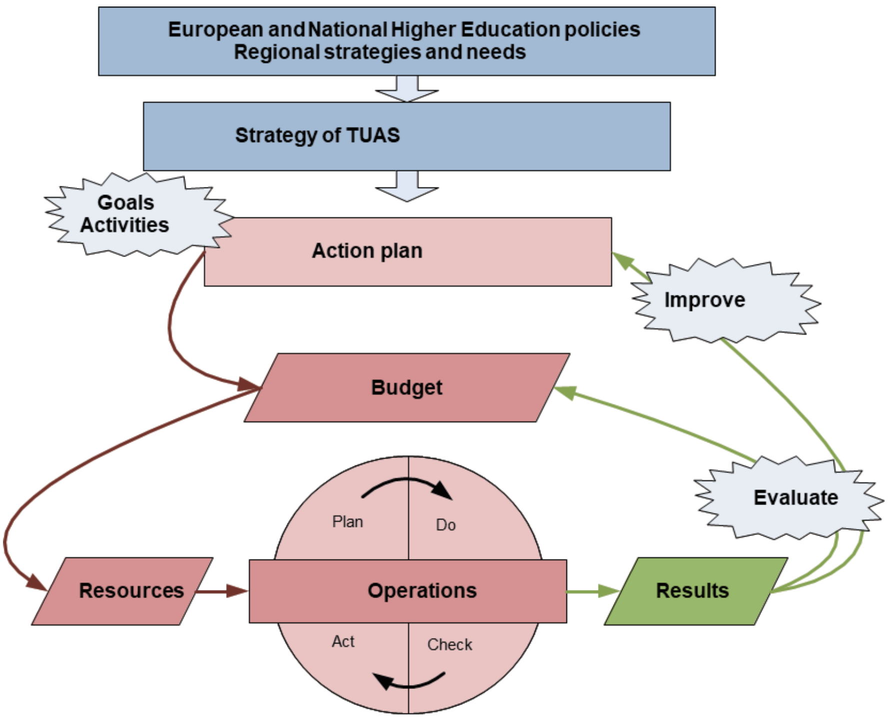


Figure 5. From strategy to operations and back.

This paper has focused more on the quality enhancement aspect where the aim is more on learning and the offering of the programmes. The key element aiming for quality enhancement are at the Faculty of Engineering and Business following (Figure 6):

1. EFQM Excellence Model
2. Corporate Spirit employee survey
3. CDIO self-evaluation
4. Student barometer.

The elements of quality enhancement are actively used and correcting continuous improvement actions are taken whenever they are necessary and possible. As the Figure 6 describes, the next year's action plan receives input from many sources. This richness of input is a

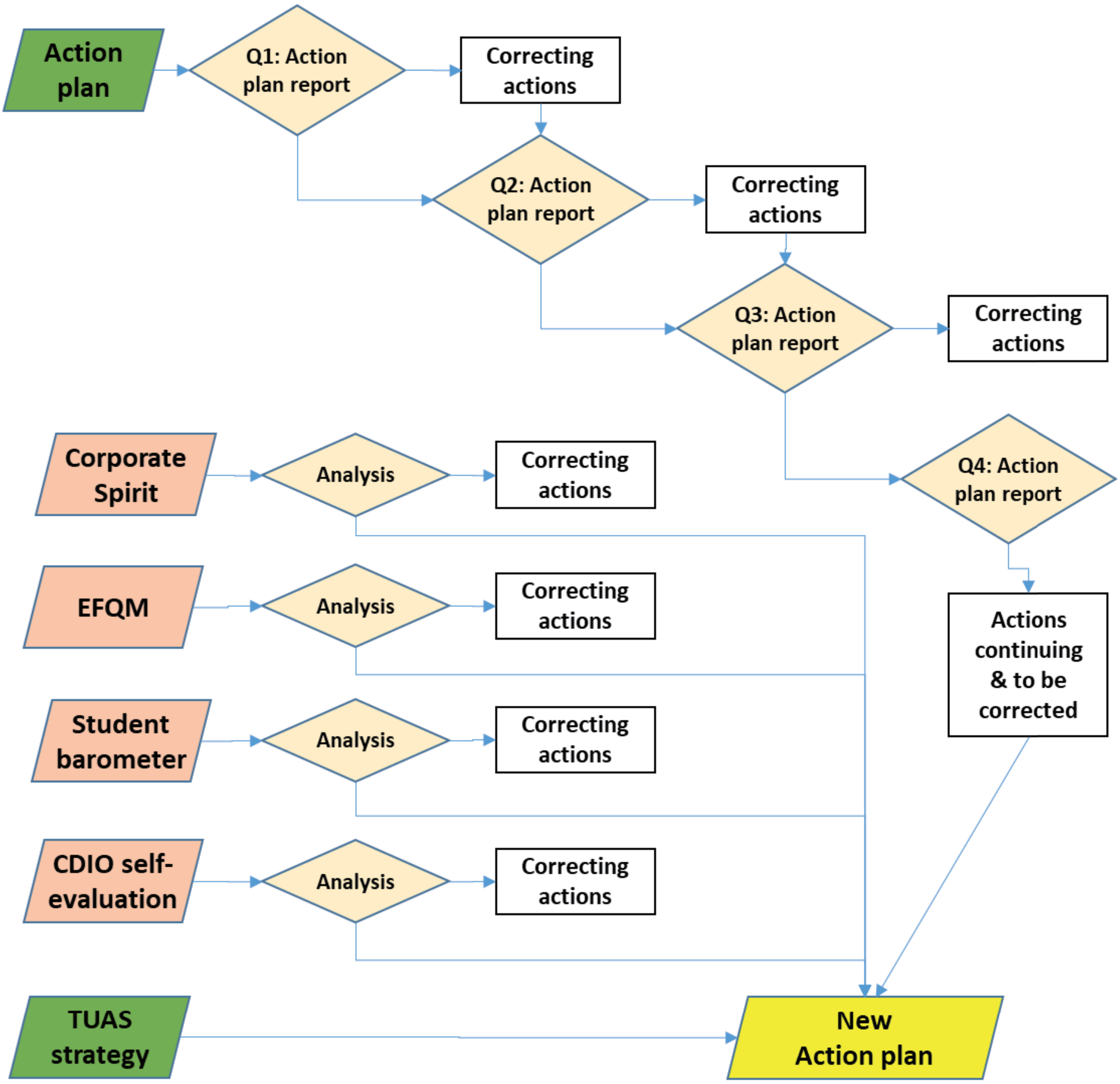


Figure 6. Quality Enhancement.

positive issue, but at the same time, it challenges us to really be able to absorb all the input and feedback. One possible solution might be timing the elements better together and define the roles and expectations more clearly. For example, the Corporate Spirit employee survey could happen later in the Autumn and the results could impact directly to the next year's action plan and no additional correcting actions should be defined.

Conclusions

The presented quality assurance and quality enhancement system is relatively new. The Corporate Spirit employee survey has been used three years, EFQM Excellence Model two years and the CDIO self-evaluation from Spring 2019. At this point, we already see that we have good elements in our hand, but we need to learn using them better together. At the moment, they act as independent tools and the wholeness of quality enhancement has to be described. This paper has opened this discussion and the work will continue internally.

The paper has described a QA and QE system that probably has similarities as well as differences to systems in place in other universities. Hopefully the paper initiates further discussion and leads to better quality in higher education.

References

Amaral, A. (2007). Higher Education and Quality Assessment. The Many Rationales for Quality. *Embedding Quality Culture in Higher Education, EUA Case Studies*, 6-10.

Bennedsen, J., Rouvrais, S., Roslöf, J., Kontio, J., Georgsson, F., & McCartan, C. D. (2018). Collaborative quality enhancement in engineering education: an overview of operational models at a programme level. *European Journal of Engineering Education*, 1-16. doi:10.1080/03043797.2018.1443058

Cavaye, A. L. M. (1996). Case Study Research: a multi-faceted research approach for IS. *Information Systems Journal, 6*, 227 - 242.

CDIO. (2019). The CDIO initiative. Retrieved from www.cdio.org

Corporate Spirit Oy. (2019). Engaging People for Success. Retrieved from https://corporatespirit.fi/en/

Crawley, E., Malmqvist, J., Östlund, S., & Brodeur, D. (2007). *Rethinking engineering education - the CDIO approach*: Springer.

EFQM. (2019). EFQM Excellence Model. Retrieved from https://www.efqm.org/

ENAEE. (2019). European Network for Accreditation of Engineering Education. Retrieved from https://www.enaee.eu/

ENQA. (2015). *Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG)*. Retrieved from http://www.enqa.eu/index.php/home/esg/

ENQA. (2019). European Association for Quality Assurance in Higher Education (ENQA). Retrieved from https://enqa.eu/

Filippakou, O., & Tapper, T. (2008). Quality Assurance and Quality Enhancement in Higher Education: Contested Territories? *Higher Education Quarterly, 62*, 84–100.

FINHEEC. (2019a). The Finnish Education Evaluation Centre. Retrieved from https://karvi.fi/en/

FINHEEC. (2019b). The Finnish Education Evaluation Centre - Higher Education. Retrieved from https://karvi.fi/en/higher-education/

Gray, P. J., & Patil, A. S. (2009). Internal and External Quality Assurance Approaches for Improvement and Accountability: A Conceptual Framework. In A. S. Patil & P. J. Gray (Eds.), *Engineering Education Quality Assurance: A Global Perspective*. Boston: MA: Springer.

Gray, P. J., Patil, A. S., & Codner, G. (2009). The Background of Quality Assurance in Higher Education and Engineering Education. In A. S. Patil & P. J. Gray (Eds.), *Engineering Education Quality Assurance: A Global Perspective*. Boston: MA: Springer.

Harvey, L. (2019). Analytic Quality Glossary. Retrieved from http://www.qualityresearchinternational.com/glossary/

Houston, D. (2008). Rethinking Quality and Improvement in Higher Education. *Quality Assurance in Education, 16*, 61-79.

Kontio, J., Roslöf, J., Edström, K., Thyberg Naumann, S., Munkebo Hussman, P., Karhu, M., & Schrey-Niemenmaa, K. (2012). Improving Quality Assurance with CDIO Self-Evaluation: Experiences From a Nordic Project. *International Journal of Quality Assurance in Engineering and Technology Education, 2*(2), 54 - 65.

Kontio, J., & Tuohi, R. (2011). *Engaging students in the development and quality assurance of degree programs – a case study.* Paper presented at the ICEE Conference, Belfast, Ireland.

Ministry of Education and Culture. (2019). Ministry of Education and Culture. Retrieved from https://minedu.fi/en/frontpage

Turku University of Applied Sciences. (2019a). Innovation Pedagogy. Retrieved from http://www.tuas.fi/en/about-us/operations-and-organization/innovation-pedagogy/

Turku University of Applied Sciences. (2019b). Strategy 2019-2031. Retrieved from http://www.tuas.fi/en/about-us/operations-and-organization/values-and-strategy/

Williams, J. (2016). Quality assurance and quality enhancement: is there a relationship? *Quality in Higher Education, 22*(2), 97-102. doi:10.1080/13538322.2016.1227207

Yin, R. K. (1994). *Case Study Research - Design and Methods* (2 ed.). Thousand Oaks: SAGE Publications, Inc.

Yin, R. K. (2002). *Applications of case study research*: SAGE Publications Inc.

Implementation of the Remote Classes Between Maritime Colleges (Taking the ship health supervisor "Special lecture" as an example)

Teruo HOSHUYAMA[*,a], Mitsuo TADA[a], Norio YUDA[a], Keiji SASAYA[b], Tomohito ITO[c], Yoshiaki KAWAMURA[d] and Tetsuya SUMIDA[e]

[a] NIT(KOSEN), Yuge college / Dept. of maritime technology, Yuge, Kamijima-cho, Ehime, Japan
[b] NIT(KOSEN), Toyama college / Dept. of maritime technology, Imizu-city, Toyama, Japan
[c] NIT(KOSEN), Toba college / Dept. of maritime technology, Ikegami, Toba-city, Mie, Japan
[d] NIT(KOSEN), Hiroshima college / Dept. of maritime technology, Toyota, Hiroshima, Japan
[e] NIT(KOSEN), Oshima college / Dept. of maritime technology, Oshima, Yamaguchi, Japan

*E-Mail housyuyama@ship.yuge.ac.jp

Abstract

No doctors, no nurses, and no other medical workers are on board except only a few vessels like the passenger ship sailing internationally. Most of the vessels have seafarers appointed by the ship owners concurrently serving as health manager. The person in charge of health manager for vessels which sail the deep sea and greater coastal zones, and in addition, which have a gross tonnage of over 3000 tons needs to be qualified as a "Ship health supervisor ".

Until now, in order to qualify as a "Ship health supervisor", it has been necessary to take a 100-hour health supervisor course provided by the Association for Promoting Safety and Sanitation for Seafarers. At the examination meeting on the training for health supervisor qualification, which was held in 2017, we received a total of 57 hours of certification in the curriculum of the department of maritime technology and in the ship health supervisor "Special lecture". Therefore it is possible to obtain the qualification by taking a 43-hour course on ship health supervisor (B) conducted by the Association for Promoting Safety and Sanitation for Seafarers.

The ship health supervisor "special lecture" was conducted as a five-day intensive lecture during the spring vacation, with qualified personnel such as doctors, nurses and nutritionist as lecturers. The intensive lectures were conducted at NIT (KOSEN), Yuge College as the main venue, and other mercantile marine college of technology as remote class venues. We have formulated the criteria for the remote learning system and certified by the examination meeting on the training for health supervisor qualification and authorized by the Maritime Bureau of the Ministry of Land, Infrastructure, Transport and Tourism.

The ship health supervisor "special lecture" has been offered twice until now. This lectures were offered from March 5th to 9th in 2018 with 59 participants, and from March 4th to 8th in 2019 with 60 participants.

We were also anxious about the implementation of remote classes. However, the evaluations of lecturers who were in charge of remote learning, teachers who gave instruction in remote learning colleges, and students who participated in the remote learning were good, and the effectiveness of the remote classes implemented this time was confirmed.

Keywords: *Remote learning system, The ship health supervisor "special lecture", Intensive lectures, The Association for Promoting Safety and Sanitation for Seafarers, The examination meeting on the training for health supervisor qualification, The Maritime Bureau of the Ministry of Land, Infrastructure, Transport and Tourism*

1. Introduction

No doctors, no nurses, and no other medical workers are on board except only a few vessels like the passenger ship sailing internationally. Most of the vessels have seafarers appointed by the ship owners concurrently serving as health manager. The person in charge of health manager for vessels which sail the deep sea and greater coastal zones, and in addition, which have a gross tonnage of over 3000 tons needs to be qualified as a "Ship health supervisor ".

Until now, in order to qualify as a "Ship health supervisor", it has been necessary to take a 100-hour health supervisor course provided by the Association for Promoting Safety and Sanitation for Seafarers. At the examination meeting on the training for health supervisor qualification, which was held in 2017, we received a total of 57 hours of certification in the curriculum of the department of maritime technology and in the ship health supervisor "Special lecture". Therefore it is possible to obtain the qualification by taking a 43-hour course on ship health supervisor (B) conducted by the Association for Promoting Safety and Sanitation for Seafarers.

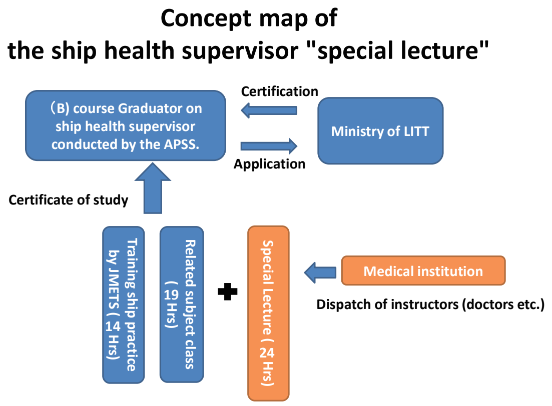


Figure 1 Concept map of the ship health supervisor "special lecture"

Figure 1 shows a concept map of the ship health supervisor "special lecture".

In this paper, we would like to introduce the ship health supervisor "special lecture" which is conducted in the five mercantile marine colleges of technology as a remote class.

2. Outline of the ship health supervisor "special lecture"

The ship health supervisor "special lecture" was conducted as a five-day intensive lecture (total 30 hours) during the spring vacation, with qualified personnel such as doctors, nurses and nutritionists as lecturers. The intensive lectures were conducted at NIT (KOSEN), Yuge college as the main venue, and other merchantile marine college of technology as remote class venues. We have formulated the criteria for the remote learning system and certified by the examination meeting on the training for health supervisor qualification and authorized by the Maritime Bureau of the Ministry of Land, Infrastructure, Transport and Tourism.

The ship health supervisor "special lecture" has been offered twice until now. These lectures were offered from March 5th to 9th in 2017 with 59 participants, and from March 4th to 8th in 2018 with 60 participants.

Table 1. Sample schedule of the ship health supervisor "special lecture" 2019

The schedule of the ship health supervisor "Special lecture" 2019

DATE		Morning time schedule			Lunch	Afternoon time schedule				
	8:50	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	
4th Mar. 2019	Opening ceremony and guidance	Health guidance 2 (3 hours) Lecturer: Dr. Shinohara				The same (2 hours) Lecturer: Dr. Shinohara		Examination (Health guidance 2)		
		Internal medicine theory(1)	Internal medicine theory(2)	Theory of surgery(1)		Theory of surgery(2)	First aid treatment method			
5th Mar. 2019		Disease prevention 2 (3 hours) Lecturer: Dr. Matsumoto				The same (3 hours) Lecturer: Dr. Matsumoto			Examination (Disease prevention 2)	
		Infectious disease and prevention(1)	Infectious disease and prevention(2)	Infectious disease and prevention(3)		Infectious disease and prevention(4)	Infectious disease and prevention(5)	Summary and review		
6th Mar. 2019		Disease prevention 1 (3 hours) Lecturer: Dr. Ono				The same (3 hours) Lecturer: Dr. Ono			Examination (Disease prevention 1)	
		Health management	Lifestyle disease and prevention(1)	Lifestyle disease and prevention(2)		Cancer prevention(1)	Cancer prevention(2)	Summary and review		
7th Mar. 2019		Food hygiene (3 hours) Lecturer: Dr. Miyata				The same (4 hours) Lecturer: Dr. Miyata				
		Food	Nutrition and health(1)	Nutrition and health(2)		Food hygiene(1)	Food hygiene(2)	Food hygiene(3)	Summary and review	
8th Mar. 2019		Labor physiology (3 hours) Lecturer: Dr. Umeda				Health guidance 1 (3 hours) Lecturer Dr. Umeda			Examination (Food hygiene) (Labor physiology) (Health guidance 1)	Closing ceremony
		Structure / function of human body	Structure / function of organs(1)	Structure / function of organs(2)		disease(1)	disease(2)	Summary and review		

Table 2. The number of students who have taken ship health supervisor "special lecture" in the past two years

The number of students who have taken ship health supervisor "special lecture" for the past two years(2018 and 2019)

Year (Date)	Toyama	Toba	Hiroshima	Oshima	Yuge	Total
2018 (5 days, from 3/5 to 3/9)	8	3	4	11	33	59
2019 (5 days, from 3/4 to 3/8)	18	5	7	3	27	60

Table 1 shows sample schedule of the ship health supervisor "special lecture" 2019.

Table 2 shows the number of students who have taken ship health supervisor "special lecture" in the past two years (2018 and 2019).

The main venue has been implemented at NIT (KOSEN), Yuge college for the past two years. In addition, the implementation lecture time was 30 hours.

Implementation guideline of the ship health supervisor "special lecture" 2019 is as follows.

(1) Schedule of lectures
From the 4th March to the 8th March, 2019.

(2) Attendance confirmation
At the start of each class, please check the attendance by the person in charge at each college.

(3) Questions and answers
At the last hour of each subject, questions will be given in college units. (Toyama → Toba → Hiroshima → Oshima → Yuge)

(4) Class management during the lecture
Please instruct the class supervisor in a suitable way, such as rotating numbers, etc. by the teachers of each college.
Please be aware of internet problems and poor physical condition of the students.

(5) Break time
There is 10 minutes break in 50 minutes of lecture.

(6) Examination and scoring
After each lecture, an exam will be conducted for each subject. The passing score is over 60% of the full score in each subject examination. Those who fail will carry out a re-examination. If it is after the last examination of "special lecture", conduct time of re-examination is good by judgment of each college.

(7) Handling of answer sheets for each subject
Please prepare an appropriate file holder, convert it into an electronic file, and save it in the same way as for the regular exams to be conducted at each college.

In the past two years, the exams for each subject were partially taken by students who took re-examination, and all the students passed.

The textbook used for this special lecture is the "Health Management Manual" issued by the Association for Promoting Safety and Sanitation for Seafarers Japan.

Photo 1. State of the lecture in main venue (Yuge college)

The lecturers in each lecture invited medical experts in each field from Tokyo University of Technology, Kawasaki University of Medical Welfare, and Okayama University, respectively.

We have been giving intensive five-day special lectures twice in the past two years, but fortunately there were no students who were absent or complaining of poor health during the course of the lecture.

3. Remote learning system

The intensive lectures were conducted at NIT (KOSEN), Yuge College as the main venue, and other mercantile marine college of technology as remote class venues. We have formulated the criteria for the remote learning system in February 2018 and certified as "On the eligibility of remote classes in Technical college (Kosen)" by the examination meeting on the training for health supervisor qualification and authorized by the Maritime Bureau of the Ministry of Land, Infrastructure, Transport and Tourism.

The proposed criteria named and formulated as "Criteria required for new remote classes" was approved and authorized as draft. The details are as follows.

(1) The student must be able to confirm with certainty. The teachers of each college are present at each class and take attendance.

(2) Content of remote classes can secure equivalence with contents and level of face-to-face class by clear image and sound.

Remote classes will be conducted by the communication system using the internet connection etc. In addition, even in remote classes, teachers and staff will assist in each class, and ensure that the content and level of face-to-face classes are the same.

(3) The teachers of each college should supervise the student's learning situation. The teachers of each college attend and supervise each class.

(4) Ability to ask questions and answers during class. Provide time for questions and answers for each class.

(5) Conduct final exams for each subject and confirm the correct learning status of the students.

1) The acceptance criteria for the final exam have been established.

The acceptance criteria is to conduct a final exam for each subject and score at least 60%.

2) For those who do not meet the acceptance criteria, ensure that they are mastered until the acceptance criteria are reached.

Conduct self-study and then take the final exam again.

The following comments were received from the lecturers who gave lectures and the teachers in charge of each college after the remote class.

① Remote classes using the Internet tend to be one-way.

② It is difficult to provide the situation to use practical skills, so teaching method should be improved.

③ Because it is unfamiliar, it took time to set and adjust the BlueJeans.

④ It was the first time for teachers and the students to learn .

⑤ There were no major problems with the lectures, but there was an internet problem during the "special lectures" period (For the most part it was restored soon).

4. Conclusions and future issues

The ship health supervisor "special lecture" related to the acquisition of “Ship health supervisor” qualification was conducted as a five-day intensive lecture during the spring vacation with qualified personnel such as doctors, nurses and nutritionist as lecturers. And we have formulated the criteria for the remote learning system and certified by the examination meeting on the training for health supervisor qualification and authorized by the Maritime Bureau of the Ministry of Land, Infrastructure, Transport and Tourism.

The ship health supervisor "special lecture" has been offered twice until now. This lectures were offered from March 5th to 9th in 2018 with 59 participants, and from March 4th to 8th in 2019 with 60 participants.

At first, We were anxious about the implementation of remote classes. However, the evaluations of lecturers who were in charge of remote learning, teachers who gave instruction in each colleges, and students who participated in the remote learning were good, and the effectiveness of the remote classes implemented this time was confirmed.

The third "special lecture" is scheduled for five days from March 2nd to 20th March in 2020. The total lecture time will be reduced from 30 hours to 24 hours which is the minimum requirement. Table 3 shows the comparison of the total lecture time of “special lecture” .

Table 3 Comparison of the total lecture time of ship health supervisor “special lecture”

Comparison of lecture time of ship health supervisor ″special lecture″					
Time \ Subjects	Labor physiology	Food hygiene	Disease prevention	Health guidance	Total hours
24 Hours (Standard on the rule)	3	7	10	4	24
30 Hours (2018, 2019 results)	3	7	12	8	30
Change time	±0 Hrs	±0 Hrs	△2 Hrs	△4 Hrs	△6 Hrs

Future issues are as follows.

① Currently, the Ministry of Education, Culture, Sports, Science and Technology is providing support for the implementation costs of "special lectures". However long-term support cannot be expected due to the austerity, it is necessary to become financially independent.

② Currently, all lecturers are medical professionals, but in the future, it may be difficult to search for those lecturers. In the past, this problem caused each mercantile marine college to cancel the ship health supervisor education in the individual curriculum.

Acknowledgements

At the implementation of the ship health supervisor "special lecture", We would like to thank members of the General Affairs Division Planning Section of NIT(KOSEN), members of the Association for Promoting Safety and Sanitation for Seafarers and staff of the Maritime Bureau's contact point of the Ministry of Land, Infrastructure, Transport and Tourism for carefully explaining, supporting and advising in this opportunity.

References

The Association for Promoting Safety and Sanitation for Seafarers. (2014). *Regulations for Labour Safety and Health for Seafarers.* Japan Maritime Center.

The Association for Promoting Safety and Sanitation for Seafarers. (2018). *The text book of Health supervisor.*

Feasibility Study of English Program Based on Communication using Standard Marine Communication Phrases (SMCP)

I. Sakuma[*,a] and T. Murakami[a]

[a] National Institute of Technology (KOSEN), Yuge College/Maritime Technology Department, Ehime Pref., Japan

*sakuma@ship.yuge.ac.jp

Abstract

We are aiming to improve our English program. We have to meet the challenge of designing attractive and efficient programs our students to acquire more easily way the maritime terminology. Therefore, we tried a feasibility study of English program based on verbal communication using the Standard Marine Communication Phrases (SMCP). The SMCP, which is a set of key phrases in English, is supported by the international maritime community for use at sea and developed by the International Maritime Organization (IMO) in 2001. Maritime English can be defined as "the English language used by the seafarers both at sea and in port and by individuals working in the shipping and ship building industries."

The SMCP constituted by the Maritime English is accepted as a common working language for safety operation at sea and in port in order to avoid misunderstandings on verbal communication caused by English locality of each seafarers coming from various non-English speaking world. It consists of a set of terms, phrases used on board ships. And it is a standardized safety language, precise, concise, simple and unambiguous so as to avoid confusion and error.

The SMCP program is different from current the teaching of English. We introduce examples of the program of a short and intensive English course and a practical training on our training ship. The aim is to improve not only students' ability of using and understanding the SMCP communications but also their general English-speaking ability.

The short and intensive English course has been held about once a year for five years in the spring vacation. In the program, native English language teachers grouped students in small groups of about four students and then each group carried out trainings such as roll-playing. And students played each role of ship officers, and done communicator training using SMCP. On the training ship, the students learned English like role playing game the same way as on our campus.

From these results, we provided an English program using SMCP on our campus and on our training ship, and showed the possibility of a new English program.

Keywords: *SMCP, Training ship, Maritime English, Active learning, English education*

Introduction

The shipping industry is the most standard global society. Various people are working in the borderless area of the sea without a border. The most important of them is communication. As shown in the figure, work cannot be established without communication on board. At present, English is a standard as a communication tool. Many people who don't speak English are working on ships. According to one theory, 80% of ship accidents are said to be caused by lack of communication. In order to solve these problems, the IMO introduced SMCP to enable safe navigation even for seafarers who are not familiar with English. There is a teaching material using a CD-ROM (IMO 2002) as shown in the figure 2 as the teaching method, and there is a reference book of figure 3 in Japan (Ministry of Land, Infrastructure, Transport and Tourism 2018).

The maritime technology department in the National Institute of Technology (KOSEN), Yuge College has tried to improve their English language education program together with other 4 maritime technology departments in the KOSEN colleges.

Figure 1 Communication of work on board (The nautical Institute 2007)

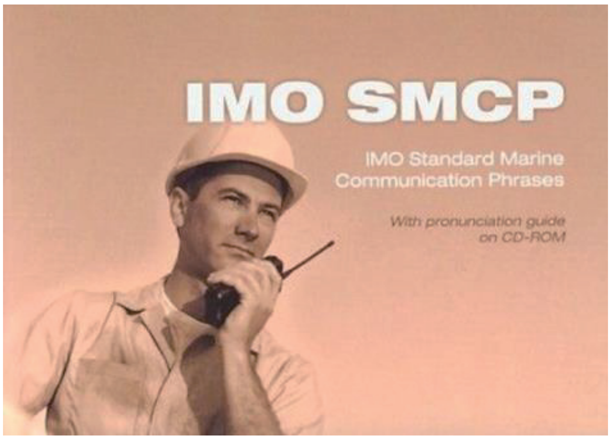


Figure 2 SMCP text on CD-ROM (IMO 2004)

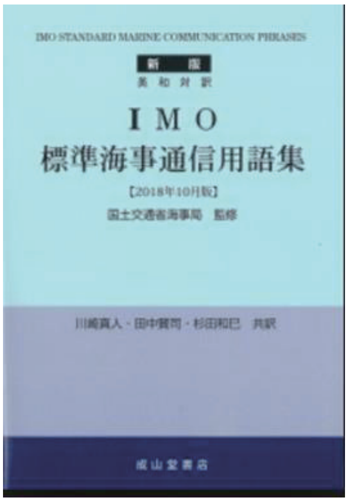


Figure 3 IMO standard communication glossary (Ministry of Land, Infrastructure, Transport and Tourism 2018)

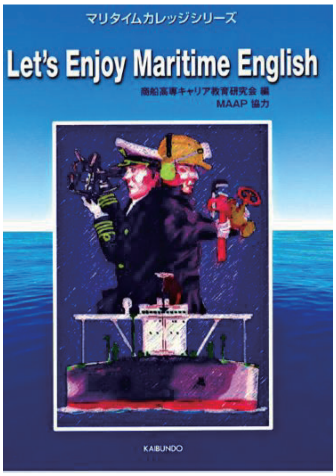


Figure 4 Let's Enjoy maritime English (Magallon 2016)

Yanagisawa (2018) previously indicates their various international internships succeeded to enhance students' motivation to be seaman. These internships effectively improve students' maritime and general English ability. These internship programs are effective and practical; however, sort of economic burden and time burden limit their participants. On the other hand, the department provided various opportunities of learning English as short courses and actively learning maritime technology such as onboard training in the college. These actively learning opportunities worked effectively for raising students' motivation for learning maritime technology and learning English.

The department in Yuge KOSEN has focused on maritime English language education. The maritime communication ability consists of not only maritime English represented SMCP but also general English ability. Therefore, the English language education of the department is required to rise the maritime communication ability of students to a usable level. However, present regularly lectures of maritime English have based classroom lectures. The lectures effectively worked to learning massive amount of knowledge. By the contrast, it is effective to provide lectures based on active learning methods to increase the ability of communicative English.

From the above, we have improved our in-school maritime English education program by combining these actively education programs and SMCP education program. We tried two way of adapting SMCP education to present English education program. Furthermore, we tied to conduct a test about maritime English owing to evaluate improvement of students' ability of maritime English.

We firstly adapted SMCP education to a short and intensive English course held in spring vacation term. The English course had provided various actively learning materials such as roll-playing and conversation by native speaker teachers. We accordingly changed contents of the English course to maritime English represented by SMCP. Secondly, we adapted SMCP education to a series of onboard training. We have tried to adapt a way of the English course such as roll-playing and departure or entering port procedures written in maritime English.

In this paper, we firstly indicated present situation of English education in the department. Subsequently, we presented two way of improving maritime education programs. And then, we show a test for evaluation about ability of maritime English. We finally concluded these programs and indicated policies to be developed.

Present English education

The English education program of the department of maritime technology in Yuge KOSEN based on

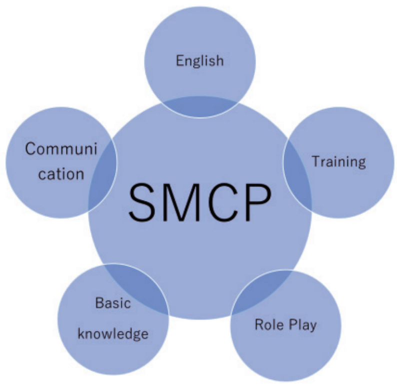


Figure 5 Schematic diagram of SMCP

classroom lectures which have taught basic grammars, reading skills, listening skills and writing skills. Most of the English lectures, which are especially held for lower grades, are common lectures extending over all departments in Yuge KOSEN. Therefore, these lectures are not optimized for the student belonging to the department of maritime technology.

On the other hand, the department has hold series of lectures teaching SMCP to higher grade students belonging to the department. In the lecture, students have memorized phrases and pronouncing phrases of maritime English by using a textbook written by Magallon in 2016 shown as figure 4, which was developed by 5 maritime technology departments of KOSEN. The textbook compress points of enormous maritime English including SMCP. These trainings are important and fundamental ways for studying basic English ability and building a vocabulary. However, actively learning programs such as conversation were required to increase communicative competence in maritime English. Figure 5 shows schematic diagram of SMCP. It indicated that maritime communication is consisted by verbal and non-verbal communication. Furthermore, English language is also a part of SMCP. Therefore, we have tried to improve our education program by adapting actively learning method owing to increase ability of maritime communication.

The short and intensive English course

The short and intensive English course was held in Yuge KOSEN from February 18th to 33th.

The course aimed to practice the maritime English education program using SMCPs. Therefore, 4 native English language teachers took part in the course every time.

The number of participants of the English course were about 20 students and 4 teachers every day. Students were consisted all grades of students.

The course is comprised of 4 terms of a term of 40 minutes. Students and teachers were separated to 4 small groups where each group had about 5 students and one teacher. Each teacher provided 4 kinds of English training methods indicated in Table 1.

Table 1 Activities of the English course

No.	Activities
1	Roll-playing of Maritime English using SMCP.
2	Pronunciation training
3	Conversation/Discussion
4	Roll-playing of general English

Roll-playing of Maritime English using SMCP: A teacher casted students as seafarers, and played each roll as shown in figure 6. Verbal communications of seafarers performed face-to-face and radio communication regardless of onboard a ship.

Pronunciation training: A group practiced pronunciation of international phonetic alphabet containing SMCP as shown in figure 7. The alphabet is the widely used radiotelephone spelling alphabet which is enacted by IMO. Onboard radiocommunication and telephone exactly contain noise and distortion. Therefore, a speaker attaches additional information called the phonetic alphabet to convey information exactly.

This short and intensive English course effectively increased students' English communication ability and improved their motivation to study maritime English and communicative general English at the college. It is not partially easy to conduct English conversation and pronunciation training without a teacher. However, when it comes to SMCP, students can train themselves by using textbook and conducting roll-playing games. Therefore, we can improve learning program of maritime English adapting these English actively learning method such as roll-playing to the classroom lectures of the department.

Figure 6 A scenery photograph of roll-playing game.

Figure 7 A scenery photograph of pronunciation training.

English education program on the training ship, Yugemaru

The onboard practical training on the training ship Yugemaru, of which photograph was shown in figure 9, was mainly conducted for improving marine navigation skills or marine engineering skills. Each grade of the maritime technology department has been held each onboard training. Therefore, the program of maritime English education gradually become more practical.

Figure 8 A scenery photograph of conversation.

In the training of the lower grades, students have learned words of maritime English and technical English while being exposed to the training ship to become skilled in maritime technology. As the grades increased, students have learned not only the technical terms but also usage of them and SMCP. In the training of higher grades, students who were assigned rolls of ship officer by teachers on training ship communicated with each other by using real radiocommunications or telephones which had actual noise and distortion as shown in figure 10, 11 and 12. They learned necessity and practicability of SMCP by their actual observation of the training.

And furthermore, we will try to gradually adapt English procedures based on SMCP about departure and entering port of ship. Students can learn the procedure and the maritime English while training about navigation.

This practical training was very effective for students as a trial of their actual English communication skills in a gradual manner.

Figure 9 A photograph of training ship, Yugemaru.

Confirmation and evaluation

Through these programs, students were given various Maritime English education. In particular, the most important problem is how evaluation students. We do not think good idea to do with a paper test like general English performed in a regular classroom. Because, the SMCP is all about communication. Therefore, in each country, tests using personal computers are being conducted to measure the ability of communication.

Figure 10 A training scenery photograph in the engine control room in Yugemaru. Students were assigned roles to leave port by chief engineer.

Figure 11 A training scenery photograph in the engine control room. Students ordered in English to other students in a remoted engine room as a chief engineer.

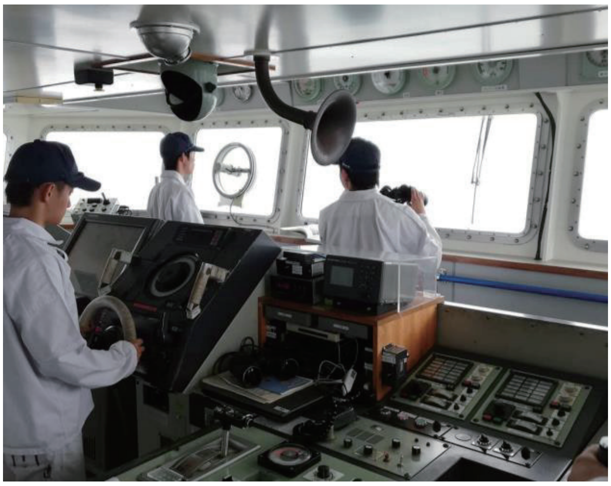


Figure 12 A training scenery photograph in the ship's bridge in Yugemaru. Students conducted navigation training.

In Japan, high school students have recently conducted real-world tests such as GTEC (Global Test of English Communication), which measure the English abilities of "listening", "speaking", "reading" and "writing" through a personal computer.

In our school, we would like to conduct the SMCP test shown in Figure 14 from now on. By conducting these tests, students themselves can know the level of understanding of General English, Communication, Maritime English and the SMCP.

Learning cycle of maritime English is shown in figure 15. The foundation of maritime English education is general English and maritime foundation. Then students learn maritime English and understand SMCP steadily by performing communication training such as role play. At this time, it is possible to move on to the next step by clarifying whether you are stumbling in general English, whether the maritime foundation is a lack of knowledge, or you do not know the SMCP phrase. For this reason, this test is very important.


Figure 13 English Test using personal computers (Studyplus 2018)

Figure 14 Test for SMCP (Road 2019)

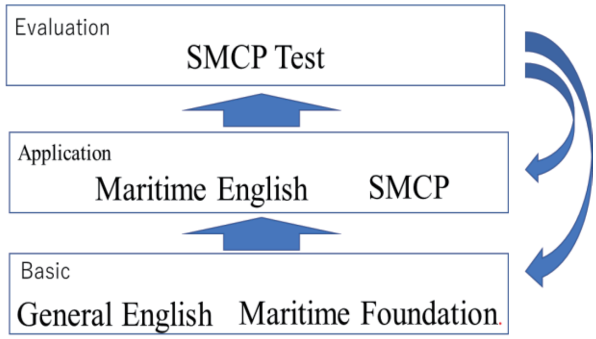


Figure 15 Learning map of maritime English

Conclusions

This study clarified what is necessary to fill the gap between general English education and practical maritime English, focusing on English education in maritime education.

In order to cultivate the power of using maritime English, it is best to use the learned English in a practical situation and also to use foreigners who do not understand Japanese. Therefore, we would like to establish a system to practice in English using training ship, ship handling simulators, etc.

We have now delivered our Maritime English program every year and will begin onboard training at Yugemaru in October 2019. The situation we are in is still far from ideal in terms of Maritime English matter knowledge. but using group work in this way has done much to improve the quality of the Maritime English offered at this program.

Reference

The Nautical Institute. (2007). Effective communication: The key to successful operations. *The International Maritime Human Element Bulletin*. 14. 1.

IMO. (2004). *IMO SMCP on CD: A Pronunciation Guide Version 1*. IMO.

Ministry of Land, Infrastructure, Transport and Tourism. (2008). *IMO standard marine communication phrases*. Seizando-shoten publishing Co., Ltd..

Yanagisawa, O. *et al.* (2018). Implementation of an International Maritime English Educational program at Maritime Technology departments in five NIT in Japan. *Proceedings of 30th International Maritime English Conference (IMEC30)*, 1-13.

Magallon, J. *et al.* (2016). *Let's Enjoy Maritime English*. Kaibunndo Publishing Co..

Benesse Coproration. (2019) English | GTEC Retrieved from https://www.benesse.co.jp/gtec/

Studyplus Inc.. (2018) What is GTEC? Retrieved from https://www.studyplus.jp/675

Road, W, L. (2019) Standard Marine Communication Phrases Multiple-Choice Test. Retrieved from http://www.maritimetraining.pro/index.php/products/index.php

Building Life Cycle Based Model in Civil Engineering Education – Better Co-operation with Working Life

E. Leinonen

[a] Turku University of Applied Sciences/Civil Engineering, Turku, Finland

*esa.leinonen@turkuamk.fi

Abstract

This paper presents a civil engineering education model based on building life cycle, connecting it into real working life. In a traditional study process it may be unclear for the student in which phase of a construction process the selected course information is needed and how different studies are related. Several factors define the content and methods in civil engineering education. Objectives of the education are naturally based on the demands of working life. Furthermore, there are specific qualifications based on law and different instructions in construction. An objective of the legislation and the authority steering is also to promote sustainable development. On the other hand, there is also a need to develop more effective learning methods to replace the traditional forms of teaching. New technology such as digitalization and virtual reality offers new ways to share information, combining it with cases in working life.

In the model based on building life cycle the studies are regarded from the perspective of a real construction process and its phases. The content of studies is defined to meet the essential stages of working life in a building life span. Education will be closer to working life, reflecting its aims and tasks. The model increases the transparency of studies and eliminates duplicate courses. Naturally, theory is combined with the studies. The model also emphasizes the requirements based on the professional qualifications. Requirements of sustainable development and building are noticed in the model inside separate courses.

The aim is also to implement the studies in co-operation with companies or organizations in the construction sector. For this purpose, specific agreements of co-operation with companies have been made. Different active teaching methods like project work, research hatcheries, expert interviews, internship, BIM and practical cases from working life have increased motivation and deepened the knowledge of students. Finally, it is supposed that the model also produces better professionals for the construction industry.

Keywords: *Civil Engineering, Education, Working Life, Life Cycle, Sustainable Development*

Introduction

The purpose of this study is to present a civil engineering education model based on building life cycle and its integration into working life. Education should be closer to the processes of working life, reflecting its aims and content. There is also a need to develop more innovative teaching alternatives to replace traditional lecture-based studies.

Traditionally, civil engineering studies, like many other studies, are usually presented in a catalogue-like format that does not necessarily create a very clear picture of the whole learning process and its content and aims. There are many types of different studies, like basic, professional, compulsory and elective studies.

Despite this classification, it may be difficult for the student to understand in which phase of a construction process the selected course information is needed and how different studies are related to each other.

The role of universities of applied sciences is aimed to be more practice-oriented than that of the scientific universities. There are several factors determining the content and methods used in education of civil engineering (Figure 1). Objectives of the education are naturally based on the demands of working life. These requirements can be divided into general demands (project management, human management, communication skills, customer service, etc.) and specific requirements coming from the construction industry. In Finland, there are specific qualifications in building planning as well in site supervision and management based on law and the Complementary Building Act and Code (Land Use and Building Act, 1999).

Sustainable development also has an important role in civil engineering education. The main driver is climate change which is affecting our environment in everyday life. In construction, it means more effective actions, like the development of better energy saving insulation or use of circulated building materials with a lower carbon footprint.

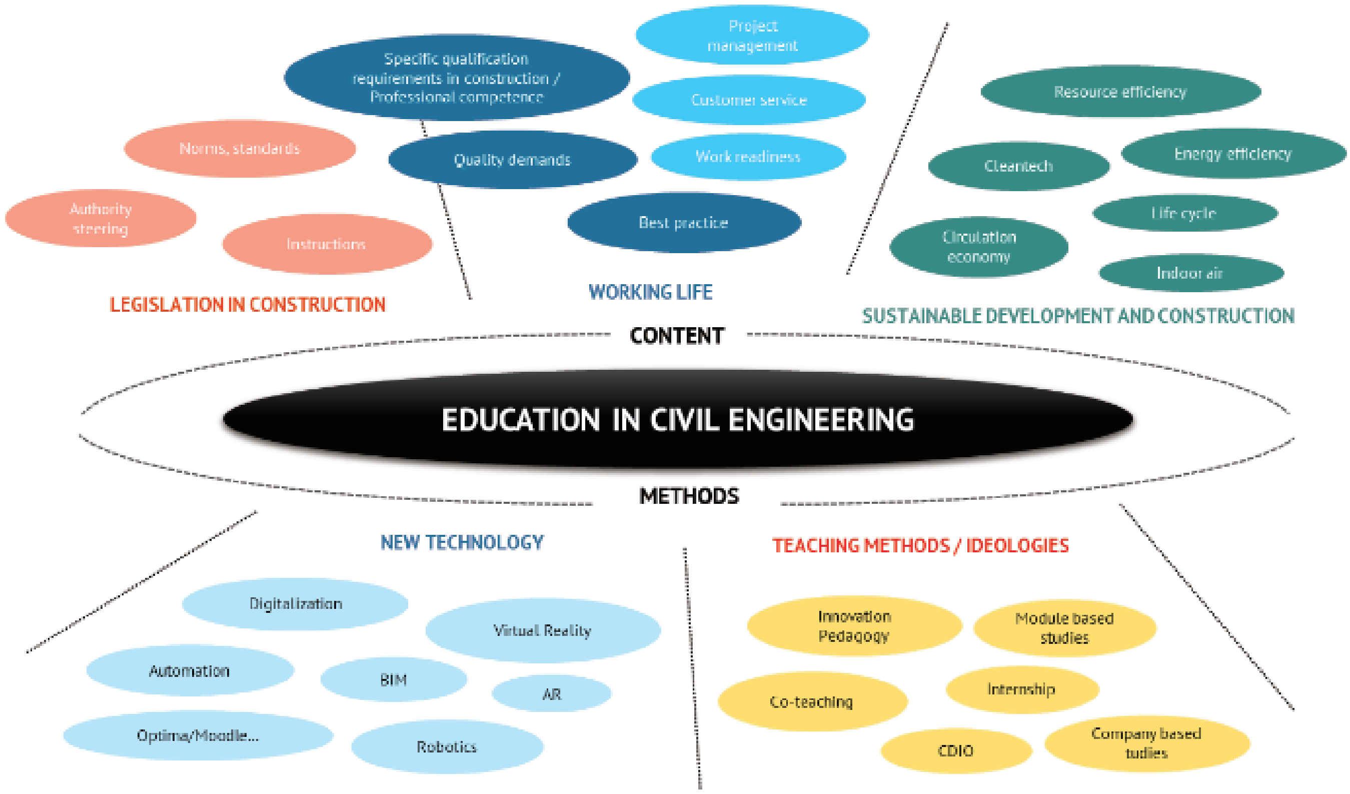


Figure 1. Background factors in civil engineering education at universities of applied sciences.

The legislation and authority steering in construction also aim to promote sustainable development. Construction and the environment have to be maintained in a manner that meets the standards for health and safety and does not ruin the atmosphere of the surroundings. According to law, a building shall satisfy essential technical requirements and be ecologically sustainable (Land Use and Building Act, 1999).

Traditional forms of teaching like classroom lectures are under pressure because teaching is mostly one-way oriented with students mainly having a passive role. New technology offers various ways to teach more innovative methods and tools, such as virtual reality, BIM or different mobile applications.

At Turku University of Applied Sciences, innovation pedagogy has a notable role in the institution's strategic policy (Lehtonen et al., 2010). In innovation pedagogy, entrepreneurship, applied RDI activities and internationality are linked to teaching in order to support innovations that benefit working life. (Kairisto-Mertanen et al., 2012). Innovation pedagogy is based on customer-oriented and multi-field needs of working life; it integrates applied research and development and entrepreneurship with education in a flexible way; and promotes regional and international networking (Kettunen, 2011).

The CDIO Initiative is an educational framework that stresses engineering fundamentals set in the context of conceiving, designing, implementing and operating (CDIO) real-world systems and products. The CDIO approach uses active learning tools, such as group projects and problem-based learning, to better equip engineering students with technical knowledge as well as communication and professional skills. (Crawley et al., 2014.)

This paper is organized as follows:

- first, the civil engineering education model based on a building life cycle is presented
- second, the demands and specific requirements of working life and how to notice them in civil engineering studies is introduced
- third,the connection between the model and working life is presented and some examples of co-operation with companies in civil engineering education are highlighted

The key point of this paper is to expand the traditional learning perspective to a wider form by combining civil engineering studies with building life span and its demands.

Civil Engineering Education Model based on Construction Life Cycle

The construction life span point of view is usually based on a linear structure of sequential activities distributed along the building life. Generally, the main phases in the construction process are project definition, design, construction and use and maintenance (Rakennustietosäätiö, 1989. Shada & Fleming, 2012).

The project definition phase includes all feasibility studies and preliminary planning up to preparation of a design brief. Design turns this into a specification for construction and construction turns this into a building. The longest life cycle stage for most buildings is use, which is concurrent with operation and maintenance. Finally the building will be demolished. During the use stage, some renovation and repair work should also be carried out. The same steps can also be found in infrastructure projects with various names.

The civil engineering education model is based on this building life cycle (Figure 2). The aims and content of studies are defined to meet the essential stages of working life in building life span. The study courses are aimed to be located within a building life cycle, taking into account the most suitable and natural location in the span.

technical and professional studies. The purpose of these general studies is to create a basis for deeper learning. Professional studies can be divided into common technical and professional studies (2nd year) and professional specialization studies (3rd & 4th years) Students can choose their professional specialization out of the three options available in building construction: Community Infrastructure Engineering, Structural Engineering and Building Repair. The two last ones are connected to the building construction. Hence, studies of production planning in construction are linked with repair and renovation. In Community Infrastructure Engineering, the studies consist of the design and construction of infrastructure projects.

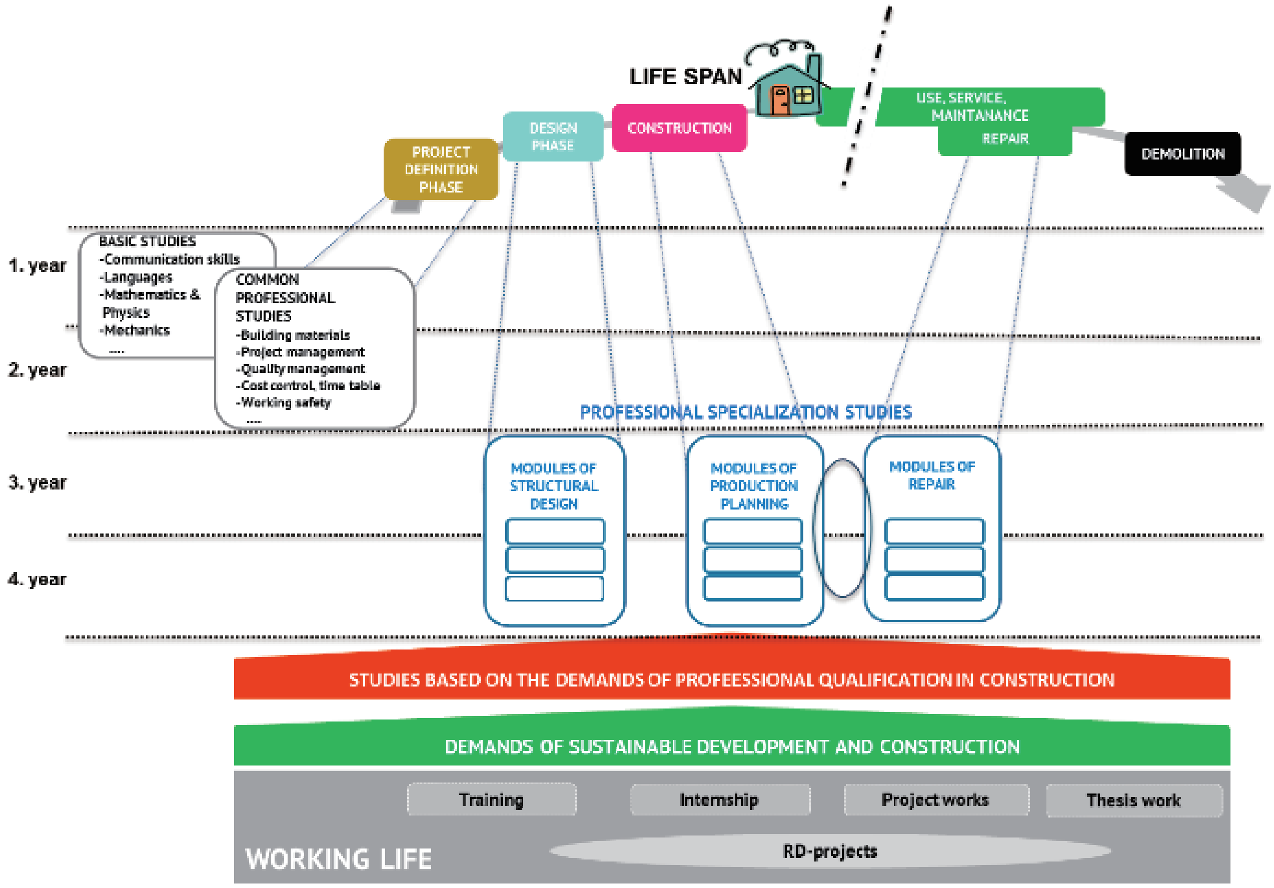


Figure 2. Civil engineering studies and a building life cycle.

The civil engineering programme aims to educate extensive professionals for all the key fields of construction. The programme consists of a total of 240 ECTS, including basic and professional studies, elective studies, project work, training and a bachelor's thesis. A significant part of the studies such as project work, training and thesis are usually undertaken in the construction industry.

In civil engineering education, the first two years of studies contain basic studies like languages, communication skills, mathematics, physics and basic

All studies have been assembled in 15 credit modules. A module should contain studies consisting of the same subject or topic. For example, each specialization consists of three different modules with a total number of 45 credits. Each separate specialization module contains topics related to a focused profession. Furthermore, there is a project work with 5 credits and a final thesis with 20 credits. The optional studies (30 credits) are supposed to consist of studies which support the chosen professional specialization.

The building life cycle based approach is in line with the curriculum guidelines. The model makes the education more transparent and eliminates duplicate studies. The studies are in a reasonable order and the knowledge will deepen during the learning process.

When comparing this model to CDIO, we can find some basic similarities in both stages. The steps Conceiving – Designing – Implementing – Operating correspond to the stages construction life span with stages Preliminary design, Design, Construction and Operation. The same conclusion is presented in the study of Nilsson, Edelbro and Edström (2016).

Professional competence requirements in the civil engineering education model

The model also emphasizes the essential things in working life such as the requirements based on the professional qualifications. In Finland, a party engaging in a building project shall ensure that the building is designed and constructed in accordance with building provisions and regulations and the permits are granted. The party shall have the necessary competence to implement the project, as required by its difficulty, and access to qualified personnel. (Land Use and Building Act, 2014)

The competence of the parties such as the principal designer, special designers and site manager is based on training and experience. The qualifications required depend on the adequate competence of a party in proportion to the difficulty of the project concerned. According to the guidelines and decree of Ministry of the Environment, the difficulty classes of tasks can be classified as (Ministry of the Environment, 2015):

- minor (simple building, max. 1 floor, <25 m2, for example shed, small shelter)
- conventional (<2 floors, <300m2, e.g. single family house)
- difficult (3–12 floors, over 300 m2, e.g. residential apartment house)
- exceptionally difficult (3–12 floors, over 300 m2, e.g. residential apartment house)

A designer or other party must be a natural person. To achieve the necessary qualifications, the party has to obtain the required training or education. For each task, there are specific studies related to the task under consideration. In the Ministry of the Environment guidelines on the qualification of building designers and site managers, the required degrees and needed studies with credits are presented (Ministry of the Environment, 2015).

A completed degree programme in civil engineering at TUAS provides the degree of a Bachelor of Engineering. Depending on the chosen studies, the following training levels for the requirement tasks will fulfill:

- site manager in a conventional task for all students (40 cr)
- site manager in an exceptionally difficult task for students specialized in production management (45 cr)
- designer of load-bearing structure in a difficult task for students specialized in structural design (40 cr)
- designer of foundation structure in a difficult task for students specialized in structural design with studies connected to foundation structures (40 cr)

Sustainable development and building should be a natural part of the building life span and education. Thus the requirements of sustainable building will be integrated inside civil engineering studies. Some of these requirements are based on legislation and must therefore include education. For example, energy demands are noticed in the building permit process and they are observed as a part of the specific study course. Also other sustainable building features like the life time and carbon footprint of different building materials have been taken into account in particular study courses. Lean-philosophy supporting resource efficiency has been addressed in the building procurement studies.

The link between teaching and working life – better co-operation

Traditionally, studies in separate modules and courses are reflected in working life in practice with different exercises and case studies. Usually they are connected to separate study courses, project works or RDI projects. Compulsory practical training is carried out in three separate sections after every academic year in different construction companies or organizations. Finally, the thesis work coming from working life measures the competence of a student in a particular area of expertise (Figure 3).

In principle, theory-based lectures with instructions and exercises are mostly held in a classroom. During the last years, the number of online study courses has also increased. When the study material is in electronic format or there are existing working life based applications or software, it is natural to use them in on-line studies. This information can be transferred into Optima, which is a web-based environment for educational use at TUAS. The information in Optima is easy to obtain also outside lecture hours and exercises can be returned for review to the teacher via a return box. Students can also utilize electrical information (RT-cards) and other official instructions in a cloud service maintained by Building Information LTD (Rakennustieto 2019). The company publishes instructions for building and property management, regulations, contract documents and forms and product information both in printed format and on the Internet.

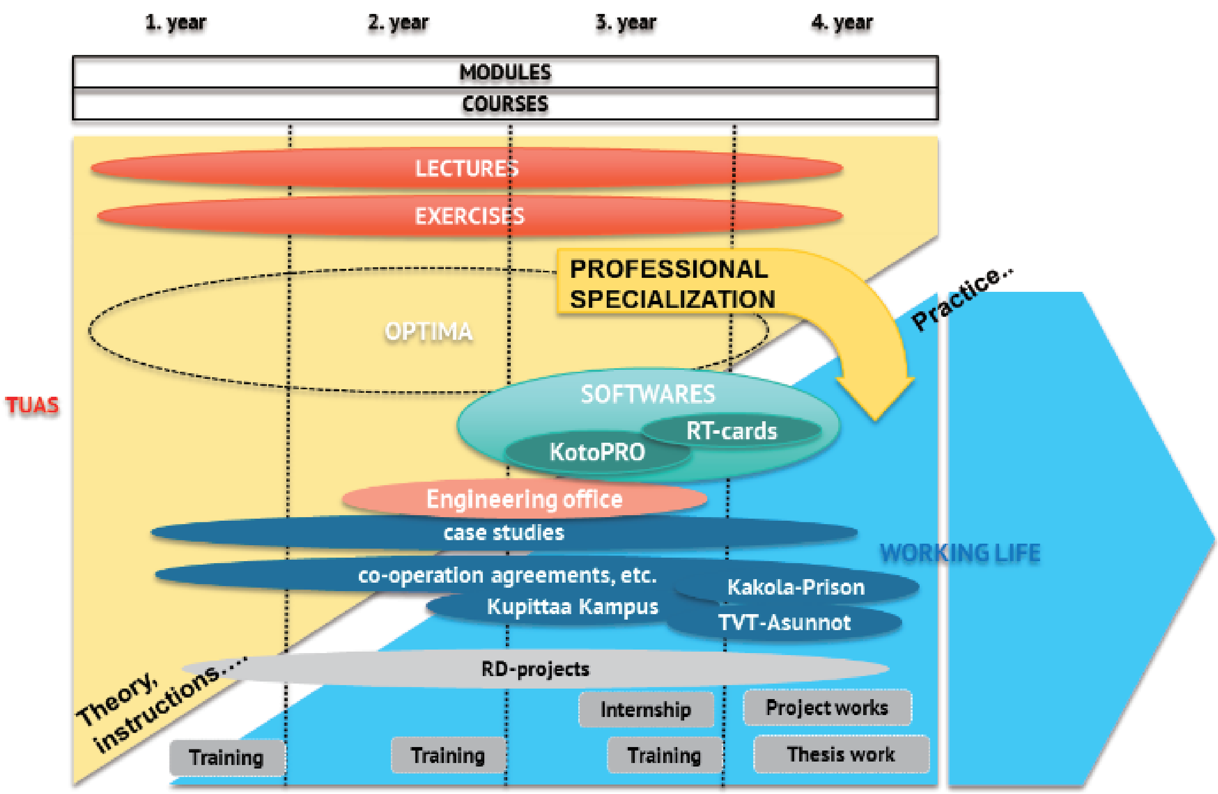


Figure 3. Combining civil engineering studies into working life.

The civil engineering programme has a long tradition of applying different active teaching methods such as project work, research hatchery, expert interviews, internship and an engineering office (Lehtonen et al, 2009). The Department of Civil Engineering Education was awarded with the National Quality Unit Award by the Higher Education Evaluation Council in 2008. A significant criterion was the development work of the curriculum and teaching methods.

In *Project work*, each student acquires a project assignment from working life to be completed in the guidance of a teacher from the degree programme. The compulsory project work strengthens the student's project skills and produces a natural channel for networking with working life (Lehtonen et al., 2009). In addition, several external assignments have been carried out in connection with teaching in the construction laboratory, for example condition assessment of a building, humidity measuring, air tightness measurement or thermal imaging.

Research hatchery is a form of project-based learning that emphasizes tutoring. The idea is to offer a functional learning environment, where students under counselling can create new information with reliable methods by carrying out research assignments from the university of applied sciences, companies or other universities (Kanerva-Lehto et al, 2010).

Along with compulsory training, there is a special *internship* period in working life for the students specialized in production planning on construction site. Students complete a 2– 4-month period in a construction company or other organization related to construction production. The idea is that students will deepen the skills needed in construction management with the guidance of a workplace instructor. Studies at the workplace are planned and supervised, and the goals are agreed between the university, a workplace instructor and a student. During the internship period, the student will become familiar with the management and planning tasks of production management in construction. The student will acquire sufficient capacity to apply the learned theory in practice.

Engineering office is based on the idea to create a realistic work environment resembling the CAD design process. The method is carried out with project work. An assignment is typically a single-family house or other small house design given mainly by private persons. The degree programme and client will make a contract agreement on the work content and schedule. A typical assignment is designing the drawings for the building permit. Frequently, a structural planning is included in the contract, especially in wooden houses or concrete structures in foundation. A student will work under the supervision of an experienced teacher. The design is performed using common CAD-software like AutoCAD or Archicad. For structural design, Tekla Structure or Autodesk Robot software are used. Some other software may also be utilized, for example DOF for energy consumption calculation.

Currently, the main object of developing different new and active teaching methods is to improve the quality of education, i.e. to obtain better learning outcomes. Thus today's development work is mainly focused on utilizing virtual reality or the existing applications used in construction companies and organizations.

KotoPro is a mobile platform which enables to carrying out many things electronically instead of paper work (Kotopro 2019). It is meant to be used by anyone involved in construction. Contractors can document their work with pictures, videos etc. In educational use, a student can record and photograph their learning assignments with a mobile phone straight into the application. The teacher can then instruct and report remotely. The application is especially suitable in the documentation of training and internship.

RDI projects can also be linked in the studies. In the TÄO project (Future's Intelligent Learning Environment), civil engineering students carried out the construction design, structural design and made a BIM model of detached houses according to the engineering office ideology. The project was done in co-operation with the City of Turku and the houses were constructed by the students of Turku Vocational Institute.

Furthermore, there are construction company-study course cases in which a construction company offers a real project or construction site for a learning environment. By connecting real building for teaching, the requirements of innovation pedagogy will also be realized. The learning environment is an authentic building with its demands. The theory of different studies can be reflected in practice for example in planning of work, preparing of schedule or work safety, etc. A real project forces to test the theory in practice and a company gets comparative data and maybe more experienced employees in the future.

An example of a long-time co-operation with a building developer is case Kakola. Verkaranta Ltd, the owner of an old prison facility, Kakola, and TUAS made an agreement in 2015 to use a prison facility in the studies. In civil engineering education this means especially the possibility to combine renovation studies with an old, challenging building target. Another similar case is an old wooden house of TVT-Asunnot in which a real project offers a platform for different studies, covering all aspects of the building process. In both cases old facilities have been utilized as a learning environment. Instead of a single project, the studies can be combined with a multi-year project. The long-time schedule will enable following construction works by connecting them with different separate study courses like condition assessment, planning of repair, production planning of repair, etc. Other study methods are also suitable in project work in old buildings, for example moisture measurement, air tightness measurement or thermal imaging.

Kupittaa Campus is an example of a new building which is currently under construction aimed to be completed 2020. The Campus project enables to combine civil engineering education with the actual construction of teaching spaces intended for own use. The construction process with different documentation will offer a lot of raw material for education of civil engineering. For this purpose the building information model BIM of the Campus is shared for studies. Also some theses have been done, for example a LEED – environment certificate label of the Campus.

In some cases with appropriate study options, over 30 percent of all studies of 240 credits can be performed in working life. Especially in the professional specialization of a repair and production planning, the training periods, internship, project work and thesis work are done in construction companies or different organizations.
These studies also construct a natural path to working life and career. After the training periods, the internship and project work are usually performed in the same workplace. In civil engineering studies, over 90 percent of the authors of a thesis will also start their first job with the same employer.

Conclusion

The civil engineering education model based on a building life span combines the demands of working life and sustainable development with education. It offers a new, more practical approach to link the needs of working life on practical level. The qualification requirements of different building party tasks are integrated into the studies in the model and they are taken into account in the correct phases of the building process. The model also fulfils the requirements of sustainable building.

In several courses, theory and practice are combined in a balanced manner. The collected course feedback indicates the students look forward to the future courses and career in working life, because they are already familiar with the reality in working life. The model is also expected to increase motivation and to shorten the study time. This may also educate better professionals for the construction industry. The engineering office and other reality-based projects and study methods help students to adopt project working skills as a part of a project team and to create customer contacts and to participate in different negotiations. All of this brings students closer to the demands of real working life.

In many cases, new teaching methods operate well independently, but the best result can be achieved when different applications and ways are used together. For instance, when performing exercises in individual study courses or in an engineering office, the student can check specific work methods and instructions in RT-cards. However, it should be remembered that any technical software or method cannot entirely replace a teacher or work by itself. The theory must be lectured by somebody or it should be made known in some way. The new technology helps teaching and offers new tools for further development.

In the future, the aim is to gather building information into a common data model. This product data model or BIM-model could be both a structural model as well as a construction process model, offering support for basic teaching and web-based studies being available anytime and anywhere.

References

Crawley, E.F., Malmqvist, J., Östlund, S., Brodeur, D.R., Edström, K., (2014). *Rethinking Engineering Education – The CDIO approach.* Springer.

Kairisto-Mertanen, et al, (2012), *Innovation pedagogy – learning through active multidisciplinary methods.* Revista de Docencia Universitaria. Vol.10 (1), Enero Abril 2012, pp. 67–86

Kettunen J. (2011), *Innovation Pedagogy for Universities of Applied Sciences*. Creative Education 2011. Vol. 2, No. 1, pp. 56–62

Kotopro (2019). Retrieved from http://www.kotopro.com

Land Use and Building Act. (1999). Statute Book of Finland 132/1999. 24 pp.

Lehtonen, Vierimaa, Hänti & Kalen (2010). Inventions as Support for Learning. Article in publication "Towards Innovation Pedagogy – *A New Approach to Teaching and Learning for Universities of Applied Sciences. Research Report 100* (2010) pp. 44–48.

Nilsson, Edelbro and Edström (2016). *Adapting CDIO to Civil Engineering: Investigate - Plan - Design - Construct - Operate and Maintain.* 9. 2016 12th International CDIO Conference, Turku, Finland

Kanerva-Lehto H, Lehtonen J, Jolkkonen A & Riihiranta J. (2010). Research Hatchery – A Concept for Combining Learning, Development and Research. *Towards Innovation Pedagogy – A new Approach to teaching and learning for universities of applied sciences*. 163 p.

Rakennustietosäätiö (1989). Talonrakennushankkeen kulku, RT 10-10387, 1989, 24 s.

Shada & Fleming (2012). Construction Project Management Handbook. FTA Report No. 0015 Federal Transit Administration. 143 p.

The Land Use and Building Act. Section 119/120 d 41/2014. 2014

Ministry of Environment, Government Decree on the determination of difficulty classes of building design tasks. 2015. 7 pp.

Ministry of the Environment, Ministry of the Environment guidelines on the difficulty classes of design tasks, YM1/601/2015. 24 pp.

Rakennustieto (2019). Retrieved from http://www.rakennustieto.fi

DEVELOPMENTAL TRANSFER OF JAPANESE LANGUAGE TO ENGLISH SKILL FOR JAPANESE ADULT LEARNERS OF ENGLISH

M. Ikematsu[*,a] and T. Izumi [a]

[a] Toyohashi University of Technology/Institute of Liberal Arts and Sciences, Toyohashi, Japan

*E-Mail mineo.ikematsu@las.tut.ac.jp

Abstract

There has been some research on Japanese college students inferring that L2 (English) learning outcomes could be predicted by L1 (Japanese) proficiency at the beginning of L2 learning in college. The linguistic threshold hypothesis suggested by Cummins and others indicates that the reading ability of L1 transfers to that of L2 when L2 skill surpasses a certain threshold. However, what it deals with is the static or at-a-point correlation between L1 and L2 reading ability found in L2 learners, not the developmental or dynamic aspects of the relation between L1 and L2, and how such a dynamic correlation between L1 and L2 occurs has not been made clear.

In order to address the issue, we chose two Japanese training classes at Toyohashi University of Technology, *Essay* and *Film*, offering the Japanese (L1) training with different achievement goals, to improve students' *logicality* for the *Essay* class and *emotionality* for the *Film* class, and measured their L1 and L2 proficiency before and after the L1 training by a Japanese verbal aptitude test and the TOEIC, respectively.

By comparing the results obtained from both classes, we found that the average scores of L1 and L2 of the *Essay* class improved with statistical significance ($p < .05$) whereas no significant improvement was seen for the *Film* class, and the correlation between the reading skills of L1 and L2 of the *Essay* participants with scores in the TOEIC above 400 points became much stronger (R^2: 0.114 to 0.961, p: 0.578 to 0.003) after L1 training.

The results indicate the existence of the L2 threshold for L1 to L2 transfer for adult L2 learners and that L1 training that focused on improving leaners' logicality could enhance their L1 reading ability that eventually transferred to L2 reading ability, and thereby be one of the alternatives to a regular L2 teaching for L2 learners whose L2 proficiency is beyond the L2 threshold.

Keywords: *Linguistic threshold, Developmental transfer, L1 training, Reading skill, Logicality*

Introduction

Watanabe (2011) and Yamamoto (2016) have reported that, for Japanese college students, L2 (English) learning outcomes seem to be predicted by L1 (Japanese) proficiency at the beginning of L2 learning in college. Neuroimaging technologies have recently become tools for addressing such an issue. Individual differences in resting-state connectivity have been associated with language learning abilities when acquiring L2 sounds (Ventura-Campos et al., 2013) and L2 words (Veroude et al., 2010). Regarding to L2 reading abilities, Chai et al. (2016) found that pretraining functional connectivity within two different language subnetworks (L1: English; L2: French) correlated strongly with learning outcomes in two different language skills: lexical retrieval in spontaneous speech and reading speed, in which subjects were homogeneous in L1 proficiency based on a subjective questionnaire. The work indicates that the human capacity to learn a second language can be predicted by an individual's intrinsic functional connectivity within the language network in the brain.

According to Chai and co-workers (2016) above, there was no apparent difference in the L1 of the participants even with differences in brain network connectivity. One possible answer to the question of why this happens is that the L1 proficiency was not properly assessed because only a questionnaire was used for the purpose in the experiment. It might be possible to differentiate participants with regard to L1 proficiency if a more accurate or suitable assessment were used.

From linguistics point of view, the linguistic threshold hypothesis proposed by Cummins (1979, 1991) and others (Bossers, 1991; Yamashita, 2002) indicates that L1 reading ability transfers to L2 reading ability when a certain L2 threshold is attained. The linguistic threshold hypothesis seems to be working on us, however what it deals with is the static or at-a-point correlation between L1 and L2 reading ability found in L2 learners, not the developmental or dynamic aspects of the relation between L1 and L2. However, how such a dynamic correlation between L1 and L2 occurs has not been made clear.

In order to address those issues, we used a Japanese verbal aptitude test to assess the participants' L1 (Japanese) proficiency and reported that, even in adults, L1 proficiency improves after L1 training, and L2 (English) learning outcomes improve accordingly (Ikematsu et al., 2016, 2017, 2018). However, this work started after L1 training had begun due to budget restrictions and different groups for "before" and "after" taking L1 training had to be used, and hence the results needed to be further verified. Here we choose two classes from our course subjects as did in the previous study, *Essay* and *Film*, receiving L1 training with different achievement goals, to improve students' *logicality* for the *Essay* class and *emotionality* for the *Film* class and report that L1 and L2 of the *Essay* class improved with statistical significance, and the correlation between reading skills of L1 and L2 of the participants in the *Essay* class with TOEIC scores above 400 points became much stronger (R^2: 0.114 to 0.961, p: 0.578 to 0.003) after L1 training.

The results indicate the existence of the L2 threshold for L1 to L2 transfer for adult L2 learners and that L1 training that focused on improving leaners' logicality could enhance their L1 reading ability that eventually transferred to L2 reading ability, and thereby be one of the alternatives to a regular L2 teaching for L2 learners whose L2 proficiency is higher than the L2 threshold.

Methods

Participants: Two classes: *Essay* and *Film* were chosen from several Japanese training classes for third-year students at Toyohashi University of Technology (TUT) called Japanese Expression Skills Course, in which their achievement goals differ depending on classes. *Essay* and *Film* have objectives to improve students' *logicality* and *emotionality*, respectively, and were held in the spring semester. *Essay* and *Film* consisted of 12 and six students, respectively. Figure 1 shows the classification of learners by the language training they received. The first digit indicates whether or not learners received English language training (ET) while the second digit indicates Japanese expression skills training (JT) (1 = training; 0 = no training). Figure 2 shows a hypothetical learning process for learners classified in Figure 1. Both *Essay* and *Film* took compulsory English classes in the spring semester and, therefore, they were in the process of transitioning from classification 00 to 11.

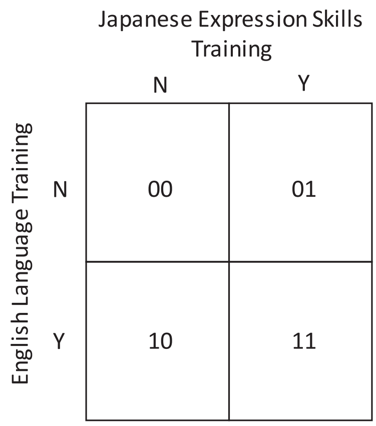


Figure 1. Learner classification by trainings received.

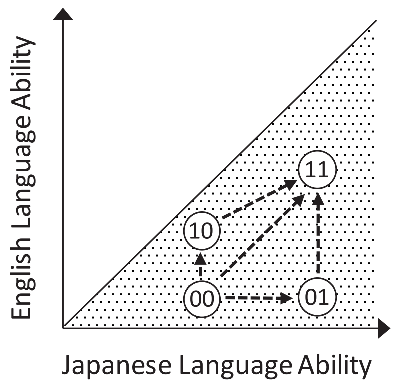


Figure 2. Hypothesis: English language (L2) skill develops in accordance with the improvement of Japanese language (L1) proficiency.

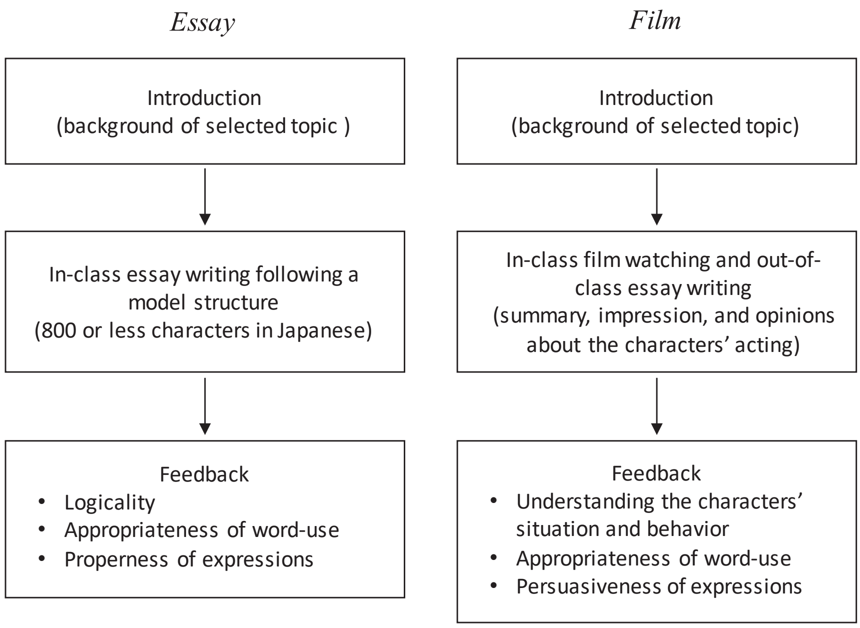


Figure 3. Activity flow of an essay writing-based ("*Essay*") and a film watching-based ("*Film*") Japanese expression skills training course at TUT.

Japanese expression skills training course: The objective of the JT the participants of *Essay* and *Film* took in the spring semester was again to develop learners' *logicality* and *emotionality*. Figure 3 shows the class activity consisting of three sub-activities for both classes. For *Essay*, students were first given instruction for 45 minutes on a topic with its background presented at the start. Then the students were given another 45 minutes to write an essay following a model structure on the topic of more than 800 characters in Japanese. Finally, the essay was checked and assessed by the instructor based on logicality, appropriateness of word usage and proper usage of expressions. The students completed this activity 15 times during the course of one semester. For the *Film*, students were first given instruction for 45 minutes on a selected film with its background at the beginning. Then the students were given another 45 minutes to watch the film and told to write an essay at home on the film including a summary, impression, and opinions about the characters' acting. Finally, the essay was checked and assessed by the instructor based on understanding the characters' situation and behavior, appropriateness of word usage and persuasive usage of expressions. The students completed this activity 15 times during the course of one semester.
Assessment of language proficiency: Japanese verbal aptitude and English proficiency of the participants were assessed by the Kokugo-ryoku Kentei (Kokugo-ryoku; Z-kai Incorporated) and TOEIC (The Institute for International Business Communication), respectively.
Data analyses: Average test scores from Kokugo-ryoku Kentei and TOEIC before and after JT were used to judge, with a paired *t*-test, whether or not observed increases in the average scores were a result of the training conducted. Individual scores of the reading section from both tests were used for a simple linear regression analysis. R was used for the analyses.

Results and Discussion

Table 1 shows how the average scores of language skills improved after JT was conducted in the spring semester. TOEIC was further conducted at the beginning of the next spring semester. As seen in the table, both Japanese and English proficiency improved after JT irrespective of their class objectives. English proficiency continued to improve even in the fall semester, namely EPT2 to EPT3. Language aptitude has long been assumed to be stable or fixed over long periods of an individual's life span (Carroll, 1981). However, Dweck (2006) has considered the malleability of human abilities and, in connection to L2 learning, Grigorenko, Sternberg, and Ehrman (2000) viewed that language aptitude is partly based on expertise in certain kinds of information processing that, like any other kind of expertise, can be developed. The results shown above might be caused by the malleability of language aptitude.

Among the improvements, JPT1 to JPT2 and EPT1 to EPT2 for the *Essay* were statistically significant ($p < 0.05$). The *Essay* results were divided into two sub-groups, the *Essay* < 400 and the *Essay* > 400 depending on EPT1 below and above 400 points, respectively,

Table 1
Language skill variation in the spring and fall semester

Group	Average Difference		
	JPT1 - JPT2	EPT1 - EPT2	EPT2 - EPT3
Film	6.3	9.2	5.8
Essay	**12.6 ***	**25.0 ***	17.7
EPT1 < 400	**23.8 ***	4.0	22.0
EPT1 > 400	6.0	**40.0 ***	**57.0 ***

Note. *"Film" and "Essay"* received Japanese expression skills training in the spring semester. Both classes received almost no English training in the fall semester. JPT and EPT represent a total score of TOEIC and Japanese Proficiency Test, respectively. The numeral 1, 2 and 3 put after JPT or EPT represent before, after taking the course and the end of the fall semester, respectively.
* $p < 0.05$.

because of the reason discussed below by using Figure 4. Figure 4 shows the relation between JPT1 and EPT1 for the *Essay* class. As in Figure 4 (a), the trend shows somehow weak to moderate relation between both languages at the onset of JT (R^2=0.3728). However, when taking a closer look, we could recognize that the trend is formed by two different subgroups, namely one with EPT1 below 400 points and the other above 400 points as extracted and separately shown in Figure 4 (b) and (c) giving R^2 of 0.4019 (moderate) and 0.6028 (strong), respectively. Returning to Table 1, we can see that the improvement of JPT1 to JPT2 for the *Essay* was from < 400 subgroup and EPT1 to EPT2 from > 400 subgroup. From the results above, we can perceive that *Essay* class is effective in improving Japanese as well as English proficiency unlike *Film* class that is not necessarily working in improving either of the two language skills. The cause of the improvement by the *Essay* class is probably in the objective of JT given in the spring semester. The aim of the course was to develop learners' *logicality* by using a logically-structured model essay. According to Harley and Hart (1977) who investigated the role that language aptitude and its various components play, the stronger correlation was found with language analysis component with older learners, whereas with younger children, it was the memory component that gave the most persuasive account. They found further evidence that analytical language ability is more closely associated with second language outcomes when intensive exposure to the language is first experienced in adolescence (Harley and Hart, 2002). In addition, English is known to be more of a logical language unlike Japanese, and the *logicality* that improved through the essay writing even in Japanese could help understand what is written in English, and thus transfers to English skill. On the other hand, the *Film* class received the course with an objective to develop learners' *emotionality* or *sympathism* which is considered difficult to be applicable to understanding reading script in English unless the learners have words expressing emotions in English, which are often on a list of difficult words, and hence, scarce transfer from Japanese to English occurred (Table 1). The improvement in

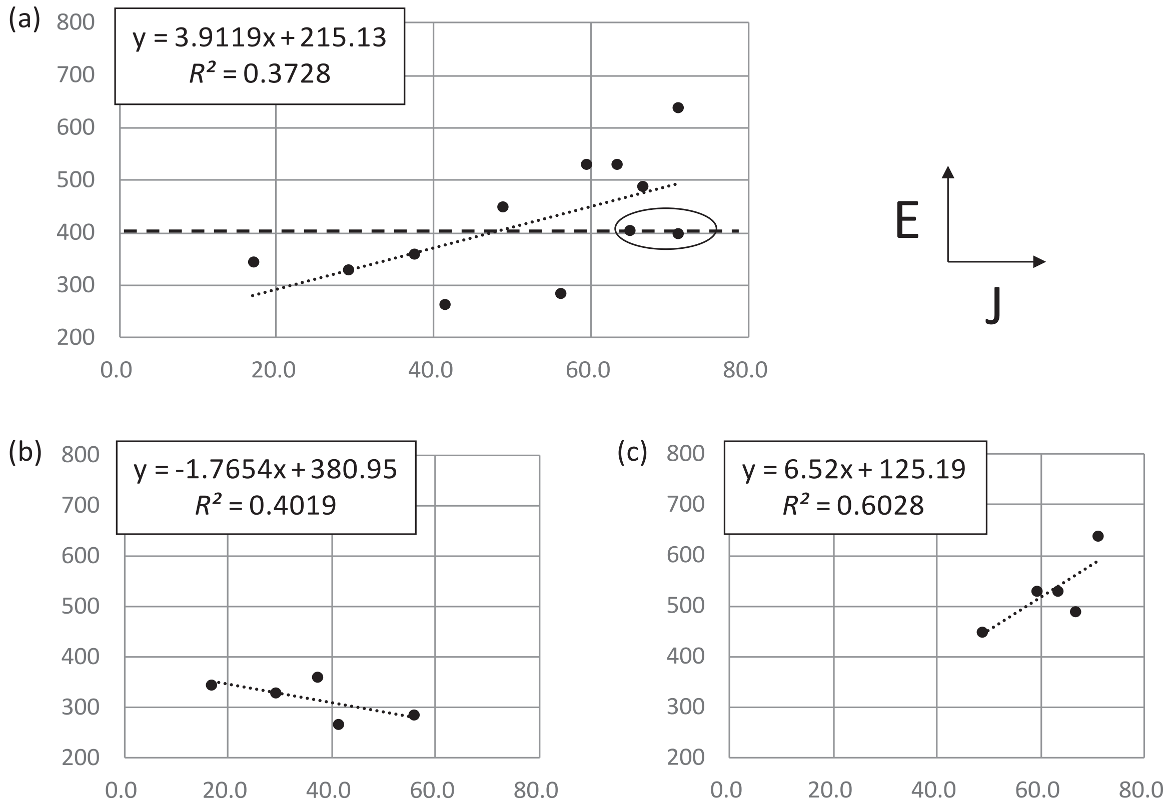


Figure 4. The relation between the total scores of Japanese and English proficiency test for the participants before taking an essay writing-based ("*Essay*") Japanese expression skills training course. (a) For all *Essay* participants. Two data circled were omitted for further analysis because of the lack of data in the year end. (b) For participants with below and (c) above 400 points on TOEIC, the level of which is shown with a broken line in (a).

Japanese skill for the *Essay* < 400 subgroup is probably due to their low proficiency in Japanese skill before taking the course. The Japanese to English transfer seems to happen only when Japanese skill is high enough as seen in the *Essay* > 400 subgroup although the reason for the transfer is not necessarily clear and further discussion is needed by way of accumulating the educational results from the classes onward. However, it seems likely that a certain level of proficiency in Japanese should be attained if the Japanese people learning English need to express something in mind in English. If this is truly the case, what the Japanese people learning English or other languages generally need is to improve their proficiency of English or the learning languages to a certain level and enhance it through many kinds of inputs including their L1, namely Japanese language.

As mentioned above, no improvement with statistical significance in Japanese skill was seen in the *Essay* > 400 subgroup, however Japanese reading skill, Y, and English reading skill, R, of the group are found only correlated and strengthened as JT progresses judging from a simple regression analysis as shown in Table 2. Their Japanese reading score before taking the *Essay* course, Y1, had a weak correlation (R^2: 0.114, p: 0.578) with their English reading score, R1. The correlation is found a little stronger (R^2: 0.474, p: 0.199) when R1 is correlated with Y2, their Japanese reading score after taking the *Essay* course, indicating that R1 could predict Y2 and vice versa. At the end of the JT, the correlation between R2 and Y2 became very strong (R^2: 0.961) with a p-value of 0.003 showing statistical significance at the 1% level. More than interesting for the result is that we see such a drastic change in the correlation between reading skills of both languages even though there was no statistically significant improvement in either of their reading averaged scores (not shown). Why the correlation is seen only in mutual reading skills probably, as mentioned earlier, comes from the class objective to improve students' *logicality* through model structure-given essay writings with a related feedback because we obtained similar results previously (Ikematsu et al., 2017, 2018). The improvement in average scores in the reading skills of both languages was not significant probably because the number of participants was rather small (n=12) as compared with that of previous work (n=20). Even in such a condition, there was found a clear correlation between both reading skills and consequently, considered inherent. From the trend in the variation in R^2 and p-value, we could tentatively understand the linguistic transfer process, in which L1 and L2 are dynamic enough to affect with each other during the learning process until they reach to a point where L1 and L2 become substantially equivalent. We see the phenomenon only in the reading skill for the *Essay* class. This indicates, from a view point of language teaching, that we should take account of the typical or substantial

Table 2
Simple linear regression analysis between English and Japanese reading ability of the *Essay* participants *with TOEIC scores above 400 points*

Variables	*slope*	R^2	*F*	*p*
R1-Y1	0.987	0.114	0.39	0.578
R1-Y2	2.623	0.474	2.69	0.199
R2-Y2	2.765	**0.961 ***	72.9	**0.003**

Note. R stands for "Reading" of English and Y for "Yomi" meaning reading in Japanese. R1 and Y1 represent participant's reading score of TOEIC and Japanese Proficiency Test before taking the *Essay* class, respectively and R2 and Y2 after the class. * $p < 0.01$.

difference between L1 and L2 or Ln and teach the target languages by focusing on such a difference, *logicality* in the case of Japanese and English although L1-related factors other than a particular difference between L1 and L2 is no doubt considered affecting the transfer process because L1 must be a basis of thought of individuals.

We found that the linguistic threshold for Japanese transfer to English is around 400 points in the total score of TOEIC as mentioned earlier. As in Table 3, the tentative threshold is seen in the very middle of the range between A2 and B1 in European CEFR levels. Learners at the B1 level are recognized "independent" and having a "threshold" distinctively separating from the A2 level, meaning learners at the B1 level could learn target languages by themselves independent of teachers. Those at such a level are considered to use various resources to consciously or unconsciously improve their proficiency in the learning language themselves. Japanese language skill could be one of such resources. Four hundred points in TOEIC is below the minimum score in TOEIC for the B1 level. However, the transition from A2 to B1 is no doubt progressing somewhere between those two minimum scores, namely 225 to 550 points, and 400 points could be seen as the "entrance" to or beginning of the B1 level.

Accumulating similar results is needed to make the transfer process of L1 to L2 clear during the course of language training. However, the results obtained in the present study on the dynamic characteristics of the transfer process of L1 should lead to improved teaching methods of English to Japanese learners of English with regard to improving English proficiency through Japanese training. Japan has no concept of official language as Japanese is the only language used in daily life and without exception every Japanese becomes able to use it, and hence no need to learn other languages. In such circumstances, it is not surprising that most Japanese are not motivated enough to learn foreign languages. Various methods in language learning have long been applied to educational settings to overcome such a drawback, however unfortunately the situation remains unchanged, and hence some other schemes should be needed. Japanese or L1 training is considered one of them as L1 is the basis of thought for Japanese people. The present study confirmed that L1 training aiming at improving logicality in particular could work

Table 3
TOEIC Total (Listening and Reading) scores and European CEFR levels.

Total minimum scores (10 to 990 pts)	CEFR levels	
945	Proficient – Effective Operational Proficiency	C1
785	Independent - Vantage	B2
550	Independent - Threshold	B1
225	Basic - Waystage	A2
120	Basic - Breakthrough	A1

Note. Correlation Table from "TOEIC Listening and Reading Scores Descriptors and European CEFR levels"

in this context. There could be other factors affecting improving language skills and they might vary depending on the environment and thus people who need to tackle similar issues where no motivation is anticipated toward foreign language learning should analyze what is lacking in relation to the target languages and try to change the resultant factors to improve the proficiency in the learning languages.

Conclusions

In the development of L2 proficiency, L1 transfer should completely be understood because L1 and L2 are known to be correlated with each other. In order to gain insight into the details of the transfer process, the dynamic correlation between Japanese (L1) and English (L2) during the course of L1 training for college students was examined. Here we chose two groups receiving L1 training with different achievement goals, the *Essay* subgroup to improve students' *logicality* and the *Film* subgroup to improve *emotionality* and examined their performance in L1 and L2 before and after taking the L1 training. As a result, we found that both groups showed improvement in L1 and L2, and the improvement of the *Essay* group was statistically significant. We further found that *Essay* group participants with TOEIC scores below 400 points (*Essay < 400*) improved L1 and those above 400 points (*Essay > 400*) improved L2. A simple regression analysis for the *Essay > 400* showed that the correlation between reading skill of L1 and L2 became stronger after the L1 training (R^2: 0.114 to 0.961 and p: 0.578 to 0.003).

The results first showed an L2 threshold at 400 points in the average total score of TOEIC, below which only L1 improved after L1 training, and above which only L2 improved, inferring L1 transfer to L2. The results further showed a mutual compensation between L1 and L2 during the course of L1 and L2 training. We suggest *logicality* may be the key to the L1 to L2 transfer and to the mutual compensation between L1 and L2. Our research addresses an important process that will hopefully lead to an ideal teaching method of L1 (Japanese) to Japanese learners of L2 (English) or other languages. For foreign language teaching under the circumstances where limited learning motivation is anticipated, we should analyze and work on what is lacking in relation to the target or learning languages like *logicality* in the case of Japanese.

References

Bossers, B. (1991). On thresholds, ceilings and short-circuits: the relation between L1 reading, L2 reading and L2 knowledge. In J.H. Hulstijin and J.F. Matter (Eds.), *Reading in two languages: AILA review., Vol. 8*, 45-60.

Carroll, J. B. (1981). Twenty-five years of research in foreign language aptitude. In K. C. Diller (Ed.). *Individual differences and universals in language learning aptitude*. Rowley, MA: Newbury House.

Chai, X. J., Berken, J. A., Barbeau, E.B., Soles, J., Callahan, M., Chen, J.K. & Klein, D. (2016). Intrinsic functional connectivity in the adult brain and success in second-language learning. *Journal of Neuroscience*, 36 (3), 755-761.

Correlation Table, *TOEIC Listening and Reading Scores Descriptors and European CEFR levels*. Educational Testing Service.

Cummins, J. (1979). Linguistic interdependence and the educational development of bilingual children. *Review of Educational Research*, 49 (2), 221-251.

Cummins, J. (1991). Conversational and academic language proficiency in bilingual contexts. In J.H. Hulstijin and J.F. Matter (Eds.), *Reading in two languages: AILA review., Vol. 8*, 75-89.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York: Random House.

Eiken Institution Based Assessment, Eiken Foundation of Japan (https://www.eiken.or.jp/eiken-iba/).

Grigorenko, E. I., Sternberg, R. J., & Ehrman, M. E. (2000). A theory based approach to the measurement of foreign language learning ability: The Canal-F theory and test. *The Modern Language Journal*, 84 (3), 390-405.

Harley, B. & Hart, D. (1997). Language aptitude and second language proficiency in classroom learners of different starting ages. *Studies in Second Language Acquisition*, 19 (3), 379-400.

Harley, B. & Hart, D. (2002). Age, aptitude and second language learning on a bilingual exchange. In P. Robinson (Ed.), *Individual differences and instructed language learning* (pp. 302-330). Amsterdam: John Benjamins.

Ikematsu, M., Izumi, T. & Nakamori, Y. (2016). Is Japanese verbal aptitude related with performance of English learning or Japanese? *Proceedings of the 10th International Symposium on Advances in Technology Education (ISATE) 2016*, 391-394.

Ikematsu, M., Izumi, T. & Nakamori, Y. (2017). Is Japanese verbal aptitude related with performance of English learning or Japanese? *Bulletin of the Institute of Liberal Arts and Sciences, Toyohashi University of Technology, 39*, 13-22.

Ikematsu, M., Izumi, T., Nakamori, Y., Kato, M., Mouri, M., Levin, D., Ryan, E. & Shakouchi, Y. (2018). Is Japanese verbal aptitude related with performance of English learning or Japanese? (Part 2) *Bulletin of the Institute of Liberal Arts and Sciences, Toyohashi University of Technology, 40*, 1-10.

Kokugo-ryoku Kentei, Z-kai (https://www.zkai.co.jp/kentei/).

Veroude, K., Norris, D.G., Shumskaya, E., Gullberg, M. & Indefrey, P. (2010). Functional connectivity between brain regions involved in learning words of a new language. *Brain and Language*, 113, 21-27.

Ventura-Campos, N., Sanjuan, A., Gonzalez, J., Palomar-Garcia, M.A., Rodriguez-Pujadas, A., Sebastian-Galles, N., Deco, G. & Avila, C. (2013). Spontaneous brain activity predicts learning ability of foreign sounds. *Journal of Neuroscience*, 33, 9295-9305.

Watanabe, S. (2011). The potentiality for use of the Japanese placement test. *Journal of the Japan Association for Developmental Education,* 6 (1), 16-20.

Yamamoto, H. (2016). Preliminary research on the correlation between English and Japanese competence of Japanese university students. *International Education*, 9, 75-90.

Yamashita, J. (2002). Mutual compensation between L1 reading ability and L2 language proficiency in L2 reading comprehension. *Journal of Research in Reading,* 25 (1), 81-95.

STUDENT PERCEPTIONS AND EXPERIENCES OF CO-TEACHING IN A PROJECT-BASED SUBJECT

Benson K.H. Hung[*,a] and K.C. Ying[b]

[a] Department of Construction, Hong Kong Institute of Vocational Education (Tsing Yi), Vocational Training Council, HKSAR, China
[b] Department of Construction, Hong Kong Institute of Vocational Education (Tsing Yi), Vocational Training Council, HKSAR, China

* bensonhung@vtc.edu.hk

Abstract

A co-teaching model of instruction that goes beyond a traditional model of one teacher one class is becoming an important shift in education in today's society. With this new model, all students may be provided with the best opportunities for success in an inclusion learning environment. This paper examines higher diploma student perceptions and experiences of co-teaching between two classes in a project-based subject at the Hong Kong Institute of Vocational Education (Tsing Yi). The research study covers two different groups of students who learn either in a co-teaching classroom or in a traditional classroom. In a traditional classroom, student perceptions about co-teaching are studied while in a co-teaching classroom, student experiences on co-teaching are assessed. Data for this study was collected on each teaching model through two identical surveys and a two-tail t-test (inequality) between the groups was employed for analysis. In total, data was collected from 39 student responses. The observed difference between the sample groups is not convincing enough to say that the students' favour between a co-teaching classroom and a traditional classroom differ significantly. More importantly, students seem to endorse the co-teaching approach, but this is not how they judge the success or failure of any co-teaching effort. This study argues that the most critical factor in determining the success or failure of a co-teaching effort is the actual composition of the team. In presenting the findings, this study can help educators in school and similar situations maximize effectiveness of the co-teaching experience and can contribute to the knowledge of teaching practice by identifying different aspects of the co-teaching approach that facilitates student learning.

Keywords: *co-teaching, student perceptions, student experiences, project-based learning.*

Introduction

A co-teaching model of instruction has drawn much attention in higher education nowadays. Co-teaching is when two or more teachers share in the roles of planning, implementing, classroom management, and assessing to ensure that students have met the goals of the learning objectives. A teaching method that is frequently cited as a means to address the problem of doing more with less is what is interchangeably labelled as 'collaborative' or 'team' teaching (Mason 1992; Booth et. al. 2003).

In previous researches, a particular focus on the co-teaching in a project-based subject has rarely been examined. Rather than essay- and exam-based traditional classroom learning, a project-based learning focuses on developing critical thinking and problem solving skills in the students. Since the student engagement and needs are central to the project-based learning, a selection of a teaching method that can foster the degree of engagement students have and the level of responsiveness shown by a teacher to a student's needs is expected.

The goal of this study is to determine if students who are enrolled in a co-teaching classroom favour this model of instruction than that of students in a non-co-teaching classroom or in an individually teaching classroom. This paper begins with a review of the literature on co-teaching, particularly on what co-teaching is, and its advantages. This is followed by a section on methodology and data analysis. Finally, the co-teaching practices in this study are discussed, along with implications, and the study's limitations.

Literature Reviews

Eccleston (2010) defines collaboration where "two or more people create an outcome for a student that no one of them could have created alone". Furthermore, Eccleston (2010) shares that "collaboration between the general classroom teachers and the special education specialist teacher has become critically important and is the most common method for planning for the success of students with exceptionalities in inclusive settings". The two teachers need to have a relationship with each other and must work together cooperatively to collaborate effectively for their students. Both classroom teachers should be responsible for the education of their students.

Co-teaching is not seen as an instructional strategy; it is a "method by which educators can work collaboratively to deliver quality instruction" (Murawski and Hughes 2009). Wilson (2008) identifies twenty ways to be an active co-teacher in an inclusive classroom and she reveals ways that "the co-teacher who is not leading instruction" can know a "variety of activities to employ" in the co-taught classroom. When grazing, the teacher is "helping with classroom management and overseeing student performance" (Wilson 2008), and while observing, the co-teacher can also create an assignment based on the lesson being taught to ensure that students are retaining the information and meeting the objectives from the lesson planned.

The collaborative model in classrooms shows that the special educator and general educator share the tasks of lesson planning, assessments of students and implementation (Austin 2001). Austin (2001) further explains that both general and special education teachers need to be prepared for co-teaching and collaboration. Collaboration is one of the most important pieces to guarantee student achievement in an inclusive classroom setting for students. Nurturing environment that is conducive to achievement is essential and can be derived from various pedagogy and educational strategies. Co-teaching allows teachers to achieve this goal and it allows "teachers and other professionals to interact in structured ways that allow flexibility of instructional options and providing intensive instruction for students at the time they need it" (Murawski and Hughes 2009).

Methods

Module Setting

Two classes of students who were studying the same module named Industry Based Student Project (IBSP) of Higher Diploma in Civil Engineering at the Hong Kong Institute of Vocational Education (Tsing Yi) were selected for study. In this module, students will be assigned on IBSP and will work under the real environment in engineering field. Students will start their projects at the beginning of the semester and carry them full-time throughout the whole semester. The project work will be highly student-centered, in that students will gain knowledge through their own research and application of findings to solving problems associated with the work in a creative manner.

Participant

A class of students was served in a co-taught classroom in which pair of teachers including one Project Supervisor and one Special Educator (an engineer in this case). To support the student, the Project Supervisor and Special Educator acted as mentors and guide the student throughout the project. Each student was required to have regular meetings with his/her Project Supervisor and Special Educator to discuss about the progress and problems associated with the project work and acted as a valuable source of practical knowledge and advice.

On the other hand, a class of students was served in a non-co-taught classroom in which pair of teachers including one Project Supervisor and one Project Assessor. The Project Assessor only worked for the allocation of the project marks which fairly and accurately reflected the standard of work and students' effort. No particular supervision was required from Project Assessors and the overall contact hours including work attachment, coaching and student support activities were the same across both classes.

Study Design

This study was a qualitative research design in which the researcher surveyed students currently learning collaboratively along with their Project Supervisors. Different questions about how students learn best and what they see their teachers engaging in within the co-teaching classroom were asked.

Results and Discussion

Responses from the five-point Likert scale questions were analysed for descriptive statistical purposes. A total of 39 surveys were distributed to and returned from students. All students responding to the survey were currently certified and 4 t-Tests were done and the results were tabulated in Table 1-4.

The t-Test is used to test the null hypothesis that the means of two populations are equal. A two-tail test (inequality) was employed and if t Stat < -t Critical two-tail or t Stat > t Critical two-tail, we reject the null hypothesis. In the following four t-Tests, we do not reject the null hypothesis. The observed difference between the sample means is not convincing enough to say that the students perceptions and experiences between co-teaching and non-co-teaching students differ significantly.

Table 1) t-Test: Two-Sample Assuming Unequal Variances (Class Management)

	Co-teaching class	*Non-co-teaching class*
Mean	2.923	3.115
Variance	1.577	1.706
Observations	13	26
Hypothesized Mean Difference	0	
df	25	
t Stat	-0.445	
P(T<=t) one-tail	0.330	
t Critical one-tail	1.708	
P(T<=t) two-tail	0.660	
t Critical two-tail	2.060	

Table 2) t-Test: Two-Sample Assuming Unequal Variances (Teaching and Learning)

	Co-teaching class	*Non-co-teaching class*
Mean	3.077	3.115
Variance	1.244	1.706
Observations	13	26
Hypothesized Mean Difference	0	
df	28	
t Stat	-0.096	
P(T<=t) one-tail	0.462	
t Critical one-tail	1.701	
P(T<=t) two-tail	0.924	
t Critical two-tail	2.048	

Table 3) t-Test: Two-Sample Assuming Unequal Variances (Students' Performance)

	Co-teaching class	*Non-co-teaching class*
Mean	3.000	2.962
Variance	1.333	1.398
Observations	13	26
Hypothesized Mean Difference	0	
df	25	
t Stat	0.097	
P(T<=t) one-tail	0.462	
t Critical one-tail	1.708	
P(T<=t) two-tail	0.923	
t Critical two-tail	2.060	

Table 4) t-Test: Two-Sample Assuming Unequal Variances (Preference for Co-teaching)

	Co-teaching class	*Non-co-teaching class*
Mean	2.692	2.962
Variance	2.064	1.958
Observations	13	26
Hypothesized Mean Difference	0	
df	24	
t Stat	-0.556	
P(T<=t) one-tail	0.292	
t Critical one-tail	1.711	
P(T<=t) two-tail	0.583	
t Critical two-tail	2.064	

Further disccusion with students revealed that co-teaching can facilitate student learning through the generation of interest and exposure to 'experts', but can hinder student learning if the team fails to act as a cohesive unit and work together to adequately link learning concepts.

Like all research, the present research is not without some limitations. First, the research only examined students from the Hong Kong Institute of Vocational Education (Tsing Yi). Students on different campuses might generate different results about co-teaching and its effects on the ways students achieve social and academic integration. Second, the method that was employed to compare might skew the results as well. Selective scopes of studies might have greatly influenced the results. The directions of studies and observations of researcher could influence a lot

Conclusions

The shift from a traditional model to a co-teaching model opens opportunities and creates challenges for higher education institutions. Collaboration is essential to effective co-teaching. The goal in any co-teaching environment is to share methods and knowledge of effective instructional practices that will best suit the needs of every student in the class.

The result reveals that the observed difference between the sample groups is not convincing enough to say that the students' favour between a co-teaching classroom and a traditional classroom differ significantly. This study argues that the most critical factor in determining the success or failure of a co-teaching effort is the team composition. A key implication of this study is that a team that comprises of skilful teachers in teaching is far more important than a team comprising of experts in a particular knowledge area. This aspect of co-teaching is often overlooked in the literature. Hence, this research has a significant implication on maximizing effectiveness of the co-teaching experience and identifying different aspects of the co-teaching approach that facilitates student learning

The observed difference between the sample groups is not convincing enough to say that the students' favour between a co-teaching classroom and a traditional classroom differ significantly. More importantly, students seem to endorse the co-teaching approach, but this is not how they judge the success or failure of any co-teaching effort.

The findings of this study suggest that students recognise the advantages of team-teaching, but this is not how they judge the success or failure of any team-teaching effort. Students agreed that co-teaching does not greatly affect student behavior and students recognized that the second teacher was there to provide extra assistance, and many students seemed to appreciate this. While students are conscious of the need for collaboration within the team, the critical success factor appears to be the composition of a team.

. Like all research, the present research is not without some limitations. Despite these limitations, previous research has not explored the impact of co-teaching has on college students for academic purposes. Therefore, this study provided rich information about how co-teaching might be used associated with academic and social integration.

This study was conducted to investigate the effectiveness of a co-teaching pedagogy and student perceptions and experience were examined. Overall perceptions and the experience were positive. However, the co-teaching strategy can be more effective in the future under proper circumstances. The lack of common planning that hindered effective communication would ultimately benefit the students if teachers can receive certain level of training before the course had begun. It seems very importatnt that preparedness for beginning the co-teaching experience should be enhanced to promote the effectiveness of co-teaching in a project-based subject.

References

Austin, V.L. (2001). Teachers' beliefs about co-teaching. Remedial and Special Education. 22(4).245-255.

Booth, R, Dixon-Brown, M, & Kohut, G 2003, 'Shared teaching models for business communication in a research environment', Business Communication Quarterly, 66(3), 23-38.

Eccleston, S. T. (2010). Successful collaboration: Four essential traits of effective special education specialists. The Journal of the International Association of Special Education, 11(1), 40-47.

Mason, J 1992, 'Business schools: Striving to meet customer demand', Management Review, 81(9), 10-14.

Murawski, W. W., & Hughes, C. E. (2009). Response to intervention, collaboration, and co-teaching: A logical combination for successful systemic change. Preventing School Failure: Alternative Education for Children and Youth, 53(4), 267-277.

Wilson, G.L. (2008). Be an active co-teacher. Intervention in School and Clinic.43(4).24-243.

Engineering Education as Citizenship Education by P4C

T. Ogawa [a], T. Murase [b] and K. Nishiyama [c]

[a] Department of General Education, National Institute of Technology, Ube College, Japan
[b] Department of General Education, National Institute of Technology, Tokyo College, Japan
[c] Senior Research Officer, Crawford School of Public Policy, The Australian National University, Australia

*ogawa-t@ube-k.ac.jp

Abstract

Engineering and technology aim to lead a better life for people. But the meaning of "better" is highly contested in modern democratic societies where different citizens have different cultures and values. Engineers, as one of the citizens in such societies, are also living in multicultural and multi-value settings, and therefore they need to be responsible for such diversity when they engage in technological developments.

Therefore, in engineering education, it is necessary to aim at not only acquiring the specialized technological knowledge but also cultivating citizenship. By citizenship, it refers to a set of abilities to communicate and care for people with respect by taking into account different opinions and expertise of others.

Nevertheless, this has not been emphasized much in engineering education in Japan. For example, even in the class of engineering ethics, emphasis is placed more on the acquisition of textbook-based knowledge and virtue of problem cases, and less on abilities to discuss freely and gently.

Then, in general education of NIT we have conducted a dialogue-based educational program where learners/students ask questions, listen together and discuss with others. This program is designed based upon so-called Philosophy for/with Children (P4C). Matthew Lipman, one of the founders of P4C, defined the primary aim of P4C as multidimensional-thinking: critical thinking, creative thinking, and caring thinking. In addition, this multidimensional-thinking may, according to many P4C scholars, have a potential of creating active citizenry.

The discussion by P4C have three characteristics as follows:

1) People make a circle in the classroom and create a space where students can feel an emotional and intellectual "safety".

2)Questions being discussed is proposed by students themselves based on their interests, not by teachers

3) Rather than rushing to reach a conclusion, students are asked to concentrate on listening to the differences between each other.

This paper begins by explaining what P4C is and why/how P4C is suitable for citizenship education, and then the following sections show our P4C classes in NIT (Tokyo and Ube) and learner's responses. Finally, we claim that the "community of inquiry" created through P4C can prevent the "self-righteousness" of engineers.

Keywords: *Philosophy for/ with children(=P4C), Community of inquiry, Engineering Ethics, Citizenship, Discussion-based education*

Introduction

Today, quite a few people can live without science and technology. Engineering and technology have always aimed at enabling a better life for people. However, in 21st modern democratic societies conditioned by diversity of cultures and values, people are also living in multicultural settings as citizens. Therefore, there is no single conception of "good" that engineering and technology ought to pursue, and thus this fact lets engineers consider multicultural values more seriously. In other words, in a society where people have various cultures and values, engineers *as one of the citizens* should not presuppose their given value of technologies as "good," but keep on examining their own technological knowledge and abilities from the standpoint of democratic citizenship. Then, in engineering education, it is necessary to aim not only at acquiring the specialized technological knowledge but also at cultivating their sense of *democratic citizenship*, which includes the ability to communicate and care with respect for people with different opinions and expertise.

Nevertheless, this has not been emphasized much in engineering education in Japan because conventional engineering education has been conducted under the *professional* education curriculum of engineers. For example, even in the textbook on engineering ethics, emphasis is placed on the acquisition of knowledge and virtue of the real-world cases, namely professional ethics. (Cf. Kuroda, Todayama& Iseda, 2012; Saito& Sakashita, 2014). What is missed in such context is the premise that engineers were also citizens living in diverse cultures and values and being responsible for making multicultural society democratic.

In addition, the problem of "*self-righteousness*" of the engineer strongly requires the engineer ethics as citizenship education. For example, it is a "self-righteousness" that *only experts with technical knowledge can participate in a democratic decision-making process on the controversial ethical problems (*such as Minamata disease, Fukushima Daiichi nuclear disaster*)* In conventional engineering ethics education, teachers have tried to warn them by showing various ethical cases happened in the real world. However, as Hiyane (2011) rightly indicates, in order to prevent a serious accident due to the lack of ethical arguments, it is not enough to simply know various cases, but "students are *aware of the values that change according to their position* and realize that their sense of ethics is *relative*. By doing so, we can prevent the self-righteousness of engineers that is common in many ethical cases" (p. 11. - emphasis added). In this way, *a deep awareness of the unobviousness of rightness of one's own ethical judgment* is important in engineering ethics education.

Thus, it is clear that what is needed for current engineering education is not education for knowledge acquisition. Rather, *we insist, what is needed is a discussion-based citizenship education*, in which students in the lower grades can share various values, exchange opinions with each other, and think deeply, thereby realizing that *engineers* are *also* citizens. Of course, it is true that sometimes engineers are expected to serve as a professional figure who makes ethical decisions more frequently than lay citizens. However, there is no contradiction between being a professional engineer and being a citizen. In fact, it can even be said that today, *professionals must be the most civil and democratic persons*. (Cf. Dzur, 2008)

Based on the background, in order to establish engineer education as citizenship education, we have conducted a discussion/inquiry-based program in general education of NIT(KOSEN) by introducing the practice of *Philosophy for/with children*(*=P4C*).

This paper begins by explaining what P4C is and why/how P4C is suitable for citizenship education, and then the following sections show our P4C classes in NIT (Tokyo and Ube) and learner's responses. Finally, we claim that the "community of inquiry" created through P4C can prevent the "self-righteousness" of engineers.

What is P4C?

Philosophy for/with Children is one of the inquiry-based education programs, originally started in the USA in the 1970s and now becomes popular across the world. Recently, many Japanese schools have also introduced the P4C style discussion program. Especially, as for NIT, several colleges have worked on the P4C program, such as Tokyo college, Ube college, Fukui college and Akashi College.

Matthew Lipman (2003), one of the pioneers of P4C, argues that the primary aim of P4C is a cultivation of students' multidimensional-thinking: critical thinking, creative thinking, and caring thinking. Since, from his perspective, thinking had often been omitted from modern school education, creating a "community of philosophical inquiry" is a better way to improve thinking education. In other words, philosophy "*properly reconstructed and properly taught*" (Lipman, 2003, p. 3. - emphasis original.] can bring children's surprise and wonder about the world to the forefront of discussion. To this end, Lipman wrote some philosophical reading books for kids at the various developmental stages to think deeply.

Although most practitioners today are not likely to use Lipman's texts, many of them follow's Lipman's idea of "the community of inquiry" as a primary ideal of P4C. By the community of inquiry, Lipman (2003) defines:

"W[w]e can now speak of "*converting the classroom into a community of inquiry*" in which students listen to one another with respect, build on one another's ideas, challenge one another to supply reasons for otherwise unsupported opinions, assist each other in drawing inferences from what has been said, and seek to identify one another's assumptions. (p. 20. - emphasis added.)"

P4C aims to converting the conventional "classroom" in which teachers teach students various knowledge into "community of inquiry" through philosophical dialogue. In P4C style dialogue, all participants (*both* teacher and students) collaboratively talk and think about open-ended philosophical questions. Since even teachers do not know the answer of the questions being inquired in dialogue, they need to change their role, from a traditional model of knowledge-provider to a co-inquire and facilitator.

Moreover, in order to create the community of inquiry, teachers should be responsible for creating the situation where all participants feel like "I can say anything." Jackson (2013), the founder of Hawaiian style P4C (= p4c Hawaii), named it "*intellectual safety*" where "*all participants in the community are free to ask virtually any question or state any view so long as respect for all is honored*" (p. 102. - emphasis original). It should be made clear that such intellectual safety is different from a creation of good friendship in the classroom. A genuine intellectual safety is anchored by a relationship where students can feel that they can tell what they truly want to say and that their voice is sincerely considered by others. Once intellectual safety is created, all participants come to feel "intellectual courage (to one's own authentic thoughts)" anchored by deeper mutual respect (ibid.)

Given these characteristics of P4C education (especially p4c Hawaii), it seems that, in the community of philosophical inquiry, students can learn some virtues of citizens, like mutual-respect for different opinions or beliefs.

P4C for citizenship education

Citizenship has traditionally been understood as a legal status. It is widely known that Marshall has distinguished them from civil, political and social rights. "Here, the citizen is the legal person free to act according to the law and having the right to claim the law's protection. It need not mean that the citizen takes part in the law's formulation, nor does it require that rights be uniform between citizens" (Leydet, 2017, 1.1 Definitions).

In recent years, "active" citizenship learning has been proposed that calls for students' active involvement in the context of citizenship education. "The Crick Report" (Crick, 1988) emphasizes the concept of active citizenship, defining it as follows:

"... [active citizens are] willing, able and equipped to have an influence in public life and with the critical capacities to weigh evidence before speaking and acting... (1.5)".

So citizenship education needs:

"...social and moral responsibility, community involvement and political literacy. 'Responsibility' is an essential political as well as moral virtue, for it implies (a) care for others; (b) premeditation and calculation about what effect actions are likely to have on others; and (c) understanding and care for the consequences. (2.12)"

Therefore, *citizenship education is "not only based on knowledge about democratic institutions and systems, but also developing values, skills and understanding.*" (3.1. - emphasis added)

Likewise, in the case of engineering education, citizenship education for engineers is not just about learning knowledge. Rather, it is important to develop various attitudes as active citizens.

Recently, many researchers and practitioners have emphasized that P4C has an aspect of citizenship education. Lipman (1988) also argues:

"One of the most valuable contributions philosophy has to make to the conversation of mankind with regard to civic education is the model philosophers offer of a community of inquiry in which *the participants are profoundly aware of how much they can learn from other participants with whom they strongly disagree.*" (p. 72. - emphasis added)

In this way, by deepening understanding of people with different ideas and values in the community of inquiry, students can learn the required attitudes as a citizen. And the ability to communicate and collaborate with people who have different opinions and value is an important ability for modern democratic citizens.

Kono (2014), japanese P4C practitioner, emphasizes the concept of "attitude to participations". To cultivate such attitude of students, he indicates that "to speak to people and to society in one's own voice, and to be accepted by people and society. It may seem paradoxical, but the first thing you should do to develop the public nature of social participation is to learn to express yourself and to learn how to listen to others". (p. 55)

Such citizenship dimension of P4C is practiced in the real world. In Hawaii, some practitioners (e.g. Makaiau, 2017) conceptualize P4C as "deliberative pedagogy" where students create a public sphere in the classroom to learn democratic citizenship through reason-exchange, rational argumentation, and active listening. These skills are particularly important for creating democratic human relations in deeply divided community (such as Hawaii) where people are not willing to listen with each other.

Citizenship has many meanings. However, we think that *abilities to live with others who have diverse perspectives and to discuss with them are the primary goal of citizenship education in the context of contemporary democracy.* It is precisely these abilities that students should learn, and, as we shall see below, the community of inquiry can be efficient methods for this purpose.

The general process of P4C in Japan

The discussion by P4C in Japan (we often call it "*Tetsugaku Taiwa*" in Japanese) usually have five steps:

1) Participants make a circle in the classroom and *create a space that can feel "safety."*
2) Question for inquiry is proposed *by students, not by teachers*, based on their own interests.
3) During inquiry, all participants should keep the rules and mindsets (see Table 1).
4) *Rather than rushing to reach a conclusion*, students are asked to concentrate on listening to what others say.
5) At the end of dialogue, we usually do simple reflection with a show of hands or fill in a portfolio.

Table 1: An example of discussion rule and mindsets in P4C

(1) You can say anything. (2) You should not take a denial attitude toward what people say. (3) You do not need to speak in the community. (4) We ask questions each other. (5) You talk based on your experience rather than the textbook knowledge. (6) We don't have to make an agreement. (7) You can change your initial opinion. (8) Don't worry if you get lost. (Kajitani, 2018, p. 47) *Some people explain all every time, others just take a few and explain.

In the context of citizenship education, it is important that *students, not teachers, decide the questions of the day.* "If the teacher selects the questions to be discussed, the students are likely to interpret that act as a vestige of the old authoritarianism" (Lipman, 2003, p. 98).

The process of question-selection should be based on the student's interest. What is more important is to ask students to propose questions from their own concern and explain this in their own term. This process should be student-centric rather than teacher-centric.

The '*community ball*' (see Figure 1) is one of the important tools used for many P4C classes in Japan. It is a talking object made of woolen yarn, which is originally pioneered by a group of practitioners of p4c HI, intended to create "intellectual safety", At the beginning of the semester, students made this ball collaboratively so that this ball "becomes a symbol of a powerful symbolic shift in the circle regarding the authorization of the right to speak" (Jackson, 2013, p.102).


Figure 1: community boll

The community ball is used in the following manner:

1) A person who has the ball speaks (others who do not have a ball should listen).
2) A person who has the ball can select the next speaker.
3) If there is no student who wants to speak, the facilitator circulates the ball within the community. What students can do in this situation is to speak or to pass the ball to the neighbor.

How we are conducting classes in NIT

Based on these pedagogy and method, we conduct P4C in our classes.

In Tokyo college, we conduct the class "Introduction to Philosophy and Ethics as a Dialogue" ("Taiwa toshiteno Tetsugaku Rinri nyumon"). Textbook used in this class is "Rinri" (ethics), which is one of the subjects according to the Japanese Official Curriculum Guidance. The contents of "Rinri" include histories and theories of ethics and philosophy such as deontology, utilitarianism, liberal democracy and so forth. In our class, we teach such knowledge, but also provide students with opportunities to engage the P4C style dialogue.

At the beginning of each semester, our class begins by what we call "*Silent dialogue*". (Cf. Murase, 2015) In this practice, students write their thought about their own interests on the worksheet (see Figure 2). Students at NIT are often afraid of speaking in front of others. So, the early step of dialogue should be their familiar style – writing on the papers.

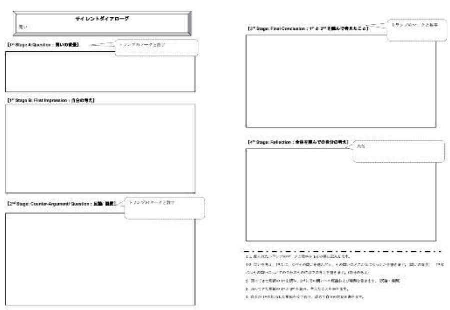


Figure 2: Worksheet of "Silent dialogue"

In "Plain Vanilla", one of basic methods of p4c HI, students themselves propose the question for dialogue The various questions are proposed by students. One day, for example, students proposed questions: "What is 'my thought'?", "Is homework (during summer vacation) necessary?", "Should we say nice things to our friends?", "All living things have life equally. But why do we treat it differently?" and "What is wrong with Baikinman (an antagonist character of the Japanese anime "Anpanman")?".

In Ube college, we have the class "Rinri (ethics)" for the second grade students (16-17years old) and "Gendai Shakai" (Civics)" for the first grade students (15-16years old). Like Tokyo college, we used textbook officially authorized by the Japanese Government. We use the textbook not only for transferring knowledge but also for doing P4C dialogue (see Figure 3).

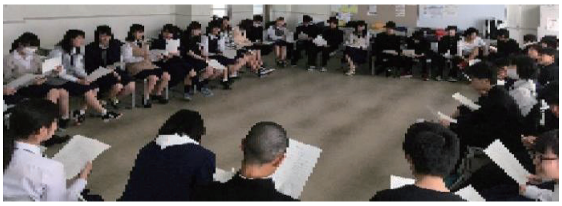


Figure 3: p4c style in Ube

In the class, we repeatedly ask students to describe new questions and their "moyamoya" (their ignorance clarified through dialogue) in the portfolio after lectures and dialogues. Through a continuation of this practice, students are more likely to be aware of their initial assumptions about the subject.

In addition, we use a method called "fishbowl" (Gregory, 2008, p. 44) in order for us to facilitate dialogue among 40 students in one class effectively. In this practice, students are divided into two groups. While the Group 1 (20 students and 1 teacher/facilitator) engages in philosophical inquiry, Group 2 students (20 students) listen to dialogue outside the circle. 15-20 minutes later, the students swap their role (Group 2 students talk, while Group 1 students listen) Using this method, our bioethics classes thought about many questions, such as "Can a designer baby be happy?", "Should the right to abortion be granted?", and "Is it justifiable if parents design their child's life through genetic engineering?".

Students' reflection

In the Tokyo college, we focus on student's descriptive reflection note. That asks "What did you notice and learn from this class?" Examples of students' answer include, "Each person has a different opinion", "There are people who have similar ideas, but few people who have exactly the same ideas". As such, *students found out a diversity of opinions.*

In addition to this, students understand the significance of dialogue and listening to others voice: "(I learned from this class) listening to and understanding others' opinions", "Even if you think by yourself, there are only a few fixed answers, but adding other people's opinions creates new ideas.", "It is important to discuss the process to reach a conclusion."

One student wrote that "(I learned that) people think various ideas and there are differences in the nuance of words they express", and he continues, "I want to know the opinion of the others who keep silence during dialogue". As such, his motivations to know multiple perspectives of the other are cultivated. *This shows that the philosophical community of inquiry fosters their interest in gaining multiple perspectives of others.*

We asked students "When did you think 'fun(pleasure)' when you engaged a philosophical dialogue?". We found out many answers, such as "when I know thought of others," "when someone says their idea differently".

One student wrote "when new ideas are shaped through listening to the idea of others", and on a free comment, he wrote, "It was very interesting that everyone had various opinions in the discussion, and it was good that I could hear many opinions from other people."

The other students wrote "(I feel fun) when someone notices the point I did not notice previously", and on a free comment, he wrote, "I like to listen to the other's voice." What is shown here is not only to notice the presence of diverse opinions but also to find it interesting to hear various perspectives. This means that students find P4C interesting *not* because they listen to the same opinion. Nor do they find it interesting because their initial opinion is strengthened. Rather, they find it interesting *because* P4C enabled them to encounter different, or even opposite, opinions. In other words, *the community of inquiry enables students to learn how interesting listening to new ideas and changing themselves are*. *This could be the experience that serves as the basis for relativizing one's own opinion, opening oneself up to others without falling into the "self-righteousness".*

In Ube college, in addition to the classical themes of Western philosophy such as freedom, happiness, religion, and reason, the class also dealt with modern issues such as gender, bioethics, information society, and modern cultural relativism. By writing a new question and unknowns on the portfolio after P4C discussion, students become *ambivalence of their ideas that they initially thought as true*. This awareness is effective from the viewpoint of defeating "self-righteousness" of the engineer. It is because engineer must be able to relativize their positions and listen to the opinions of different stakeholders without being stick to their own values and assertions.

P4C has made various contributions to this purpose. For example, when comparing student's opinion before and after dialogue on the ethics of enhancement (including designer baby, ethics of abortion, ethics of genetic engineering), students critically examined their opinions. What follows are some examples.

1)About the question: "Can a designer baby be happy?"

> "Before we talked, I thought it would be unpleasant to make designer babies because they are artificial. But *after I listened to various opinions* from everyone and a teacher through the dialogue, *part of me it comes to think it might be good to have an edited gene that is not likely to cause diseases*. But the equal part of me still thinks that I don't like the situation where I'm designed..." (2th grade, Department of Business Administration – emphasis added)

2)About the question: "Should the right to abortion be granted?"

> At the beginning, I thought abortion should not be permitted because abortion may neglect children's rights to live. But *after philosophical dialogue*, *I agreed with one opinion that points out parents' viewpoint.* For this account, it is meaningless for parents if they cannot raise their kid. And I was thinking that the government should be responsible for supporting such parents. But, I am also wondering whether the government has an enough capacity to make it possible. Thus I thought this issue is quite difficult to consider (2nd grade, Department of Chemical and Biological Engineering – emphasis added)

3) About the question: "Is it allowed for parents to design their child?"

> "In philosophical dialogue, *there was an opinion that was opposite to mine*. It said we should not design an "inconvenient" child to be "convenient" to mirror the child's feelings. *I am not sure whether it is ok to remove children's inconvenience on behalf of the children.* (2nd grade, Department of Mechanical Engineering – emphasis added)

Every student became aware that *their initial beliefs and assumptions were not self-evident*, as exemplified by the fact that many students changed their initial opinions through dialogue. This change has occurred mostly because the community of inquiry created a space where students could think and talk with no rush to reach conclusion. *As the inquiry focuses on the process of careful listening and reason-exchange, students can grow their citizenship abilities that engineers should have* – that is, listening, reasoning, critical thinking, and reflective thinking.

Conclusion

In this paper, we have shown that the community of philosophical inquiry created an important space where students learn citizenship. Students in particular learnt *the pleasure of dialogue with different others* (Tokyo) and *the skills for relativizing their beliefs and assumptions* (Ube). As we have seen, these are some of the citizenship that is needed for students who are becoming engineers. By taking such discussion-based education into general courses from the lower grades, we can expect them to learn how to prevent the self-righteousness.

Further consideration should be needed to understand how students' reflective reactions and their opinion-change contribute to the cultivation of their citizenship. To this end, we are currently undertaking a new research working. (Nishiyama, 2019; Nishiyama, Murase & Ogawa, 2019.). In our new project, we have investigated one of the democratic moments in dialogue – that is consensus-making. Although P4C is not a practice aimed at creating "universal" consensus, our research has attempted to identify types of so-called "meta-consensus" (e.g. consensus for collaboration, consensus for making dialogue progress forward, consensus on dissensus) and analysed how such meta-consensus contributes to cultivating students' citizenship abilities (e.g. recognition for diversity, understanding opinion of others with respect). In addition, since the technology college is usually conditioned by like-mindedness (e.g. male-centric, technology optimistic attitudes), our research group also focuses on how the community of inquiry can avoid creating echo-chambers.

It should be made clear that we do not contend that teaching knowledge is totally unnecessary. What is really needed actually is to make *a balance between teaching professional knowledge and learning a practice of citizenship*. Therefore, it should empirically be investigated the way in which we can bridge knowledge-transfer and free dialogue in the upper grades.

References

Crick, B. (1998). *Education for citizenship and the teaching of democracy in schools: Final report of the Advisory Group on Citizenship.* London: Qualifications and Curriculum Authority.

Dzur, A.W. (2008). *Democratic Professionalism: Citizen Participation and the Reconstruction of Professional Ethics, Identity, and Practice*. Pennsylvania: The Pennsylvania State UP.

Gregory, M.(ed.) (2008). *Philosophy for Children: Practitioner Handbook*. Montclair: The Institute for the Advancement of Philosophy for Children.

Hiyane, H. (2012). Engineering Ethics Education to Nurture the Sociality of Students ("Shakaisei Kyoiku toshiteno Gijutsusha Rinri"), in: *Engineering Ethics*, 60(2), 9-14. (in japanese)

Jackson. T. (2013). Philosophical Rules of Engagement, in S. Goering, N. J. Shudak & T. E. Wartenberg (eds.), *Philosophy in Schools: An Introduction for Philosophers and Teachers*. New York and London: Routledge.

Kajitani, S. (2018). *What does it mean to think: An introduction to philosophy from 0 to 100 years old ("Kangaeru toha douiukotoka? 0sai kara 100sai madeno tetsugaku nyumon.").* Tokyo: Gentosha. (in japanese)

Kono, T. (2014). *Developing Dialogue and Thinking Power through the Philosophy for Children (Kodomo Tetsugaku de Taiwaryoku to Shikoryoku wo Sodateru).* Tokyo: Kawadeshoboshinsha. (in japanese)

Kuroda, K., Todayama, K., & Iseda, T.(eds.) (2012). *Engineering ethics ("Hokoritakaki gijutusya ni narou")*. Nagoya: The University of Nagoya press. (in japanese)

Leydet. D. (2017). Citizenship, in: Edward N. (ed.). *The Stanford Encyclopedia of Philosophy* (substantive revision Mon Jul 17, 2017). Stanford University. https://plato.stanford.edu/entries/citizenship/.

Lipman, M., Sharp, A.M., & Oscanyan, F. (1980). *Philosophy in the Classroom*. Philadelphia: Temple University Press.

Lipman, M. (2003). *Thinking in Education*. Cambridge: Cambridge University Press.

Lipman, M. (1988). *Philosophy goes to school*. Philadelphia: Temple University Press.

Makaiau, A. S. (2017). A Citizen's Education: The Philosophy for Children Hawai'i approach to deliberative pedagogy, in: M. R. Gregory, J. Haynes, & K. Murris (eds). *The Routledge International Handbook of Philosophy for Children*. London and New York: Routledge, 19-26.

Murase, T. (2015). Dialogue on a Sheet of Paper: Education for Good Thinking by Philosophical Dialogue ("Shijo Taiwa toiu Jugyojissen no Kokoromi"), in: *Kosen Kyoiku*, 38, 368-373. (in japanese)

Nishiyama, K. (2019). Rethinking consensus in the community of philosophical inquiry: a research agenda, in: *childhood & philosophy*,15, 1-18.

Nishiyama, K., Murase, T., & Ogawa, T., (2019). Community of Philosophical Inquiry without Consensus?: Insights from Meta-Consensus, in: The 19th Biennial International ICPIC Conference, Bogotá: Colombia. Jul 25.2019.

Saito, N., & Sakashita, K. (eds.) (2014). *Engineering ethics ("Hajimeteno kougaku rinri").* Kyoto: Showado. (in japanese)

Active Lecture: "Community and Engineering"

Kazumi Furukawa*[a], Shinji Ushimaru[b], Kazutomo Naganawa[c], Wataru Yamanouchi[d], Madoka Kita[e], Masayuki Takeguchi[a] and Takashi Kobayashi[e]

[a] Department of chemistry and biochemistry,
National Institute of Technology (KOSEN), NUMAZU college, Numazu, Japan
[b] Department of electronic control system engineering,
National Institute of Technology (KOSEN), NUMAZU college, Numazu, Japan
[c] Department of control and computer engineering,
National Institute of Technology (KOSEN), NUMAZU college, Numazu, Japan
[d] Department of electrical and electronics engineering,
National Institute of Technology (KOSEN), NUMAZU college, Numazu, Japan
[e] Department of mechanical engineering,
National Institute of Technology (KOSEN), NUMAZU college, Numazu, Japan

*E-Mail Address: furukawa@numazu-ct.ac.jp

Abstract

We not only provide aspiring engineers with classroom lectures, we also give them an opportunity to think creatively. Numazu College at the National Institute of Technology (KOSEN) is composed of five departments: Mechanical Engineering, Electrical and Electronics Engineering, Electronic Control System Engineering, Control and Computing Engineering, and Chemistry and Biochemistry. "Community and Engineering" is an active class that students take during their 4th year. This class is an opportunity to engage in group work and think about how the specialized fields in which students are studying contribute to society. Through the other contents of this class, such as talks by speakers invited by the instructor and lectures on intellectual property ownership, students learn about "community and engineering" in various ways. In the group work, the themes in which students are engaged are examined repeatedly, and problem solving in local companies as well as in local governments have been conducted since 2015. In 2018, five themes were set: "natural disasters faced by regions and how to respond to them," "the relationship between industry and regional development," "companies as contributors to the local area," "a regional solution by -4th year Numazu-Kosen-students-," and "the extraction and solution approach to regional problems." One theme was considered by each class. In one class, groups of four to six students from five departments were formed according to the area of students' hometowns. Group work was conducted through surveys of the area or community, extraction of the issue, debating, and presentations, and students' activities were assessed through reports and presentations. This class provided students with the skills and knowledge to exchange ideas with other students in different specialties and to think about what engineering could contribute to the community. This course was carried out over the course of five months. As a result, students produced new, unique ideas on each theme and were able to understand the possibilities and roles of their own and other engineering fields.

Keywords: *local society, engineering education, cross-field learning, creative potency, group work*

Introduction

Numazu College at the National Institute of Technology (KOSEN) has five departments, each of which implements a specialized engineering curriculum. These departments are Mechanical Engineering, Electrical and Electronics Engineering, Electronic Control System Engineering, Control and Computer Engineering, and Chemistry and Biochemistry. Our educational goals are to contribute to the development of regional culture and industry by fostering students as engineers with rich humanity who are capable of creatively utilizing their engineering expertise in response to the needs of society. The specific educational goals that students acquire for this purpose are as follows. 1. Awareness of the social roles and responsibilities of engineers, 2. Ability to apply the results of natural science in response to the needs of society, 3. Ability to creatively utilize their expert knowledge of engineering technology, 4. Rich international insight and communication skills, 5. Intention to continue studying systematically as practical engineers.

In Numazu National College of Technology, in addition to the knowledge and skills provided by each specialized department, students are able to take subjects that cultivate their ability to use engineering creatively

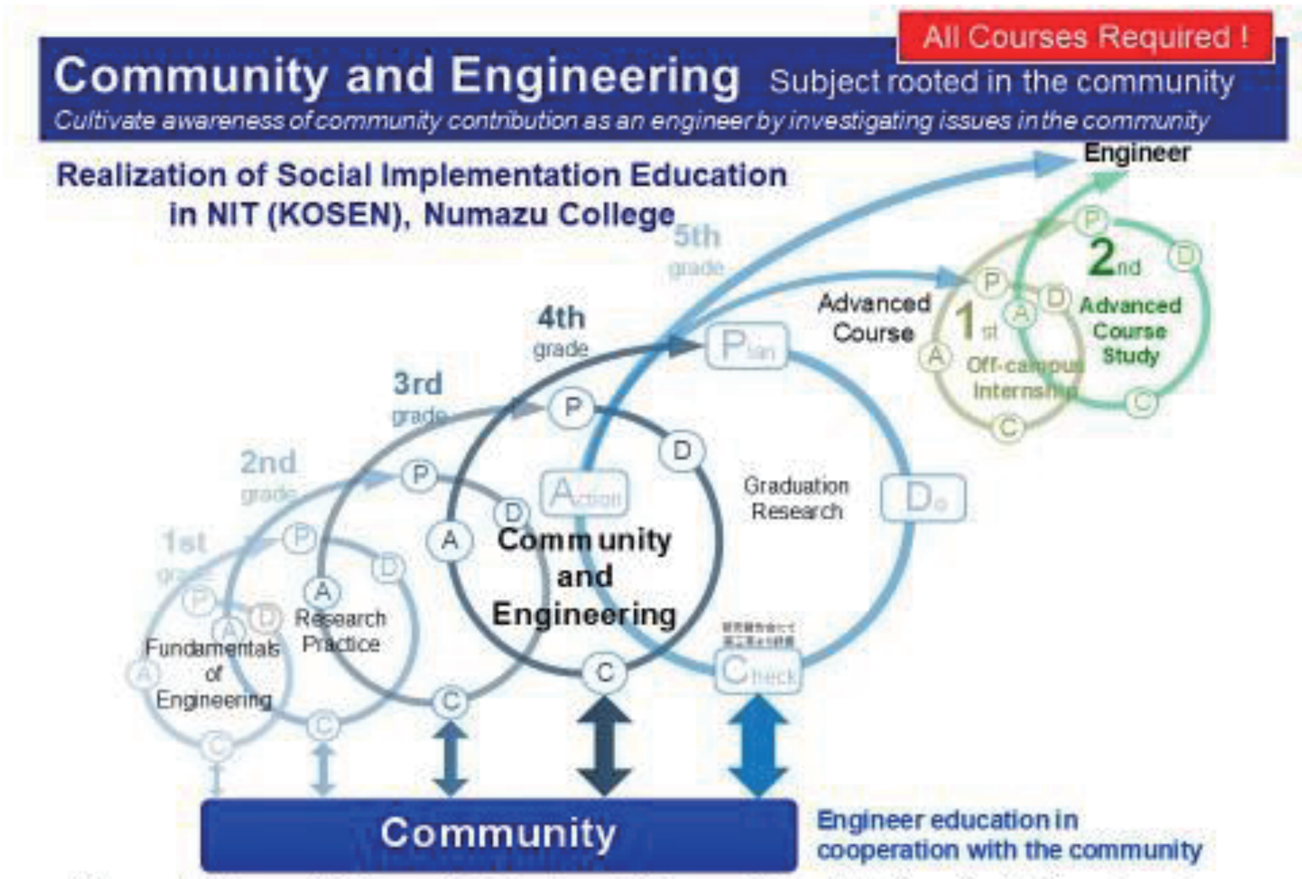


Figure 1 The positioning of this lecture "Community and Engineering" in engineering education for five years.

through group work; this course is "engineering basics" in students' first year. "Society and Engineering" is a similar course in students' fourth year of "mini research" (Figure 1). In "engineering basics," students learn about common matters in engineering through lectures and experimental training. In the "mini-study" offered in the second year, students are divided into groups of about three, and all teachers, including liberal arts instructors give assignments and receive instruction on creative solutions. In students' fourth year, specialized education is advanced and future courses are considered. The subject "Society and Engineering" is offered in this year. In this paper, we describe the educational content in this course and its effects.

What is "Society and Engineering"?

The area-oriented class subject "Society and Engineering" is offered to fourth-year students, as mentioned above. The course takes place 15 times for 90 minutes each week. The goal of the class is to enable students to acquire "the ability to creatively use their engineering expertise." The class mainly involves group work, in which students formulate and present ideas to apply engineering technology to given tasks. In order for students to learn about the various aspects of society and engineering, lectures on philosophy by company managers and unique technologies and lectures on intellectual property are provided. The focus points in setting group work have been reviewed each year from the results of student questionnaires. In the 2015 fiscal year, the first year, ten themes were established based on the issues presented by six companies, two administrative organizations, and other cooperating organizations. A team of approximately five students was created to tackle each problem (Takeguchi *et al.* 2019). The selection of issues to be tackled was randomly designated by the teachers. Students learned different approaches even if they were assigned to the same task by the four teams working on one theme. In fiscal years 2016 and 2017, ten themes were set with the cooperation of four companies suitable for regional issues and one administrative organization group (Takeguchi *et al.* 2019). Although the tasks in the 2015-2017 fiscal year were aimed at developing joint research through internships and post-graduation research, there was a gap between the level that the companies requested and the level at which students' learning had progressed. For this reason, the problem set for fiscal year 2018 was changed so that it is easier for students to perform problem extraction by focusing on local governments rather than specific companies or administrative organizations. In other words, problems were solved by devising ideas about students' own hometowns (Ushimaru *et al.* 2019). In addition, we planned a symposium by COC + program (program for promoting regional revitalization by Universities as Centers of community) in order for students to consider their careers through the activities of this lecture. These classes provided students with an

Table 1 Class objective and rubric of this lecture "Community and Engineering"

Class objective		Criteria				
		A: Outstanding	B: Excellent	C: Good	D: Pass	F: Fail
1	Can explain industries of a certain regional society.	☐ Executing studies about business contents, features, and with a particular point of view, about participating regional companies (or organizations) supporting this educational program.	☐ Can explain business contents and features about participating regional companies (or organizations) supporting this educational program.	☐ Can explain business contents about participating regional companies (or organizations) supporting this educational program.	☐ Can explain minimal business contents about participating regional companies (or organizations) supporting this educational program.	☐ Can NOT explain business contents about participating regional companies (or organizations) supporting this educational program.
2-1	Identify problems faced by a certain regional society as a team.	☐ Understand tasks to be addressed and act as a team member while also playing a leadership role.	☐ Understand tasks to be addressed, and can act accurately to attain assigned roles as a member of team belonging to.	☐ Understand tasks to be addressed, recognize as a member of team belonging to, and can act to attain assigned roles.	☐ Understand tasks to be addressed, recognize as a member of team belonging to, and can act minimally to attain assigned roles.	☐ Can NOT Understand tasks to be addressed, can NOT recognize as a member of team belonging to, or can NOT act to attain assigned roles.
2-2	Can find problems faced by industries of a certain regional society.	☐ Can point out problems faced by participating regional companies (or organizations) supporting this educational program, and can make effective proposals to solve them.	☐ Can point out problems faced by participating regional companies (or organizations) supporting this educational program, and can find out some backgrounds of them.	☐ Can point out problems participating regional companies (or organizations) supporting this educational program can agree faced by them.	☐ Can point out problems faced by participating regional companies (or organizations) supporting this educational program.	☐ Can NOT point out problems faced by participating regional companies (or organizations) supporting this educational program.
3	Can explain the necessity of finding problems.	☐ Understand the importance of identifying problems for business management, and be able to explain excellent strategic solutions.	☐ Understand the importance of finding out problems for business managements, and can explain the strategic solution of them.	☐ Understand the importance of finding out problems for business managements, and can explain the strategic solution of them.	☐ Understand most of the importance of finding out problems for business managements.	☐ NOT Understand most of the importance of finding out problems for business managements.
4	Can explain intellectual property rights.	☐ Based on the principle of intellectual property rights, can understand profoundly the power of "intellectual property" in case of developing new technologies.	☐ Based on the principle of intellectual property rights, can understand the power of "intellectual property" in case of developing new technologies.	☐ Based on the principle of intellectual property rights, can understand the power of "intellectual property" in case of developing new technologies without any big mistakes.	☐ Based on the principle of intellectual property rights, can minimally understand the power of "intellectual property" in case of developing new technologies.	☐ Can NOT understand the principle of intellectual property rights, or can NOT understand the power of "intellectual property" in case of developing new technologies.

opportunity to learn about the current state of the community and the required human resources images.

Class contents for 2018

The program was conducted as a class of 15 lessons of 90 minutes each for a total of 200 students from 5 departments.

The first class covered the target explanation, division, and theme explanation in each classroom

The 2nd and 3rd, 6-10th group work
The 4th and 5th COC + Career Symposium
The 11th group work presentation
The 12th Intellectual Property Rights
The 13th & 14th Lecture by business owners
The 15th Summary

Aim for this class and evaluation method

The goals for the class shown to the students are as follows.

1. Describe the industries in a community
2-1. It is possible to find problems in the industry of the local community on a team basis.
2-2. We can find out the problems faced by the industry in the community.
3. Explain the need to find problems.
4. Explain intellectual property rights.

Table 2 Evaluation rate Unit : %

	Lecture item	Group activity	Presentation	Group work proposal report	Report on COC+	Report on lectures by business owners	total
1	Can explain industries of a certain regional society.	20	0	0	0	0	20
2-1	Identify problems faced by a certain regional society as a team.	0	15	25	0	0	40
2-2	Can find problems faced by industries of a certain regional society.	0	0	0	10	10	20
3	Can explain the necessity of finding problems.	10	0	0	0	0	10
4	Can explain intellectual property rights.	10	0	0	0	0	10
	Overall evaluation rate	40	15	25	10	10	100

Table 3 Examples of group work for extracting and solving regional problems. (Classroom C)

Group of regional area	Theme by extraction of local society	Characteristic of idea	Key words for solving the problem
Team GOTENBA	Road surface freeze prevention	It is an initiative for local issues closely related to life	Snow melting agents from alcohol, road heating, antifreeze proteins, vibrating substances
Team NUMAZU1	Protect fisheries from tsunamis.	Challenge to solve the problem focusing on "fishing" as a target of tsunami countermeasures	Automatic control of ship, PCB processing, big box for aquaculture, debris removal robot, land debris prevention
Team NUMAZU2	Prevent agricultural damage to mandarin oranges due to typhoons and strong winds	Focusing on the local mandarin orange, “Mikan,” and the local climate.	Equipment and equipment to weaken strong winds, data application of the Japan Meteorological Agency, hardening spray
Team MISHIMA	Countermeasures against odors of waste from rivers	Aiming to solve problems faced by Mishima City, a city of spring water.	Water purification, deodorization, garbage pickup, riverside maintenance
Team FUJI	Developing outdoor sports to attract young people using CNF	Use method development of CNF that utilization is demanded in Fuji City	Various item development using CNF,Forest parkour, survival game,Starry sky tour with unmanned bus
Team SHIZUOKA	Utilization of leaving bamboo forest	There are many interventions that can be made in each department of this regional area regarding bamboo groves.	Low cost bamboo forest harvesting, bamboo shoot business, bamboo shoot exploration robot
Team FUJIEDA	Fewer street lights & lots of wildlife	Map-based analysis of terrain and highways in the target area	Blue light, private power generation system in remote areas
Team ENSHU	Lack of maintenance of tea fields	Nuclear power plant and tea industry are two major points of the land	Tea field solar panels, use of drone, full automation with sensor on machine, full automation with rail and line

As shown in Table 1, the evaluation was made in five stages of Outstanding, Excellent, Good, Pass, and Fail. Table 2 shows the rate of evaluation in each initiative. In group work, Class objective 1, 2-1, 3, and 4 were evaluated, and 2-2 were evaluated by the report of the career symposium of COC+ and the lecture by the management.

Results and Discussion

Group work activities and ideas

In the year 2018, in order to make it easier for students to conduct problem extraction focusing on local governments, the idea was formulated in terms of students' own hometowns. The method of group cretion was as follows: students made groups consisting of four to six students from various specialized departments in each area of origin. Eight groups were divided into each classroom, and a larger theme was set for each classroom, and local issues in that theme were addressed. Class M was "a regional solution by -4th grade Numazu-Kosen-students-," Class E was "companies as contributors in the local area," Class D was "the relationship between industry and regional development," Class S was "local disaster prevention," and classroom C set the outline theme of "local problems." Table 3 lists the activities in classroom C as an example of the issues and coping strategies that the students extracted at each birthplace. In each classroom, students discussed the solution, whether it was possible to investigate, analyze, and implement or not, and presented a solution. In each classroom, the students selected a group that proposed a good idea, and the highest-ranking group made a presentation with 200 people as a representative of each classroom. In the teaching method in classroom C, students decided their role assignment for smooth group work and tried a joint learning method (Yasunaga 2018) consisting of expert activities and jigsaw activities.

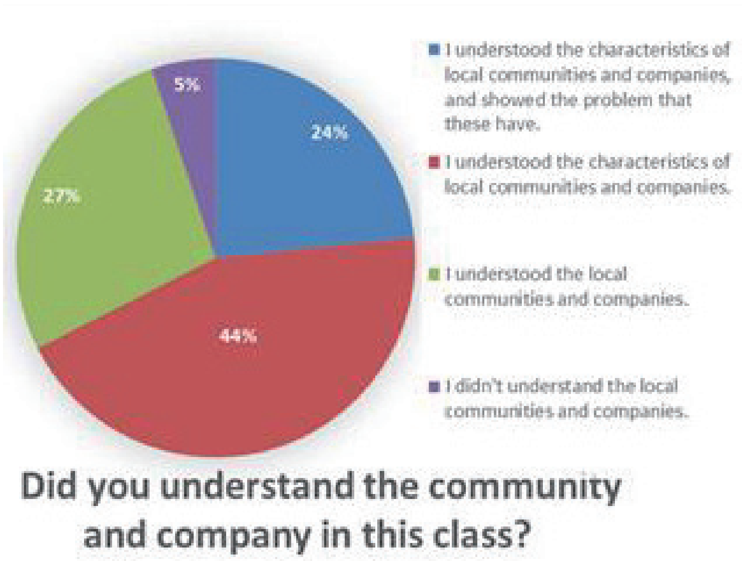
Results of the 2018 Student Questionnaire

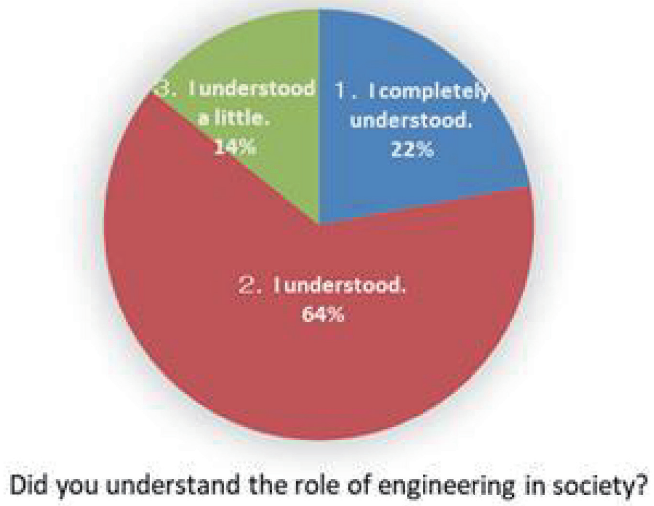
This lecture was offered to students in the 4th year, but in order to investigate how the lecture affected students as an aspect of their career as an engineer, they chose a course and theme for graduation research. The questionnaire was conducted after their 5th year. Therefore, the response rate was low. Approximately 40 percent of 200 students answered the questions.

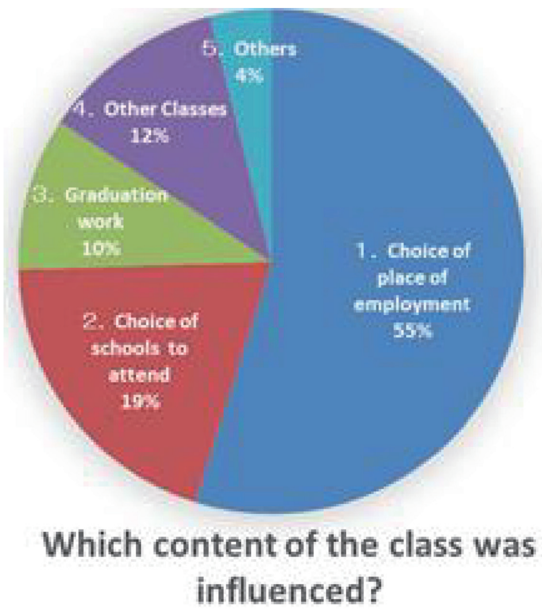
The questions in the questionnaire were as follows.

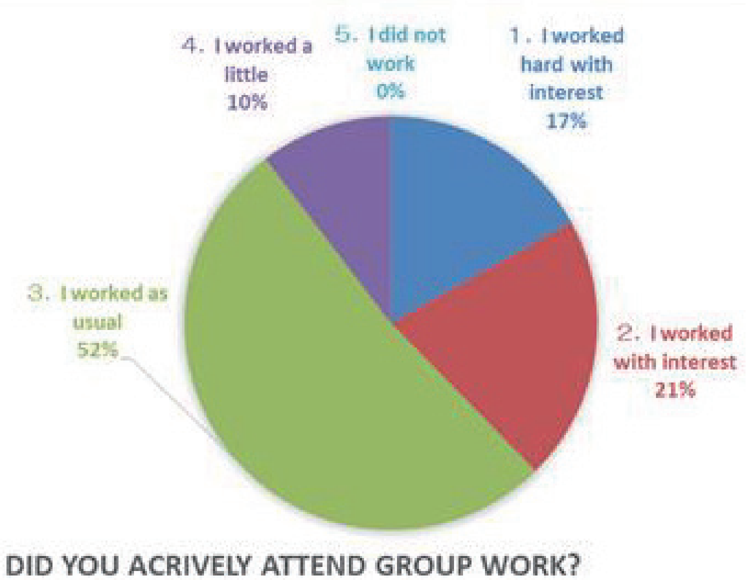
- Did you actively attend group work?
- Did you understand the community and company in this class?
- Were you influenced by this class?
- When did you feel that you were influenced?
- Which content of the class influenced you?
- Did you understand the role of engineering in society?
- What did you notice in this class?
  1. How to use one's specialized field
  2. Feature of other specialized fields
  3. Importance of cooperation among multiple fields
  4. Students can contribute to the local community
  5. Local society issues
  6. Engineering needs in the local community
  7. Invention methods
  8. Familiar invention
  9. The philosophy of the company
  10. Blue chip companies in local community
  11. Other

The results of the questionnaire are shown below (Figure 2). The results showed that the students were interested in working on this class. Most of the students understood the characteristics of local society and companies. In addition, one third of the students were influenced by social and engineering experience in their career planning. Most of them answered that they understood the role that engineering plays in society. On the other hand, at the end of the class, the majority answered that they understood the importance of collaborating with other fields in group work, so that students were able to realize the effects of activities within the group beyond the department.









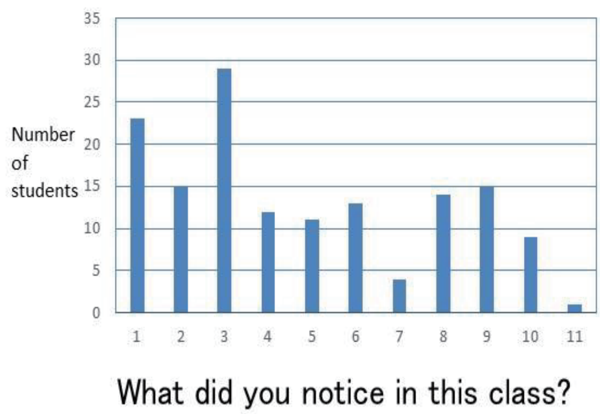


Figure 2 Results of the 2018 student questionnaire.

The results of the questionnaire showed that students were interested in this class. Most of the students understood the characteristics of the local society and companies. In addition, one third of the students were influenced by social and engineering experience in their career planning. Most of them answered that they understood the role that engineering plays in society. On the other hand, at the end of the class, the majority answered that they understood the importance of collaborating with other fields in group work, so that students were able to realize the effects of activities within the group beyond the department.

Conclusion and future plan

With the school's goal of cultivating students' abilities to use their specialized knowledge in engineering technology, we provide teachers with the opportunity to cultivate creativity that links past and future learning. Class settings have improved with this social keyword. Various differences between this course in 2017 and 2018 have been noted: whether there is participation in classes of actual companies or government agencies, whether the students themselves conduct problem extraction, whether the presentation is in a poster format or a format using PowerPoint. In any case, it became clear from the questionnaire results that the class became one in which students considered the role of engineering in their own community. From the questionnaire results (Takeguchi *et al.* 2019) of the implementation method up to fiscal 2017 and the questionnaire results of fiscal year 2018, it was clear that students had a strong awareness of the relationship between the community and engineering. With regard to the effects of group work, I could recognize that students who were usually learning in different departments were able to develop an awareness of each other's specialties and different perspectives.

As mentioned above, in this lecture, we used the local community as a subject to creatively use students' expert engineering knowledge. Students will use the specialized knowledge about engineering technology acquired up to the third year creatively while working with different teams in the department to extract problems faced by the local community, group work to formulate solutions, and problems I learned about the need for the ability to find points and to handle newly discovered intellectual property. Students also had the opportunity to think about whtheat kind of creativity they would like to use in the future by attending lectures from actual local business owners and attending COC + career symposiums. As a result, students were able to realize the role that the specialized field of their own learning plays in the community, the cooperation that can be shared with other specialized fields, and the effects of constructive activities by group work.

From now on, we will combine the intellectual property and group work that we conducted as each item in 2019, and will improve so that students can realize that their ideas become inventions. In this way, we can further realize the role that engineers play in society and to promote the awareness of engineers.

References

Takeguchi, M. *et al.* (2019). Introduction of subject collaborated with community "Community and Engineering." *Journal of Japan Society for Engineering Education,* 67, No.2, 57-62. (Japanese)

Ushimaru, S. *et al.* (2019). Engineering Education through an interdisciplinary subject "Society and Engineering", *Proceedings of Tokai Society for Engineering Education*,13,13-14.(Japanese)

Yasunaga, S. (2018). *Recommendation of collaborative learning - Making classes that enhance the activity-* (pp.27-48). TOKYO : Igaku-Shoin Ltd. (Japanese)

MAKING THE CHANGE – APPLYING FIVE MODELS OF ACADEMIC DEVELOPER PRACTICE

L.E. Kairisto-Mertanen*,a, M.Keinänen a
F
a Turku University of Applied Sciences, Technology and Business, Turku, Finland
b Turku University of Applied Sciences, Technology and Business, Turku, Finland
*liisa.kairisto-mertanen@turkuamk.fi

Abstract

The constant change of world influences education as education is supposed to produce people needed by the society. The role of education should include monitoring the changes in the environment and adjusting the approaches used, so that the students have the required knowledge, skills and character qualities needed in the working life. However, many of the pedagogical practices still used in education date back to the times when the first educational institutions were established.

Educators need support in implementing and supporting change in learning and teaching. In this paper we explore the use of Five Models of Academic Developer Practice which includes systematic development activities in five ways. These are Grass-root Model, Faculty-led Model, Strategic Model, Community Building Model, and Research-led Model. The aim of this paper is to share examples how we have applied this approach in Turku University of applied sciences aiming to implement our pedagogical strategy called innovation pedagogy during ten years.

Keywords: *educational change, managing change, innovation pedagogy, new way of learning,*

Introduction

The world is under constant change and this influences education as education is supposed to produce people needed by the society outside of the educational institutions. The role of education should include monitoring the changes in the environment and adjusting the approaches used, so that the students have the required knowledge, skills and character qualities needed in the working life.

However, many of the pedagogical practices still used in education date back to the times when the first educational institutions were established (Rüegg 2010). The knowledge awailable through research in education has not inclucenced the behavior of the teacher or changed the stuctures of the university as much as it should have.

The first universities were grounded in the middle ages in France and Italy. Since those times the environment of any educational institution has changed enormously and the challenges we are facing today are totally different. Internet has brought information to be accessible by everybody meaning that the teacher is no longer the only source of information for the students.

The present era in the field of education is often called "Education 4.0". It refers to the shifts in the educational sector in response to Industry 4.0 where digital transformation is impacting the ways in which the world of work and our everyday lives are becoming increasingly automated. The role of the teacher is undergoing big changes and old ways of carrying out education need to be challenged. Accepting and understanding new demands and finding correct ways to act in the profession call for further education for the teachers. It also has an important role concerning adjusting to the changes in the society. Looking ahead and acting in a proactive way belongs to the role of education and makes it possible to provide knowledgeable workforce to the fast developing fields of industry, economy and service sector. (Demos Helsinki, 2017; VTT, 2017.)

Education is a topic about which many people in the modern world have experience. Due to our own background we may take as granted how univerisities should be organized and education should be carried out in them. The discourse moves around teaching although learning is the concept whe really should be interested in. Teaching describes the work of a teacher but learning is the process of the student and it must happen at all levels of education.

There is plenty of research about learning and about the aspects influencing it. In spite of these clear research results, we sometimes stick to the old ways of doing things. A good question is, would we consider wise to stick to old ways of practice with f.ex. in medicine if a scientifically proven better cure would be available? Sometimes this still happens in education.

A change in education is a must and for that good leaders are needed.

Leading the educational change

Not only in education but in other organizations as well the focus is easily on management and handling the operational matters needed to keep every day work going on. However when wanting to make a change in the way how things are being done, the focus should be shifted on leadership. Management can be defined as „a set of processes that keep the system runnign smoothly. It is about planning, budgeting, organizing, staffing, controlling and problem solving.“ Then again leadership can be defined as a „set of processes that creates organizations in the first plance or adapts them to the changing circumstaces.“ (Kotter, 2012.) Leadership is about working with people and inspiring them to reach for the desired future.

Educational insititutions are organizations where the lines of authority are not always clear. It is characteristic for a teaching profession that it can be done in isolation without necessarily engaging in cooperation with other members of the organization. Sometimes the teachers do not feel commitment to the goals of the institution but have a strong belief in their professional expertize and atutonomy. (Popovic & Plank, 2016.) Making a change in this kind of circumstances is challenging and requires strong understanding about how to handle not only the people but also the prevailing structures and polices.

Focusing on maintaining the current balance is natural for people. Even changes that appear to be posite involve uncertainty. Different people and groups within the organization act in different ways when they are confronted with change. There migth appear strong resistance or undermining of the change. The most common reasons for resisting change are according to Kotter and Schlesinger (2008) 1) a desire not to lose something of value, 2) a misunderstanding of the change and its implication, 3) a belief that the change does not make sense for the organization and 4) a low tolerance for change.

Leadership skills are needed to make the change happen. Creating a vision for the future is one the first task of an efficient leader. The importance of a shared vision has been emphasized also by Senge (1992) in the litterature concerning learning organizations. Learning organizations are competent learners and updating their competences all the time (Sinkula, William, Baker & Noordewier, 1997). It becomes important to have the vision embedded in the organization to ensure a continuos cycle of improvement (Popovic & Plank 2016.)

One approach to support educators in making the change leading to new ways of learning and teaching is called Five Models of Academic Developer Practice. This approach includes systematic development activities in five ways. These are Grass-root Model, Faculty-led Model, Strategic Model, Community Building Model, and Research-led Model. (Popovic & Plank 2016.)

Purpose and structure of the paper

The aim of this paper is to share examples how we have applied the five models of academic developer practice in Turku university of applied sciences (later TUAS) aiming to implement our pedagogical strategy called innovation pedagogy during ten years. This paper not only demonstrates concrete examples of making the change but also offers new perspectives on how to support educators in reforming of education in different levels of educational system.

Innovation pedagogy - the new approach implemented

According to the legistlation for universities of applied sciences in Finland one of their tasks is to constantly monitor the working environment and act as a local influencer in their corresponding region (Finlex, 2019). Managing this task calls for tight connections with local enterprises and intensive cooperation in the field of education, research and innovation.

The need for innovations has long been recognized in the society. Already ten years ago the working life expressed a need to get graduates who have cross-disciplinary competence as there is a need for unconventional multidisciplinary knowledge (Oivallus, 2015) which can create new kind of thinking and lead to innovations. These skills require human touch even in a world where rutine tasks are handled by robots.

Innovation pedagogy aims to create not only study field specific compentences but also innovation competences. It is considered important that innovatiotion competences - creativity, initiative, critical thinking, teamwork and networking - are set as an aim for every study program regardless of the field of study. (Kairisto-Mertanen, Penttilä & Nuotio 2011; Marin-Garcia & all. 2013; 2016).

The change calls for motivated faculty who are capable of continuous learning and rethinking their ways of delivering education. (Kettunen, Penttilä & Kairisto-Mertanen 2013; Konst & Scheinin, 2018).

At TUAS the cross-disciplinary educational units make it possible to create new learning environments where students can mingle with their fellow students from different degree programs. Innovation pedagogy forms part of the strategy of the university indicating that it is the educational approach followed by every member of the organization.

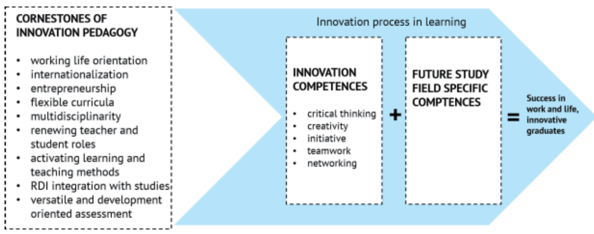


Figure 1. Innovation pedagogy in a nutshell

The idea of innovation pedagogy is presented in the figure 1. The aim of the educational process is to create success in work and life for the students but also for the university and for the whole society surrounding the university. The aims are reached when the innovation process in learning creates both study field specific competences as well as innovation competences. (Konst & Kairisto-Mertanen, 2018.) The cornerstones listed in the beginning of the arrow must be found in the learning environment and guarantee that innovation pedagogy is realized during the process. The best situation is when innovation pedagogy is present in the learning environments both through the strategy but at the same time also through the acts of individual faculty members.

The previous research on innovation pedaogy show that studying in environments where the cornerstones are present has an effect in the development of students innovation competences (Keinänen & Oksanen, 2017; Keinänen & Butter, 2018; Keinänen & Kairisto-Mertanen 2019).

Applying the five models of academic developer practice in implementing Innovation pedagogy

Referring to Kotter´s (1996) eight-stage process model of creating change Popovic and Plank (2016) present a three stage model for change management in academic development. According to them a successful change management is a three-stage process including the stages of creating a climate for change, engaging and enabling the organization and implementing and maintaining change.

Having in mind the three stages by Kotter (1996) different approaches to introduce a change in the organization can be used. In this paper, we presen the five approaches: Grass-root Model, Faculty-led Model, Strategic Model, Community Building Model, and Research-led Model, presented by Popovic & and Plank (2016), and discuss how these approaches are used by us when supporting and implementing innovation pedagogy at TUAS.

Grass-root Model

Implementing innovation pedagogy in the work of any university can be started by interested individuals. This is the case when an individual teacher is eager to develop the ways of delivering education. For example, activating learning and teaching methods and versatile and development oriented assessment are examples of cornestones of innovation pedagogy where the desicion to start applying them does not need involvement from others than just the teacher who is applying them.

Although individual-focussed work many times has low impact accross institution (Popovic & Plank 2016) it can still serve as an example to those individuals who are more cautious concerning making changes. Good experiences can be shared and this way they can provide encouragement for other memebers of the educational isntitution. Alexander (2018) urges those committed to reformed pedagogy in higher education to act as role models in the face of change.

In the case of introducing innovation pedagogy staff members were encouraged to try new ways of delivering tuition. They were constantly told by the management in the faculty that mistakes are allowed and that the most important thing is to consentrate on student learning. Through experience we learned that sometimes the students also have big prejudices concerning changing the way they are expected to work. For anyone who is trying new ways of doing things it is necessary to accept also negetive feedback from the students. Sometimes the change requires perseverance and belief from the people involved in it about moving to the right direction regardless of the feedback. The experiments applyed by individual teachers was supported in the faculty by organizing different events, such as pedagogical seminares, open discussion sessions, and rewarding events, where good practices could be shared.

Faculty led-model

Althoug the grass-root is crucial part of educational refroming, the faculty-led aspect is also needed. In the case of innovation pedagogy the whole initiative started from one faculty. It was the multidisciplinary faculty of technology, environment and business whrere the majority of the students studied engineering or business. The multidisciplinary working environment provided a good template for giving the students opportunity to study also in multidisciplinary groups.

Many of the cornerstones of innovation pedagogy can be implemented by a desicion of the faculty management. In our case when we started implementing innovation pedagogy, the faculty could decide about all the cornerstones presented in the figure 1. However it is easier for the faculty members not to accept the approach if it is not officially approved to be used in the whole university.

In the case of the faculty of technology, environment and business we engaged ourselves in many discussions concerning the applicability of the approach in different disciplines. Many of the more traditional members of the faculty expressed opinions which were totally agains applying innovation pedagogy in their discipline and courses. At this phase it was important to find people who were willing to piloting new ways of doing things. Piloting was needed and it was important to share the results of the pilot projects with the whole faculty.

We also introduced several new applications of courses which were meant for all the students of the faculty. For example, the Project hatchery was developed to incorporate all the new students starting in the faculty regardless of the degree programme. It included a project assignment on which the students in a multidisciplinary project hatchery group were expected to work during one semester. Implementing this new approach required plenty of discussions with the students and finding a multidisciplinary group of teachers who were willing to work together in a new way.

It was possible to attract people from the faculty to form a group of enthusiatic people who truly believed in changing the ways of working according to innovation pedagogy. The mistake we made here was being too entrusiastic about the concept and forgetting that some of the felt like outsiders. An advice for future change makers is to find ways to get across the „not invented phenomenom“ which quite easily appears in an expert organization.

Strategic model

As explained above innovation pedagogy started as an approach applied by only one faculty. In the early years in the faculty of tehnology, environment and business several measures were taken to implement it to the everyday activities of all the degree programs. After succesfull results, such as, improved working atmosphere in the faculty, increase in the RDI assigments and other assignments coming from working life and being included in the studies, increasing amount of exchange periods taken by the students, and improved numbers of graduating students, the approach was adopted officially as the learning strategy of the whole university. At the same time it was also included in the university strategy.

At this point all the faculties were supposed to start acting according to the principles of innovation pedagogy. However plenty of resistance was met, not only by the faculty members in the whole university but also by the students who were not used to active working methods or multidisciplinary way of working.

It proved to be extremely important to give the people in different study programs across different faculties opportunities to get to know each other and this way build trust among them. Although, plenty of different meetings and internal conferences were organized where good practices could be shared, it still took years until the concept was fully understood and accepted by the whole university. Now innovation pedagogy is included in the latest strategy of the university. It is an approach which is constantly evolving and developed by all the people working for the university.

During these years, one of the important support systems in innovation pedagogy, were internal innovation pedagogy trainings. First, these training were organized by the faculty of technology, environment and business internally, and later for the whole university by the central acdemic unit of the university. These trainings proved to be extremely important in familiarizing understanding about innovation pedagogy. In the trainings people across the university and study programs got to know each other and created common understanding about innovation pedagogy.

Community building model

In community building model the focus is put on breaking down unwanted individualism by encouraging people to sharing of ideas, peer support and networking. (Popovic & Plank 2016). In the case of innovation pedagogy, in the addition to the intearnal trainings, the community building model was also supported by organizing montly meetings and annual internal conferences. In those meetings, which we called „innostudios“, teachers have opportunities to share their experiences, find solutions for pedagogical challenges, and also discuss latest research results in the field of education. Similarly, the annual intrenal conferences, is served for the purpose of encouraging people to connect and cooperate with their colleagues.

About 20 % of the faculty members took part in the innostudios. The internal conferences proved to be much more popular, they were organized outside of the university in attractive places. The measures connecting people accross disciplines proved to build understanding and bonding between people who were traditionally used to working only with their peers from the same discipline.

Our experience shows that it is important to connect people across disciplines to form communities where they cans share good practices. When there is enough trust and time between people also the bad experiences can be shared. Help which is awailable from peer to peer has shown to be extremely important when wanting to implement new ways of doing things.

Research-led model

In the case of innovation pedagogy the faculty members were encouraged to do research about their experiments when applying new methods for learning. The research conducted and reported accordingly is an important tool when wanting to develop learning in the university. The research results shared by peers are efficient in convincing people about the usefullness of the new apporach.

In our case a special research group for innovation pedagogy was established. We were lucky enough to get funding for projects which had an important role in conceptualizing innovation pedagogy. New research ideas developed the practices further and research results gave faith in moving forward with the new concept.

Conclusions

Implementing innovation pedagogy at TUAS is at the moment in a reasonably good phase. The concept forms part of the strategy and it should be in use in all the sectors of the university. however, we are still facing the challence of encouraging people to do research about their own work and share the results with the colleagues.

All the approaches: Grass-root Model, Faculty-led Model, Strategic Model, Community Building Model, and Research-led Model, have proven to be applicable when introducing a change in a university. In our case it meant implementing innovation pedagogy as the pedagogical approach used at TUAS.

When using these approaches we have noticed that several reasons for resisting change could be met in the university. To overcome the resistance it has proven extremely important first to create a climate for change. People in an expert organization need to understand the reason for changing their ways of doing things. The need for change must be visualized to them. After that, enough information and help is needed to make it possible for the faculty to change their ways of opertaing. In our case, the trainings proved very usefull helping in making people more knowledgeable. Maintaining change is a constant process which must be planned visely. Including the concept in the strategy helps in keeping people alert about how the university wants them to behave.

References

Alexander, P. (2018). Chapter 3: Information Management Versus Knowledge Building: Implications for Learning and Assessment in Higher Education. In O. Zlatkin-Troitschenskaia et al. (Eds.), Assessment of Learning Outcomes in Higher Education, Methodology of Educational Measurements and Assessment (pp. 43-56). Springer International Publishing AG, part of Springer Nature 2018.

Demos Helsinki. (2017). Työ 2040. Scenarios of the Future Work. Helsinki: Demos Helsinki & Demos Effect.

Elinkeinoelämän Keskusliitto EK. (2011). Oivallus-loppuraportti. Viitattu 21.6.2017 www.ek.fi/oivallus.

Finlex. Ajantasainen lainsäädäntö. Ammattikorkeakou-lulaki. 2017. Referred 2.7.2019. http://www.finlex.fi/fi/laki/ajantasa/2014/20140932

Kairisto-Mertanen, L., Penttilä, T., & Nuotio, J. (2011). Defining innovation competence– the learning outcomes of innovation pedagogy. In I. Torniainen, S., Mahlamäki-Kultanen, P. Nokelainen, & P. Ilsley (Eds.), Innovations for competence management. Conference proceedings. Series C Articles, reports and other current publications, part 84 (pp. 25-33). Lahti: Esa print Oy.

Kettunen, J., Kairisto-Mertanen, L., & Penttilä, T. (2013). Innovation pedagogy and desired learning outcomes in higher education. On the Horizon, 21(4), 333-342.

Keinänen, M., & Butter, R. (2018). Applying a self-assessment tool to enhance personalized development of students' innovation competences in the context of university-company cooperation. Journal of University Pedagogy, 25(2), 18–28.

Keinänen M., & Kairisto-Mertanen L. (2019). Researching learning environments and students' innovation competences, Education + Training, Vol. 61 Issue: 1, pp.17-30, https://doi.org/10.1108/ET-03-2018-0064

Keinänen, M. & Oksanen, A. (2017). Students' perception of learning innovation competences in activity-based learning environment. Journal of Professional and Vocational Education, 19(4), 48–61.

Konst, T., & Kairisto-Mertanen, L. (2018). Innovation Pedagogy: preparing Higher Education Institutions for Future Challenges. Course Material from Turku University of applied sciences 115. Tampere: Suomen Yliopistopaino, Juvenes Print Oy.

Konst, T., & Scheinin, M. (2018). The changing world has implications on the higher education and the teaching profession. On the Horizon, 26(1), 1-8.

Kotter, J. P. (2012). Leading Change. Harward Business Review Press. USA.

J. P. Kotter & L. A. Schlesinger (2008). Choosing strategies for change. Harward Business Review, July – August, https://hbr.org/2008/07/choosing-strategies-for-change

Marin-Garcia, J., Pérez-Peñalver, J., & Watts, F. (2013). How to assess innovation competence in services: The case of university students. Direccion y Organization, 50, 48–62.

Marin-Garcia, J. A., Andres, M. A. A., Atares-Huerta, L., Aznar-Mas, L. E., Garcia-Carbonell, A., González-Ladrón-de-Guevara, F., & Watts, F. (2016). Proposal of a framework for innovation competencies development and assessment (FINCODA). WPOM-Working Papers on Operations Management, 7(2), 119–126.

Popovic, C. & Plank, K. (2016) Managing and Leading change. Models and Practices in Baume, D. & Popovic, C. (2016) Advancing Practice in Academic Development. Routledge.

Rüegg W. & de Ridder-Symoens H. (Eds.) (2010) Universities since 1945. In A History of the University in Europe: Volume 4. Cambridge University Press. ProQuest Ebook Central, retrieved http://ebookcentral.proquest.com/lib/turkuamk-ebooks/detail.action?docID=605104 1.1.2019.

Senge, P. M. (1992) The Fifth Discipline: The Art & Practice of the Learning Organization. Random House Australia: Milson Point, NSW.

Sinkula, J. M. – Baker, W, E. – Noordewier, T. (1997) A Framework for Market-Based Organizational Learning: Linking Values, Knowledge, and Behavior. Journal of the Academy of Marketing Science, Vol. 25, No. 4, 305–318.

EDUCATIONAL PROGRAM FOR FUTURE GLOBAL ENGINEERS IN NIT, SUZUKA COLLEGE

N. Hirai[*,a], Y. Ohnuki[a], T. Kusaka[a], S. Yoshida[a], K. Kondo[a], H. Shimofuruya[a] and J. Yoshida[a]

[a] National Institute of Technology (KOSEN), Suzuka College, Japan

*E-Mail hirai@chem.suzuka-ct.ac.jp

Abstract

To motivate students at National Institute of Technology (KOSEN), Suzuka College, to become global engineers in the future, the project, "the Global Engineer Program," was launched at NIT, Suzuka College in 2017. This program aims to train and nurture engineers who can act with a global mind-set as well as the cutting-edge knowledge and techniques of engineering. It is put into practice by seven consecutive years of education (five years in the regular course and two years in the advanced course). All students are required to participate in this program from the first to the third year. As for the 4th-year students in the regular course, only those who are in the top 20% of each class and who have scored 400 or higher on the TOEIC test can enroll for the project. In the advanced course, only students in the top 20% of each class and with 500 or higher on the TOEIC test score can resister for it. In order to complete this program, it is necessary to meet the following requirements at graduation of the advanced course. First, students must complete the advanced course. Second, they must score 650 or higher on the TOEIC test. Third, they must earn credits from the following classes: "Advanced English conversation", "Global Leaders", "International Relations" and "International Internship". The details of "Global Engineer Program", "Advanced English conversation", "Global Leaders", "International Internship", and the educational effects of this program will be discussed in this paper. And two of the new classes: "Engineering Basic Experiments" for the first-year students in the regular course and "Design Basics" for the second-year students in the regular course, respectively, began in 2017 and 2018. We will also focus on the details of these classes and their educational effects in this paper.

Keywords: *Cross-disciplinary educational program, Program for global engineers, Program of engineering designs, Project based learning, Educational effect*

Introduction

National Institute of Technology (KOSEN), Suzuka College, launched a new educational project in 2017. This project was closely related to the reorganization of the Advanced Course; the Advanced Courses (Advanced Electronic and Mechanical Engineering Course and Advanced Applied Chemistry and Material Engineering Course) were reorganized into one Advanced Course (Advanced Engineering Course of Science and Technology for Innovation). What is more, one Course was divided into three majors: Environmental and Resources Engineering Course, Energy and Functional Innovation Course, and Robotics Technology Course. Due to this reorganization, students can earn credits in one or two courses, and receive a bachelor's degree in engineering by acquiring the credits specified for National Institution for Academic Degrees and Quality Enhancement of Higher Education (NIAD-QE).

Furthermore, a special program, "Global Engineer Program," was incorporated in the advanced course. The Global Engineer program is to foster human resources of engineers with high technological skills as well as leadership globally acknowledged. To achieve the goals of the program, NIT, Suzuka College, deployed various classes to motivate students to become global engineers.

Global Engineer Program

Table 1 TOEIC score of 9 candidates of the program

	2017/03	2018/02	2019/02	Score 650 or higher
A	500	500	500	
B	575	575	585	
C	755	845	845	OK
D	540	540	550	
E	510	530	610	
F	735	735	735	OK
G	555	555	680	OK
H	595	660	660	OK
I	625	655	790	OK
Ave.	599	622	662	

The purpose of the Global Engineer Program is to train and nurture engineers who can exercise leadership and take action with a global mindset as well as the cutting-edge knowledge and techniques of engineering. In the five-year program in the regular course and two-year program in the advanced course, to learn English communication skills, negotionation skills, planning skills, executive skills, management skills, and management skills required for global engineers, students are assigned to different departments and courses that have fostered their adaptability, toughness, and resourcefulness in their own way. Nine candidates, who entered the advanced course in 2017, were selected for this program because they were in the top 20% of the department in the regular course and scored 500 or more on the TOEIC test.

In order to complete this program, it is necessary to meet the following requirements at graduation of the advanced course. First, they must complete the advanced course. Second, they must score 650 or higher on the TOEIC test. Third, they must earn credits from the following classes: “Advanced English conversation”, “Global Leaders”, “International Relations” and “International Internship”.

Table 1 shows The transition in the TOEIC score of 9 "the Global Engineer Program" candidates of 2017. As the average TOEIC score increases from 599 to 662 for 2 years, it is considered to be educationally effective to some extent.

Advanced English Conversation

The overall goal of "Advanced English Conversation" is to develop students' English communicative competence as global engineers. To accomplish this goal, students will be expected to develop and acquire the multiskills of English such as speech, discussion, and debate.

"Advanced English Conversation" will improve students' English communication skills in speech, discussion and debate. Students will gain a broader understanding of global issues. Topics range from cultural and social diversity to matters related to engineering while improving their communication, listening, reading, writing, and presentation skills in English.

This class consists of 3 parts: summarization, extemporaneous speech, and discussion or debate. Discussion or debate depends on the week.

For the summarization part, students will show others the news source to summarize a week before, give a presentation of the summary and have a Q&A session with the audience. And then submit a written summary on the intranet until the next week.

Duirng the extemporaneous speech part, students will choose a title by drawing lots. They will have one minute to prepare, present their speech more than 2 minutes and have a Q&A session with the audience. And then they will write the script including the contents of the Q&A session and submit it on the intranet by the next week.

As for the discussion session, students will be divided into a few groups of 4 or 5. Each group will decide the topic, prepare for the topic and fill in the opinion sheet by the day of class. And then they will write the opinion sheet including the contents of the actual discussion and submit it on the intranet.

As for the debate, students will be arbitrarily divided into pros or cons based on a topic. Until the day of the debate session, they will prepare for the topic and make the first proposition speech and a second one. And then they will submit the first and second proposition speech and the opposition speech newly written in the debate session on the intranet.

Global Leaders

Figure 1 Pictures of the classes of “Global leaders”

The purpose of “Global Leaders” is to develop human resources who will be leaders with global mindsets in various fields such as industry, academia, public service and so on, considering the diversity in the world. Six instructors, who work internationally and have considrable insights into global development, give students a series of lectures on their own experiences and knowledge. Then, they conduct a group discussion on the theme presented in the lecture and develop the qualities and skills needed to a global leader. The evaluation ratio is as follows; 25% of final presentation, 25% of final report, 50% (10% x 5 lectures) of reports and/or discussion in each lecture. Figure 1 shows pictures of students' presentaton and lecture in “Global Leader.

Figure 2 Picture of the international internship in Thailand.

According to the questionnaires, students consider that they get to know the ideas on a global leader from a series of lectures and find out what is needed to be a global leader. They feel that these lectures are so different from the ordinary classes. Therefore, it is considered xxx to be educationally more effective than expected.

International Internship

The purpose of International Internship is to experience practical problems and issues for engineers working internationally, and to acquire practical senses in working internationally. At first the implementation schedule was considered summer holidays, winter break, or spring break, but two internship implementations in 2017 were conducted during summer vacation. The schedules of international internship in 2017 are as follows.

Case 1 (Company A)

Welding training and mould maintenance training for 1 week in Japan, and press training, painting training, welding training and quality control training for 3 weeks in Thailand.

Case 2 (Company B)

Assembly training and inspection training for 1 week in Japan, and production line training and quality control process flow chart making training for 3 weeks in Thailand.

Figure 2 is a picture of the international internship in Thailand. The comments of two students who participated in this international internship were extremely positive, so that it is considered to be eduactionally effective to some extent.

Engineering basic experiments

Engineering Basic Experiment is introductory education for engineering. The goal of the course is to motivate first-year students to learn engineering as well as to foster a positive attitude toward studying engineerring. As NIT, Suzuka College, consists of five departments: Department of Mechanical Engineering, Department of Electrical and Electronic Engineering, Department of Electronic and Information Engineering, Department of Chemistry and Biochemistry, and Department of Materials Science and Engineering, each department has its own experiment formats. All students in the regular course are required to enroll into all kinds of basic experiments.

The schedule of Engineering Basic Experiment is as follows; three times for the guidances: general, and each department's ones, two times each for every experiment rotating from department to department. The content of the experiments is as foloows; mini 4WD production and gear ratio calculation, production training of basic electrical and electronic circuits, programming and microcomputer, fundamentals of lactic acid fermentation engineering, and optical microscope observation on the smartphone by self-made UV resin. The evaluation is performred by reports of five experiments. Figure 3 shows pictures of the classes.

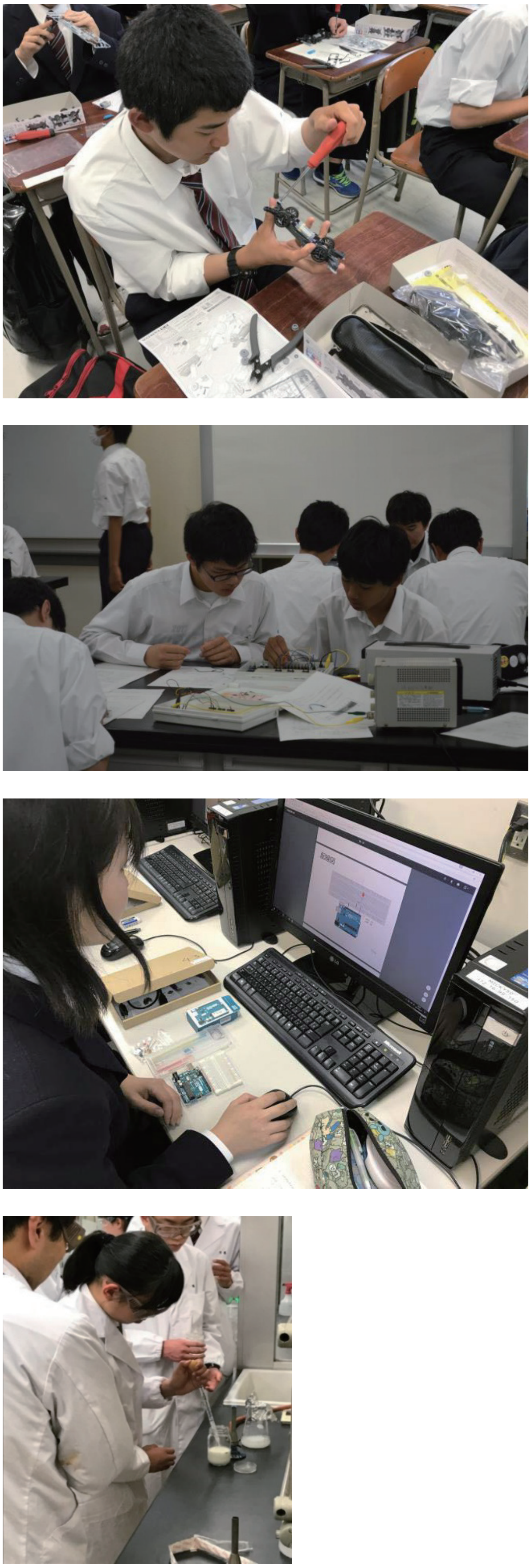


Figure 3 Pictures of the classes of "Engineering basic experiments"

Table 2 Results of questionnaire for "Engineering Basic Experiments" in 2017-2019

Q 1	Question	How fun or boring was the Enginnering Basic Experiments for you to participate in ?					
	Choices	Very fun	Fun	Neither	Boring	Very boring	Unanswered
	Number of answer	259	334	38	2	1	0
	Percentage	40.9	52.7	6.0	0.3	0.2	0.0
Q 2	Question	How aggressive were you to participate in the Engineering Basic Experiments?					
	Choices	Very Aggressive	Aggressive	Neither	Negative	Very negative	Unanswered
	Number of answer	374	247	12	0	0	1
	Percentage	59.0	39.0	1.9	0.0	0.0	0.2
Q 3	Question	Did you get interested in learning contents of the other departments in the Engineering Basic Experiments?					
	Choices	Strongly agree	Agree	Neither	Disagree	Strongly disagree	Unanswered
	Number of answer	183	389	38	22	2	0
	Percentage	28.9	61.4	6.0	3.5	0.3	0.0
Q 4	Question	Is the Engineering Basic Experiments is useful for you to study at National Institute of Technology in the future?					
	Choices	Strongly useful	Useful	Neither	Not useful	Not at all useful	Unanswered
	Number of answer	207	380	38	2	2	5
	Percentage	32.6	59.9	6.0	0.3	0.3	0.8

Table 2 is the result of the questionnaire conducted at the end of the course. This is the record for 3 years from 2017 to 2019. In this paper, the items indicate to students' satisfaction with the experiments.

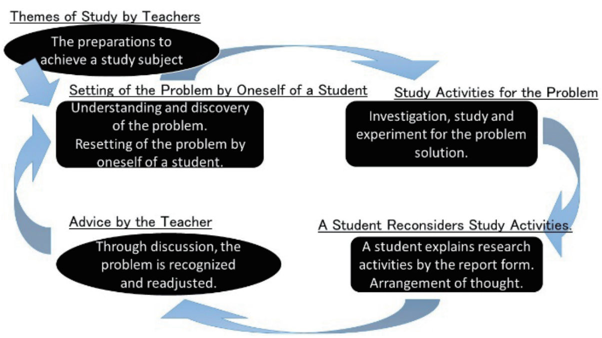


Figure 4 Active cycle of "Design Basics" .

As for question 1, 93.6% of students had fun participating in each experiment. As for question 2, 98.0% of students were able to positively participate in each experiment. The result shows the contents of experiments were attractive to students sufficiently. Moreover, 90.3% of students showed an interest in the contents of experimants in other departments, and were also affirmative to the purpose of "Engineering Basic Experiments". As the results of question 4 showxxx, it is expected that "Engineering Basic Experiments" will be a new education format to motivate students to become global engineers in the future.

Design Basics

Figure 5 Pictures of poster presentations.

"Design Basics" began for 2-year students in the regular course in 2018. The purpose of the course has three points as follows; 1) After understanding a research purpose, students make their research plan and spontaneously carry it out under the supervision of teachers in charge. 2) It is conducted by group research activities. 3) Students must report to the supervisor about the process and results of the survey per class hour. In this class, each teacher must take charge of 2 to 5 students, provide a theme related to their own major with students and implement a small-sized project based learning (PBL) education in the second semester. Students choose one theme presented by teachers and tackle it spontaneously. At the end of the course, they give poster presentations on their own research activities.

In order to foster students' positive attitudes toward working on their own task spontaneously, we give students some clues in advance as follows;

1) The teacher in charge plays a role to lead students in the right direction of research, not to teach them what and how to do in "Design Basics".
2) As Figure 4 shows, a student aims to find a solution to the problem by going back and forth in the active cycle. The part a teacher concerns is only 2 circulars, i.e. "Themes of Research Presented by Teacher" and "Supervision of the Teacher in charge".
3) The most important point is whether each student can find a theme suitable to their interest in "Design Basics" .

The schedule of the course is as follows; all teachers submit their theme of research in April. All themes are open to the students and students submit up to the third choice of the theme in May. Then, students are assigned to the theme along with their choice in July. The activities beginxxx from August, depending on the supervisor's schedule. The poster presentations are given at the end of January. Figure 5 shows pictures of the poster presentations. This course can give students opprtunities to experience a procedure of reserach from planning to presentation and recieve a response and review to what they have done from the audience including other teachers and students.

Conclusions

As we discuss and review this new education program, " Global Engineer Program", and courses: "Global Leaders", "International Internship", "Engineering Basic Experiments", and "Design Basics", in detail, this project actually has educational effects on students to some extent. We would like to continue this project, while improving the contents.

Acknowledgements

This program has been partly supported by "KOSEN 4.0" initiative.

SELF-DIRECTED RESEARCH UNDER A QUARTER SYSTEM: HOW THE UNIQUE RESEARCH CURRICULUM IMPLEMENTED, IMPROVED?

Y. Nakamura [Yoshimichi]*, Y. Nakamura [Yasuo], A. Sai, M. Yoshida, Y. Nakamura [Yoshitaka], K. Wada, and T. Niwa

National Institute of technology, Hachinohe college, Hachinohe, Japan

* nakamura-g@hachinohe.kosen-ac.jp

Abstract

The academic year 2019 marks the fifth year since Hachinohe Kosen introduced an academic quarter system with a unique research curriculum called "Self-directed research (SDR)". Fall quarter has been designated for students to totally concentrate on their own SDR activities. In this paper we report how the research curriculum under the academic quarter system has been implemented and improved since its introduction.

As we have already reported in ISATE 2016 and 2017, SDR itself is a big challenge for students, especially for the first to third year Kosen students, typically aged 15 - 18 years. Most of them had hardly been engaged in any research activity like SDR before enrolling in Hachinohe Kosen. It should be noted that their SDR subjects are not given by their teachers (SDR coordinators). Each student has to decide what to research and make their own research plan. Basically, they are allowed to start any research as long as it is considered scientific and original. Just a review and/or a reproduction of others' researches, however, do not meet the acceptance criteria of SDR. Moreover, the students have to accomplish their SDR by the end days of Fall quarter, on which SDR poster presentation is held annually at Hachinohe Kosen.

In order to support and enhance the students' SDR activities prior to Fall quarter, Hachinohe Kosen has launched "SDR day (自主探究 Day)" in Spring and Summer quarters, four to five days in total a year, since 2018. Correspondingly, a variety of "student peer discussion (SPD)" have been held for the students to report their research progress to each other not only in Fall quarter but also in Spring and Summer quarters. In addition, "SDR facilitators", about 40 qualified fourth to fifth year Kosen students to facilitate the lower-year students' SDR activities, have also been deployed. How such support system for the SDR has worked at Hachinohe Kosen is reported.

Keywords: *Self-directed research, student peer discussion, coordinator, facilitator, academic quarter system*

Introduction

Hachinohe Kosen switched in 2015 from a two-semester system to a quarter system whereby the academic year is divided up into four blocks. The biggest reason for the switch is to introduce a newly designed compulsory research curriculum, "self-directed inquiry", which has renamed "self-directed research (SDR)" since 2018. The quarter system is more manageable than the semester system to ensure about a two-month-long research activity period for the students in the academic calendar. Fall quarter has been designated to be the research-intensive period. In Fall quarter, the students need not to stay on campus for their research activity. Under the quarter system, it is much easier for them to plan off-campus research activities, especially studying and researching abroad.

What makes SDR stand out in the so-called student-centered education is that each student himself/herself has to decide "what to research". Finding an original research subject is the one they struggle hard with first in carrying out SDR, as reported previously (Nakamura, 2016[a]). How to proceed research and how to draw conclusions also have been the ones the students struggle with. The point is that most of the students struggle through the entire process of their research. It should be noted that if teachers actively and closely intervene in the students' research, SDR is no longer self-directed learning. The students' academic curiosity and self-direction should be kept and respected. How teachers are involved in SDR has been one of the key issues.

The academic year 2019 marks the fifth year since the introduction of SDR. Thanks to these five years of trial and error, the unique research curriculum, which was once considered to be too adventurous, has gradually evolved to be sustainable one. In this paper we report how it has been implemented and improved since its introduction. What has successfully worked and what has not are reported, looking back from 2015 to the present, 2019 summer.

2015: SDR quandary

All the students (from first-year to fifth-year students) were basically allowed to start any research as long as it is considered scientific and original. The students, however, were in a quandary in the Fall quarter, the research-intensive quarter. In 2015 Fall quarter, each homeroom was locked and the students were not allowed to enter and use it. The reason for the lock was to recommend the students to do their SDR off-campus.

Each homeroom teacher was appointed to play a coordinator role, together with another teacher (i.e., two coordinators each class). The coordinators are supposed to give the students a 'supportive push forward' in accomplishing their SDR, respecting the students' academic curiosity and self-direction. Most of the coordinators, however, had not successfully grasped how each student's SDR had been progressing. Actually, many students did not have a clear research plan, and some did not even come up with what to research. The students of most of the classes were practically "left alone" for a long time in Fall quarter. One of the first-year classes held weekly a "student peer discussion (SPD)" for the students to report their research progress to each other. SPD was quite helpful to the students in learning how to find the SDR subject and how to set about and accomplish their research (Nakamura, 2016[b]). As a result, the students of that first-year class successfully won four prizes, including the first prize, out of the top eight prizes at the SDR poster presentation contest on campus at the end of the Fall quarter.

2016-2017: Collaboration among coordinators

In 2015, there was no Fall quarter timetable. Each coordinator just tried to take care of his/her own students on their own way. Both students and coordinators, however, were in a quandary over how to face SDR. In addition, collaboration among the coordinators was hardly seen. Such a situation had continued for the second- and the third-year classes in 2016 and 2017. At the poster presentation contest on campus, though their posters, at a glance, looked good "in appearance", most of them were obviously less than so-so in essence from the view point of research.

For all the first-year classes, however, an important step forward was made in 2016 and 2017. A collaborative approach among the coordinators of all the four first-year classes started to make Fall quarter much better for the students. Joint SPDs, i.e., inter-class student peer discussions were planned and implemented twice a week (Nakamura et al, 2017). A timetable of Fall quarter was correspondingly prepared for the first-year classes. The outcomes of their SDR were astonishing. At the poster presentation, as a whole, the first-year students received much higher praise than the second- and the third-year students. In addition, after the Fall quarter, many first-year students went off campus to take part in research contests, in which they competed against university students. Surprisingly, Hachinohe Kosen's first-year students won the grand prize in 2016 and 2017 in such contests (Innovation Venture Idea Contest 2016, 2017).

2018: SDR Days in Spring and Summer quarters

Further steps forward were made in 2018. The collaborative approach among the coordinators were extended to all the lower-year classes (first-, second-, and third-year classes). From 2018, the fourth-year and the fifth-year students are required to find their SDR subject in close relation to their graduation studies in consultation with their thesis supervisors, not SDR coordinators. Hereafter this paper focuses on the lower-year students' SDR.

From 2015 to 2017, 24 coordinators were deployed for the lower-year classes each year (2 for each class). Since 2018, however, the number of the coordinators has been about only 6~7. They work closely to each other to support the lower-year students' SDR activities. The rest of all the teachers are supposed to "cooperate" with the coordinators for the events related to SDR. In order to support and enhance the students' SDR activities prior to Fall quarter, for example, "SDR day (自主探究 Day)" has been newly launched in Spring and Summer quarters (four to five days in total a year) since 2018. The students can consult the teachers about their SDR plans. On SDR days, not only the coordinators but also the other teachers take part in the consultation. They take part also in the screening of SDR research subject proposed by the students on SDR days. Thanks to SDR days, all the lower-year students successfully decide what to research and their tentative research plan prior to Fall quarter. The schedule of SDR Days in 2018 and snapshot examples are shown in Table 1 and Figure 1, respectively.

It should be noted that "SDR facilitators", about 40 qualified fourth- and fifth-year students to facilitate the lower-year students' SDR activities, have been deployed since 2018. The facilitators have played a crucial role in the events related to SDR. We also note that since 2018, all the students have been required to give a short presentation (1-minite presentation) in the morning on the poster presentation day prior to the poster presentation in the afternoon.

2019: Improvement of SPD and SDR days.

It has been clear that there are much room for improvement on the operation of student peer discussion (SPD) and SDR days. As result of holding joint SPDs, the number of students participating SPD greatly increased (about 90 ~ 170 in total). The meetings as a whole tend to become lengthy. The number of chances per student to give presentations has decreased though the number of meeting itself has increased. That is also the case for the consultations and screening on SDR days. Every student has felt "my waiting time is too long!".

In 2019, only 80 minutes after school were used for each SDR day. Small-group (about 4 students) SPDs were held simultaneously at each homeroom. Each student presented his/her ideas about what to research and the other members of the group gave comments for the idea. Snapshot examples of the SDR day in 2019 are shown in Figure 2. In the snapshots, we see facilitator students are activating and and enhancing the lower-year students' discussions. In contrast to the SDR days in 2018, every student was able to join the discussion every time. On SDR day4 in 2019, short presentations were held.

Table 1 Schedule of SDR day in 2018 for first-, second- and third-year classes.

period time	1 08:45	2 10:15	3 10:30	4 12:00	5 12:45	6 14:15	7 14:25	8 15:55
Day□ Apr 12					Guidance / Lecture for first-year classes (coordinators)			
Day□ Apr 16	Guidance / Lecture (coordinators)				Consultation (all teachers)		Consultation (coordinators)	
Day□ May 11	Lecture (coordinators)		Consultation (all teachers)					
Day□ Jun 04	Lecture (coordinators)		Consultation / Screening (all teachers)				Consultation (coordinators)	
Day□ Jul 17	Lecture (coordinators)		Consultation / Screening (all teachers)					

Figure 1 Consultation meeting on "SDR Day", 2018.

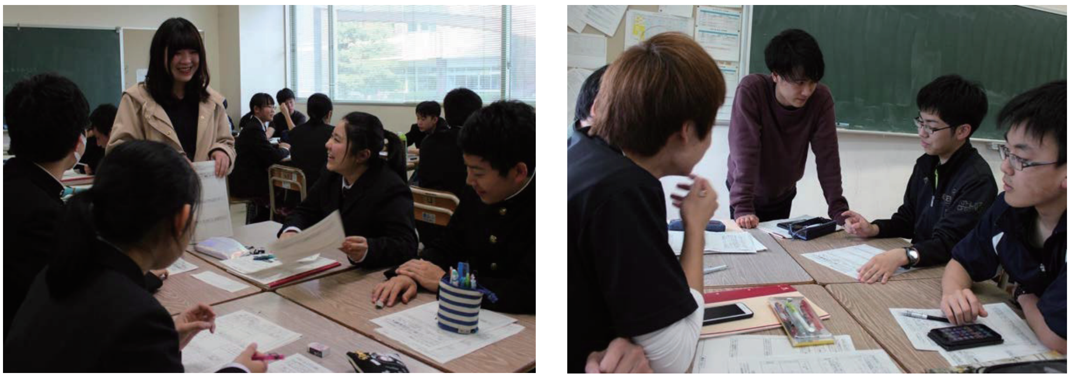


Figure 2 Group SPD (Student Peer Discussion) on SDR Day, 2019.

Conclusions

Thanks to these five years of trial and error, Hachinohe Kosen's unique research curriculum, self-directed research (SDR), which was once considered to be too adventurous, has gradually evolved to be sustainable one. Still, there are much room for improvement on the operation of SDR (Takeo et al., 2019).

SDR itself is considered to be effective to draw "brand new" academic ability from students, as we see that Hachinohe Kosen's lower-year students have dominated the grand and semi grand prizes for three consecutive years in a row since 2016 and 2017 in research contests in which they competed against university students (Innovation Venture Idea Contest 2016, 2017, 2018). "SDR must go on!"

References

Innovation Venture Idea Contest 2016 (COC+, MEXT). http://www.hachinohe-ct.ac.jp/coc/project/upload/docs/1211_idea.pdf.

Innovation Venture Idea Contest 2017 (COC+, MEXT). http://coc.hirosaki-u.ac.jp/wp-content/uploads/2017/06/inovation_venture_contest2017.jpg

Innovation Venture Idea Contest 2018 (COC+, MEXT). http://www.hachinohe-ct.ac.jp/coc/project/upload/docs/1201_venture2.pdf

Nakamura, Y. (2016[a]). Too young to do research? - Let them do self-directed inquiry, let us coordinate them in a fun, easy way. *The 10th International Symposium on Advances in Technology Education (ISATE2016)*, 651-653.

Nakamura, Y. (2016[b]). "Self-directed inquiry" into self-directed inquiry. *Research reports of National Institute of Technology, Hachinohe College*, 50, 53-56.

Nakamura, Y., Kikuchi, A., Kawabata, R. and Sai, A. (2017). A collaborative approach to coordinating students' self-directed inquiry. *The 11th International Symposium on Advances in Technology Education (ISATE2017)*, 68-70.

Takeo, F., Nakamura, Y. & Maruyama, S. (2019). An academic quarter system and self-directed inquiry implemented at Hachinohe Kosen. *Journal of The Japan Association for College of Technology*, 24, 7-12.

Examination of the effect of individualized masterly learning based on external assessment

H. Yagyu*,[a], S. Yairi [a], K. Suzuki [a], Y. Miyazaki [a] and K. Wako [a]

[a] National Institute of Technology, Sendai College, Japan

* h-yagyu@sendai-nct.ac.jp

Abstract

Masterly learning is a promising approach for fostering basic skills. Sendai KOSEN implemented the individualized masterly learning approach which allows each student to review and steadily master course units at their own pace. The aim of this study is to examine the effectiveness of this masterly learning effort, which utilizes the "Study Sapuri (RECRUIT)" an online serial self-study video and computer based testing program, accompanied by textbooks and reference books, and offered in mathematics, physics and English etc. The effectiveness of the program was examined by achievement tests in mathematics, developed by RECRUIT and a questionnaire survey. Results from the pre-post achievement score comparison reveal a small effect size of the program. Results from the questionnaire survey suggest factors correlated with growth in test scores, including "easy to review" and "can be reviewed many times". In 2019, we will further explore effective ways to improve test scores. Study Sapuri is online tutorial videos for students to learn anytime, anywhere, at their own pace. Through a series of short and captivating video lectures accompanied by digital textbooks and assessments, the video learning service turns students into motivated and engaged learners. It has been implemented as an educational support tool in 2,353 of the 5,000 high schools in Japan 2017. It is also compatible with the goals of the model core curriculum for KOSEN, the National Institute of Technology, Japan. As such, the program was implemented on second year students in the Robotics course at Sendai KOSEN. Based on the results of the 2018 implementation, we hypothesize that the growth in achievement test scores was small because there were few opportunities for academic staff to motivate students to actively engage in the program. Announcements on the importance of self-study and advice on how to continue self-study were made in some of the classes but not systematically or sufficiently. It is important for academic staff not only to offer self-study programs but also to actively motivate students to engage in the program from an early stage. We will continue the program in 2019 and further explore approaches to enhancing its effectiveness.

Keywords: Individualized masterly learning, Online serial self-study, Own pace, Achievement tests, Actively motivate students

Introduction

Sendai KOSEN is focusing on the construction of "self-paced learning" system. Because students' ability and learning speed differ in individuals, it is difficult for students to fully acquire units in classes along the curriculum. Therefore, in addition to classes, the aim is to construct an education system that allows each student to review and steadily acquire every units at their own pace. As part of the construct, in addition to textbooks and reference books, we provide learning places and opportunities that make it easy to work on self-paced learning and learning support contents, and we improve learning environment for students. This paper discusses the motivation for "self-paced learning" using the provided learning contents and the result of achievement tests as results of self-study.

Method

In order to construct the system, "Study Sapuri (©Recruit Marketing Partners Co., Ltd.)" as learning contents were provided to the second year in the Robotics course at Sendai KOSEN in both FY2018 and FY2019, and the motivation and results of their self-study were investigated. "Study Sapuri" is online tutorial videos for students to learn anytime, anywhere, at their own pace. Through a series of short and captivating video lectures accompanied by digital textbooks and assessments, the video learning service turns students into motivated and engaged learners. Since it is also possible to analyze a viewing time of each student, it can be used as a guide to investigate of degree for the self-study motivation. As above, it seems to be suitable contents for this program. The effectiveness of the program was examined by achievement tests in mathematics, developed by Recruit and a questionnaire survey. Students take an achievement test, and after about three months, take an achievement test of the same contents. By performing the achievement tests twice, it is possible to analyze the change in result for each unit due to the presence or absence of handling in the class. The unit of mathematics is (i) numbers and expressions, (ii) data analysis, (iii) quadratic functions, (iv) figures, (v) probabilities, (vi) complex number, (vii) trigonometric function, (viii) figures and equations, (ix) exponent function, (x) derivation and integration, (xi) vector. They include units learned in first year, units study in the second year during first semester from April to August, and units study in the second year during second semester from October to February. Because the contents of the achievement test are also compatible with the goals of the model core curriculum for KOSEN, the National Institute of Technology, Japan, the achievement test is suitable as one of the evaluations for KOSEN students. In addition to the achievement test, questionnaire survey was conducted on daily learning time and use of contents etc. The following are the details of program in FY2018 and FY2019.

Program in FY2018
・Meeting regarding installation of Study Sapuri in June.
・Questionnaire survey in July.
・First achievement test and Questionnaire survey in August.
・Second achievement test and Questionnaire survey in December.

Program in FY2019
・Meeting regarding installation of Study Sapuri, comprehension questionnaire survey, first achievement test and self-marking in April.
・Review and motivation in June.
・ Comprehension questionnaire survey, first achievement test and self-marking in April.
・ Comprehension questionnaire survey, third achievement test that differ from first and second tests and self-marking in July.
・ Comprehension questionnaire survey, forth achievement test that is the same test as third and self-marking in December.

Results

In the FY2018, the percentage of correct answers of the results for the second test was slightly higher than that of the first test in most units. Fig.1 shows the increase rate of percentage of correct answers for each unit of the second test compared with the results of the first one. Here, the units of (vii) trigonometric function, (viii) figures and equations and (ix) exponent function are excluded from comparison because they have a small number of problems. As can be seen from Fig.1, the increase rate of (i) decreases slightly, and the increase rate of (ii) to (x) increases. The unit of (i) to (x) are not handling in mathematics classes. These increases cannot be concluded due to “self-paced learning” using contents because the increase rate is very small, the achievement test is the same contents and the influence of the handling of mathematics in other classes. As compared with these units, the increase rate of (xi) is large. Because this unit is handled in the class in second semester, it seems to be a learning result toward the goal of the regular test.

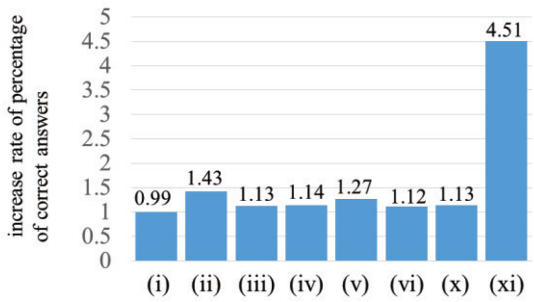


Fig1. Increase rate of percentage of correct answers by units. (i) numbers and expressions, (ii) data analysis, (iii) quadratic functions, (iv) figures, (v) probabilities, (vi) complex number, (x) derivation and integration, (xi) vector.

In addition, the answers obtained by the questionnaire survey conducted after the achievement test are shown below.

Q1. Is Study Sapuri useful for everyday study?

A. I can learn from the basics.
A. I can review where I did not understand in class.
A. It can be used for review at home.
A. It is difficult to use because of difference from the class content.

Q2. Was it useful for the regular exam?

A. I was able to review where I did not understand.
A. I'm glad I could see videos repeatedly.
A. Textbook was enough to learn.
A. It took a long time to search for a video.

Q3. How can you use more?

A. If it becomes easy to find the unit, I want to see.
A. Strengthen connection with classes.
A. Clarify goals.

Because the answers that it is easy to review at everywhere from these questionnaire results was obtained, it can be expected that the Study Sapuri functioned sufficiently as the content for "self-paced learning". However, the results of the achievement test cannot show the results of "self-paced learning". It is thought that these results are caused by the low motivation about the learned unit. In order to improve it, it is important to make them aware that they have forgotten even the learned units they have already studied and to motivate for the units not handling in classes with strong efforts from the academic staff. It was concluded that the purpose and increasing awareness of the units other than the units of regular exam were important. Based on FY2018 in FY2019, self-marking after the achievement test was adopted in this program. The purpose of self-marking is to make sure that students does not forget the learned unit and to understand which items students should learn with content such as textbooks and Study Sapuri. It is considered to take a comprehension questionnaire for each unit and compare with the results of the achievement test. In addition, since the decrease in the use of the content by students was seen from the beginning of May, we made the students set learning goals for motivating themselves in June. As a guideline for setting learning goal, the average score of the achievement in other school was conveyed to students in order to recognize their score objectively. To motivate the students, they decided on which unit they should review to achieve their goals. In addition, we provided an opportunity to convey the messages from member of society about the significance of learning math. It may be possible to maintain and improve the motivation for the forgotten unit and the unit which is not handling in class by aiming an essential goal for learning that is different from the regular exam. As a result, there was a rising trend in content usage after goal setting. In order not to make this trend temporary, it is important to make a habit of learning into the students by continuously suggest from the academic staff.

Conclusions

This program aimed at the construction of "self-paced learning" system by the utilization that combined the study support content by online service and the achievement test. The achievement test was conducted as one of the results of the program, it was not possible to confirm the significant difference in the change in achievement due to the using content. However, it is important to set the learning goal by students with the academic staff support in order to maintain the motivation of everyday study, because some students use it when their goals such as regular exams are clear.The program is still in the works and will be analyzed.

Acknowledgements

The authors would like to thank ©Recruit Marketing Partners Co., Ltd. for assistance with using “Study Sapuri”, collection of data and analysis in the achievement test.

Competition-Driven Learning for IoT Talents

Arthur T. T. Yu *,a and Frankie Y. C. Leung[b]

[a] Department of Engineering, Hong Kong Institute of Vocational Education (Haking Wong), Hong Kong SAR
[b] Department of Engineering, Hong Kong Institute of Vocational Education (Tuen Mun), Hong Kong SAR

*ttyu@vtc.edu.hk

Abstract

Smart City Blueprint for Hong Kong was proposed by the Office of the Government Chief Information Officer (OGCIO) of the Government of the Hong Kong SAR from a report of consultancy study released in 2017 under the Policy Address. The Blueprint covers six major areas includes 'Smart People', 'Smart Living', 'Smart Environment', 'Smart Mobility', 'Smart Government' and 'Smart Economy'; whereas Smart People always comes first priory. The Hong Kong Institute of Vocational Education (IVE) Engineering Discipline under Vocational Training Council (VTC) aims at cultivating engineering and technology talents to encounter a competitive and collaborative environment.

Internet-of-Things (IoT) is one of the main themes under the Smart City. Thousands of millions of IoT applications have been developing at an exponential growth rate. To nurture IoT talents fit and fulfil the tremendous demand, a Competition-Driven learning pedagogy (CDLP) is. The main objective of the CDLP is to stimulate the learning process in the IoT profession in a competition environment beyond the classroom, to consolidate both theoretical and practical hands-on skills. The paper highlights the current curriculum based on Project-Based Learning and Design Thinking Process, supplement with brief introduction of student competition, then presents the result of the students' learning outcomes and a survey conducted on students participating in the CDLP. The learning outcomes clearly shows that students under CDLP is higher than others; and the survey result indicates that the students' appreciation for learning on CDLP base on the teamwork and project management skills. This paper finally elaborates the way-forward of involvement of industrial stakeholders.

Keywords: *Smart City Blueprint for Hong Kong, Smart People, Competition-Driven Learning Pedagogy, Project-Based Learning, Design Thinking Process*

Introduction and Background

Building up a Smart City was initiated by the Hong Kong SAR Government in December 2017 covering six major areas includes 'Smart People', 'Smart Living', 'Smart Environment', 'Smart Mobility', 'Smart Government' and 'Smart Economy'; whereas Smart People always comes first priory. Based on the Blueprint, the Fifth generation (5G) mobile networks are the catalyst for smart city development, offering ultra-high speed and high capacity, supporting device-to-device ultra-reliable/low latency communications, and enabling massive machine-to-machine communications for better implementation of Internet of Things (IoT). Hong Kong is all geared up for the commercial launch of 5G services and applications in 2020. (Smart City Blueprint, 2017)

Figure 1. Data collection by smart lampposts help people access information on the weather and air quality at their destination (HKSAR News, 2018)

HKSAR Government has been working closely with industry leaders shown in Figure 1, including Siemens HK to develop the pilot Smart Lampposts with IoT applications covering environmental, health, transportation-related sensors. The collection of massive data helps the government to formulate the policies and measures in taking care of public's awareness and concern. (HKSAR News, 2018)

The Hong Kong Institute of Vocational Education (IVE) Engineering Discipline under Vocational Training Council (VTC) aims at cultivating engineering and technology talents to encounter a competitive and collaborative environment. IVE Engineering first hosted the Secondary School IoT Design Competition in 2017 for local secondary school students to encourage them to in the field of IoT. (IVE Engineering, 2017)

IVE Engineering hoisted the four-day International Symposium on Advances in Technology Education (ISATE) which put heads together to explore talent nurturing for developing smart cities. There were educators of higher education institutions and industry from the Mainland, Japan, Singapore and Finland joined the event. (ISATE, 2018)

In addition, IVE Engineering have been building the IoT Innovation & Technology Centre equipped with latest IoT - compliant software and equipment to support application development and industrial collaboration on realizing “Things”, “Sensors” & "Internet" integration in stimulating learning, and promote Smart City and Industry 4.0 development. (IVE Engineering, 2018)

To nurture IoT talents fit and fulfil the tremendous demand, a Competition-Driven learning pedagogy (CDLP) is proposed for students via Ubiquitous learning first proposed for Higher Education Revolution (Zhang, 2012) from Higher Diploma in Computer Engineering. The main objective of the CDLP is to stimulate the learning process in the IoT profession in a competition environment beyond the classroom, to consolidate both theoretical and practical hands-on skills.

Competition-Driven Learning Pedagogy (CDLP)

The current curriculum of Higher Diploma in Computer Engineering is based on Project-Based Learning and Design Thinking Process, supplement with brief introduction of student competition. Internet-of-Things (IoT) Engineering (Module Code: EEE4218) is one of the elective modules of Higher Diploma in Computer Engineering for senior (Year 2) students. The contact hours and self-study hours of EEE4218 are 52 hours and 88 hours respectively. The module covers the essential parts of the IoT connectivity, sensors, cloud services, design and implementation of IoT real-life applications.

Table 1 Assessments of EEE4218

Assessment	CA/EA	Weighting
Test	CA	20%
Assignment	CA	15%
Lab	CA	15%
Project	EA	50%

Students are required to build their own IoT project as the End-of-Assessments (EA) which is equivalent to 50% of the module marks shown in Table 1. In addition, students were given Continuous Assessments (CA) including but not limited to Test, Assignment and Lab work for introduction of IoT sensors and connectivity. A small class of 16 students was chosen in AY2018/19 as an illustrative example.

Bogdanovic proposed that a platform of learning IoT included a three-layer model of infrastructure layers: Device Layer, Service Layer and App Layer. (Bogdanovic, 2014)

Kurkovsky and Williams further enhanced to a four-layer model: Sensing (Device) Layer, Access Layer, Service Layer and Interface (App) Layer. The additional Access Layer referred to the collection and transmission of data. Kurkovsky and Williams concluded that Arduino was good for IoT Projects but Raspberry Pi was even better platform as it is capable of implementing all four layers of functionality on the device itself (Kurovsky and Williams, 2017). For hardware configuration of EEE4218 in class, both Arduino board and Raspberry Pi board were given to students to select for their own IoT projects.

Khanna proposed that the dynamics of learning alliances: competition, cooperation, and relative scope. He proved that by first setup the relative scope for a learning alliance, common benefits then formed, and eventually induced both cooperative and competitive behaviours (Khanna, 1998). In EEE4218, Teamwork (cooperation) and Presentation (in-class) were grouped and prepared within their own IoT project.

Chang introduced even-driven learning supported by a three-stage learning strategy: (1) Goal setting stage, (2) Preparing stage and (3) Participation stage. He held two English assessment competition activities in Taiwan, as an event-driven, to motivate students’ learning outcomes (Chang, 2002). Instead of just completing in-class assessments of EEE4218, a Competition-Driven Learning Pedagogy (CDLP) was proposed to all students; while 8 out of 16 students opted to take their extra effort in advocating their own IoT projects to attend a local student competition after the completion of the module. Students with CDLP were event-driven with three-stage learning strategy for goal-setting, preparing and participating not only during EEE4218 Term Time but also afterwards for the competition (ultimate event).

CDLP was divided into two phases. Phase I of CDLP as shown in Table 2 involved a team of two senior (Year 2) students to completing the IoT product during first 13-week Term Time taking the elective module EEE4218 from September to mid-December 2018. Phase II of CDLP as shown in Table 3 involved two additional junior (Year 1) students to support senior students to review and repackage the product from mid-December 2018 to mid-March 2019. The senior students were the mentors to teach the junior students what they have learnt in EEE4218 IoT Engineering.

Table 2. Phase I of CDLP

Phase I of CDLP	
Trainer	One Lecturer specialising in IoT
Trainee	8 Higher Diploma (HD) Year 2 students taking IoT Engineering as elective module from campus majoring in Computer Engineering
Period	September to mid-December 2018
Mode	Face to face lecture/tutorial weekly and connected by instant messengers.
Outcomes	To equip the HD students the subject knowledge in IoT as well as project management skills via Project-Based Learning and Design Thinking process. Prototypes are collected to be accessed for module marks of End-of-Assessment of EEE4218

Table 3. Phase II of CDLP

Phase II of CDLP	
Trainers	8 Higher Diploma (HD) Year 2 students taking IoT Engineering as elective modules from campus majoring in Computer Engineering
Trainees	8 Higher Diploma (HD) Year 1 students from same campus majoring in Computer Engineering
Period	mid-December 2018 to mid-March 2019
Mode	Student peer tutoring after classes
Outcomes	To help the junior students to go through the Project-Based Learning and Design Thinking process via a successful projects and refine the prototype for local competition outside campus

Students were initiated to Project-Based Learning (PBL) which is a student-centred education pedagogy that involves a dynamic approach to allow students deeper and more active exploration of real-life. Students needed to design their project from discovering real-life problem, proposal, literature review, prototype design and review. PBL encouraged students to match their skillsets with the exploration of problem facing. During the process of PBL, students were also encouraged to adopt Design Thinking which refers to the cognitive, strategic and practical processes by which design concepts are developed by designers and/or design teams. An example of the winning team, titled "Smart Parking Metre", is listed in Table 4 for illustration:

Table 4. Design Thinking employed for winning team titled "Smart Parking Metre"

Stage	Design Thinking Process	An example for illustration
I	Empathise	Students reflected that their parents always have difficulties in parking on HK streets during lunch or dinner times because they need to recharge the Government Parking Metre by hand in person every 2 hours, so they cannot enjoy lunch/dinner with families.
II	Define	Students were encouraged to discuss and define their own problem based on their empathy. They decided to build a Smart Parking Metre to resolve the scenario.
III	Ideate	Students were free to propose ideas or designs of their own Smart Parking Metre.
IV	Prototype	After the prototype design confirmed, all specifications and functions were listed with schedule of time management and resources needed. Prototype is
V	Test	The prototype was tested both hardware and software parts in order to ensure all functions running smoothly.

Learning and Teaching did not stop after the completion of the EEE4218 at Phase I of CDLP. The two senior (Year 2) students then leaded and trained two junior (Year 1) students without IoT background at Phase II of CDLP to prepare them for the local student competition: Hong Kong Institution of Engineers (HKIE) Electronics Project Competition 2019 (HKEPC, 2019) held by HKIE Electronics Division.

The new team formed went through the PBL and Design Thinking process again to refine their prototype and presentation to appeal the judging panel of Hong Kong Institution of Engineers (HKIE) Electronics Project Competition 2019.

As a result, eight senior students paired up with eight junior students to form four teams to attend the captioned competition. Products photos of one of the winning team of Smart Parking Metre after Phase I (for EEE4218 module assessments) and Phase II (for local competition) of CDLP are shown in Figure 2 and 3 respectively.

Figure 2. Product photo after Phase I of CDLP

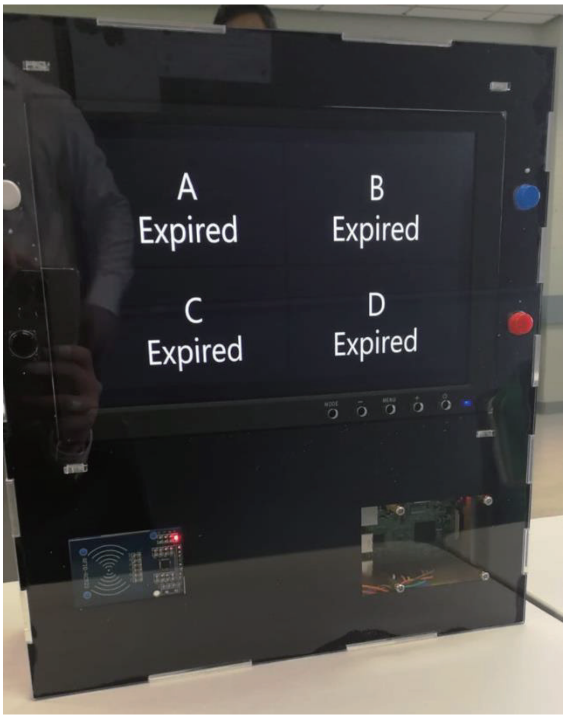


Figure 3. Product photo after Phase II of CDLP

Findings and Results

The module grades reflecting students' performances of EEE4218 were presented in Chart 1 (without CDLP) and Chart 2 (with CDLP). The performance with CDLP (eight out of sixteen students) is generally higher than ones without CDLP. Normal students without CDLP contributed 33.3% of B/B- at maximum; while, in contrast, students with CDLP performed A/B which has contributed 50% of the same class. Obviously, CDLP could enhance students' learning outcomes with greater motivation and stronger goal of participants. Students with CDLP found to archive higher bands of grades.

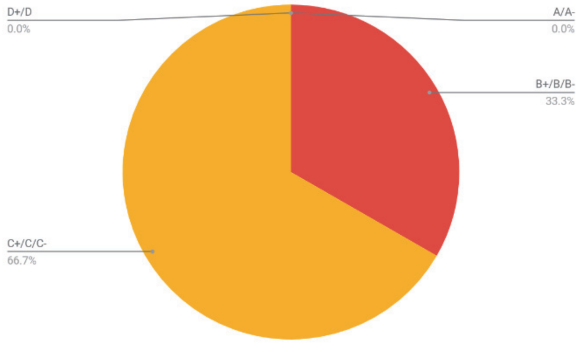


Chart 1. Performance of students without CDLP

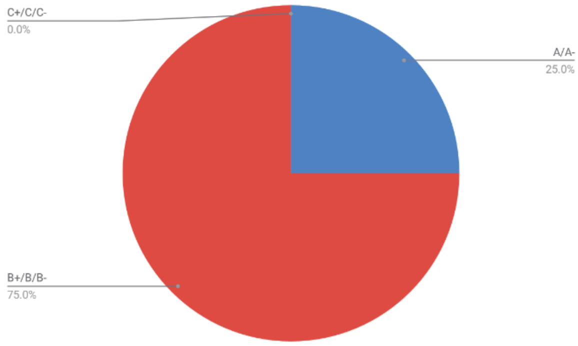


Chart 2. Performance of students with CDLP

In addition, a survey of four core capabilities: *teamwork*, *project management skills*, *problem solving skills* and *communication skills*, was conducted of all 8 participating senior students to quantify their perceptions before and after CDLP (including mentoring the junior students). The lowest score was 1.0 and the maximum score was 5.0.

The survey result in Chart 3 indicated that the students' significant appreciation for learning on CDLP based on teamwork (from 2.63 to 4.75 with 80.6% increment) and communication skills (from 2.25 to 4.5 with 100.0% increment). Nevertheless, project management skills and problem solving skills had 42.3% and 54.5% increment. The CDLP approach helped students to build up a positive impact on all four core capabilities, especially Teamwork and Communication skills, which are fundamental and essential for engineering profession and management after graduation.

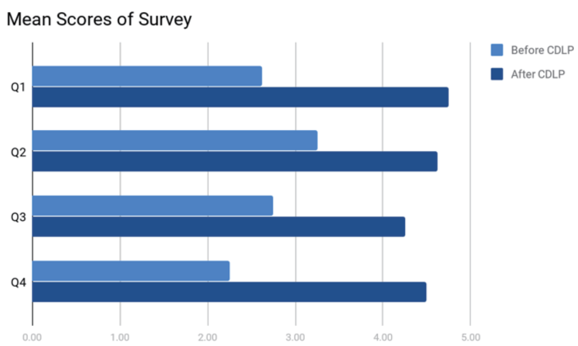


Chart 3. Mean Scores of Survey before and after CDLP (*Q1. Teamwork; Q2 Project Management Skills; Q3 Problem Solving Skills; Q4 Communication Skills*)

For the four teams (eight senior students + eight junior students) attending the competition, two teams had successfully entered the Final Round and one team was awarded the Second Runner Up of the Tertiary Education Sector in HKEPC2019. A photo of the winning team is shown in Figure 4.

Figure 4. Photo of the team awarded Second Runner-up in HKEPC2019

Conclusions

The learning outcomes clearly shows that students under CDLP is higher than others; and the survey result indicates that the students' appreciation for learning on CDLP base on the teamwork and project management skills. CDLP should be suitable for all modules consists of PBL and Design Thinking Process. The participating class was a small class of 16 students; however, additional resources are required to the facilitators to assist students based on Project-Based Learning using Design Thinking.

References

OGCIO (December 2017). *Smart City Blueprint*. Retrieved from http://www.smartcity.gov.hk.

HKSAR News (7th October 2018). *Lighting up a Smart City*. Retrieved from http:// https://www.news.gov.hk/eng/2018/10/20181004/20181004_155008_424.html.

IVE Engineering (29th April 2017). *Secondary School IoT Design Competition 2017*. Retrieved from http:// http://engineering.vtc.edu.hk/en/PastHighlightsOthersDetails.php?EDLDID=53.

IVE Engineering (2018). *ISATE 2018*. Retrieved from https://isate2018.vtc.edu.hk.

IVE Engineering (2019). *IoT Innovation & Technology Centre*. Retrieved from http://engineering.vtc.edu.hk/en/NewTeachingFacilites.php.

Tianbo, Z. (2012, November). The internet of things promoting higher education revolution. In *2012 Fourth International Conference on Multimedia Information Networking and Security*(pp. 790-793). IEEE.

Bogdanovic, Z., Simic, K., Milutinovic, M., Radenkovic, B., & Despotovic-Zrakic, M. (2014). *A Platform for Learning Internet of Things*. International Association for the Development of the Information Society.

Kurkovsky, S., & Williams, C. (2017, June). Raspberry Pi as a platform for the Internet of things projects: Experiences and lessons. In *Proceedings of the 2017 ACM Conference on Innovation and Technology in Computer Science Education* (pp. 64-69). ACM.

Khanna, T., Gulati, R., & Nohria, N. (1998). The dynamics of learning alliances: Competition, cooperation, and relative scope. *Strategic management journal*, *19*(3), 193-210.

Chang, S. B., Liang, J. K., Wang, H. Y., Liu, T. C., Yang, J. C., & Chan, T. W. (2002, December). A learning strategy of the across-classroom competition supported for event-driven learning. In *International Conference on Computers in Education, 2002. Proceedings.* (pp. 264-265). IEEE.

HKIE Electronics Division (April 2019). *Hong Kong Electronics Project Competition 2019 (HKEPC2019) "Innovation For Tomorrow"*. Retrieved from http:// http://en.hkie.org.hk/.

DEVELOPMENT of an EDUCATIONAL SYSTEM to PROVIDE for VIRTUAL LABYRINTHINE STREETS BASED on LINES DRAWN ON a PAPER

S. Tokutake[a], T. Ando[a], Y. Shimazaki[a], I. Takemoto[b], H. Tenzou[a], K. Yokoyama[b], Y. Kunimi[b] and C. Mouri[*c]

[a] National Institute of Technology, Kagawa College/Department of Electronic Systems Engineering, Japan
[b] National Institute of Technology, Kagawa College/Advanced Course in Electronic, Information and Communication Engineering, Japan
[c] National Institute of Technology, Kagawa College/Technical Education Support Center, Japan

*mouri@da.kagawa-nct.ac.jp

Abstract

The purpose of this study is to develop an interactive educational system for providing virtual space based on a maze drawn on a paper by players. The system needs a pre-processing to create the virtual labyrinthine. As the first step, the learner draws a maze by himself. The paper is scanned and converted to a digital graphic file. As the second step, the handwritten lines on the paper are automatically recognized as three dimensional virtual walls in the virtual labyrinthine by using image recognition technology. Each learner can go toward a goal of labyrinthine streets drawn by themselves in virtual space. The learner can access to the virtual space by using the head mounted display system and an Oculus Rift. The learners can arrange some monsters on the virtual streets to enhance their motivations toward to their goals. It was demonstrated that the system can create the virtual labyrinthine streets and the user can go toward a goal through labyrinthine streets. In this study, virtual enemies are reproduced in the virtual world to enhance the motivation to aim the goals. As the result, the interactive educational system enables learners to fight a brave battle against enemies with aiming the goal.

Keywords: *virtual reality, virtual labyrinthine streets, educational system, handwritten*

Introduction

In order to cultivate creativity plays with painting or clay are some of the conventional education methods used in primary school lessons.

Children handwrite objects in their imagination and they can concentrate for these creating tasks for a long time. Maze play is one of them. The purpose of this study is to develop an interactive educational system for providing a virtual space based on mazes drawn on a paper by the children themselves.

System Overview

The system overview is shown in Fig.1. The system needs a pre-processing to create the virtual labyrinthine. As the first step, the learner draws a maze on an A4 size paper. The paper is scanned and converted to a digital graphic file. As the second step, the handwritten lines on the paper are automatically recognized as three dimensional virtual walls in the virtual labyrinthine by using image recognition technology. As the final step, the output file is written into a HD. The output file is ready to play in the virtual labyrinthine streets. Each learner can go toward a goal in labyrinthine streets

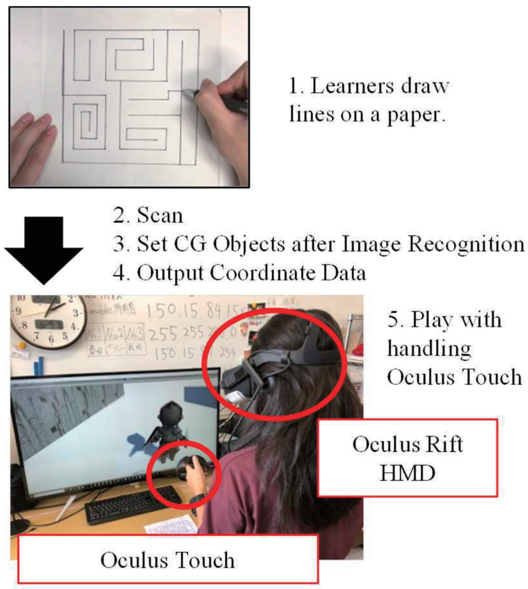


Figure 1. System Overview

drawn by themselves in the virtual space. The gaming engine Unity enables learners to walk through the virtual space. The learner can access the virtual space using the head mounted display system. The learners can arrange monsters on the virtual streets to enhance their motivation toward the goals. With the Oculus Touch, the learner can swing their arms and attack the monsters.

It was demonstrated that the system can create the virtual labyrinthine streets and the user can go toward a goal in labyrinthine streets by using an Oculus Rift cv1. In this study, virtual enemies are placed in the virtual world to enhance the motivation to aim the goals. The system is composed of a virtual reality head mounted display "Oculus Rift" (Oculus Rift 2018), a pair of Oculus Touch, and a Windows PC. A DELL ALIENWARE Area-51 15Q42 and the graphic board GeForce GTX 1080 Ti GAMING X 11G were selected to create and draw 3DCG objects in real time. Oculus Touch was used to manage both the movement of the learner and the line of sight in virtual world. The system was implemented by using Unity version 2018.1.0f2 (Unity 2018). The code was written in C# language. Unity is a useful game engine in order to create a virtual reality space.

Demonstrations

Figure 2 shows the result of image recognition for the sample handwritten-maze in Fig.1. Using the processing interface tool, the learner can set CG objects and positions of both the start and the goal on the maze map. Figure 3 is a sample of the created VR space based on Fig. 2. After recognizing the walls, the player set at the start position and the goal in the virtual world. The learner can see Omni directionally with changing the head direction and can walk with handling the Oculus Touch. The learner can also attack any monsters by the act of cutting with the Oculus Touch. The monsters automatically come up with the player with in a attach area as is shown in Fig. 4. If a monsters catch up with the player, the monster attacks the player and the player is damaged.

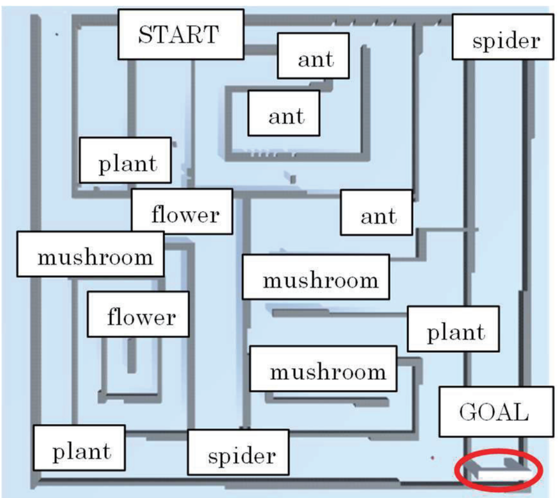


Figure 2 A Result of Image Recognition for a Sample Handwritten-Maze

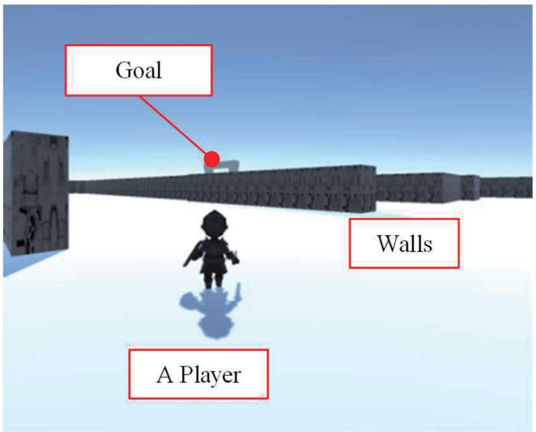


Figure 3 A Sample of a Created VR Space

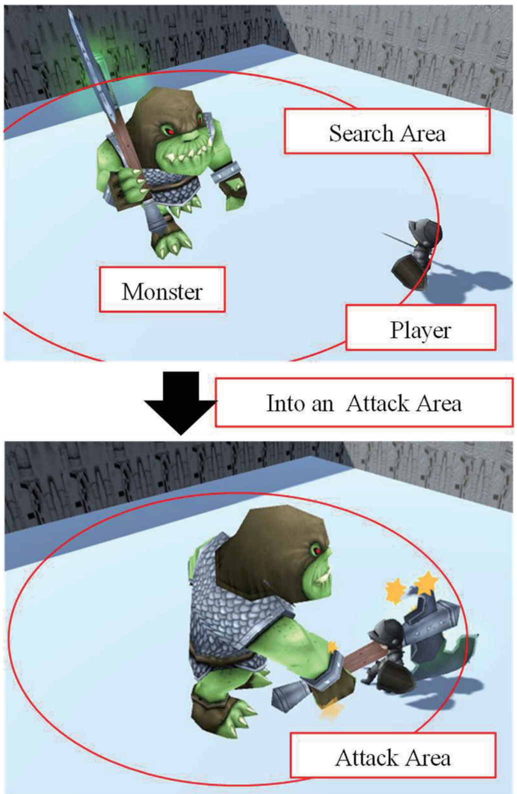


Figure 4 Works of Each Enemy

Conclusions

This study demonstrated that a virtual labyrinthine of streets could be created from the user drawings. And the user can proceed through the labyrinthine of streets towards a settled goal. The learner can access to the virtual space by using a head mounted display system and an Oculus Rift. In this study, virtual enemies are placed in the virtual world to enhance the user motivation to aim the goals. As the result, the interactive educational system enables learners to fight a brave battle against enemies while aiming the goal.

Acknowledgements
This work was supported by JSPS KAKENHI Grant Number JP18H00171.

References

https://www.oculus.com/

Learning Outcomes for Sustainable Development

A PROPOSAL OF A STUDENTS' VOLUNTARY IMPROVEMENT CYCLE METHOD BY VISUALIZATION OF GENERIC SKILLS

K. Kawasaki[*,a], H. Kobayashi[a], Y. Kubota[a] and K. Yajima[a]

[a] Department of General Engineering, National Institute of Technology, Sendai College (Sendai KOSEN), Sendai, Japan

*E-Mail kawasaki@sendai-nct.ac.jp

Abstract

The graduates of National Institutes of Technology are expected to have acquired not only technical skills but also Generic Skills (GSs), which are abilities to comprehensively adjust to society. It is difficult to assess GSs because they cannot be evaluated by examinations based on knowledge retention such as mathematical examinations. Furthermore, it is also difficult for students to recognize their own GSs levels.

From the results of PROG, students can learn the objectively evaluated scores regarding their GSs, and it is possible to clarify which abilities they should improve in school life. Furthermore, our college uses the results of Progress Report on Generic Skills (PROG) [1] for faculty development to realize class improvement.

As an analysis of PROG results, 1) the 5-year comparative survey from 1st year students to 5th year students in the same year and 2) the follow-up survey of the same students from their 1st years to 5th years were carried out. From those two surveys of 1) and 2), our students' GSs are observed to have grown in both literacy and competency as they grow older. In the survey 1), the literacy grew fast up to their 3rd year, and the competency grew up in and after their 4rd year. In the survey 2), on the other hand, literacy and competency grew at roughly constant rates. From the results of two surveys, a growth tendency in the students' GSs from admission to graduation in our college became clear.

In this paper, we will report the growth characteristics of GSs from students' admission to graduation. In addition, as for utilization of PROG results, we will propose a students' voluntary improvement cycle method by visualization of Generic Skills combining our college's learning-achievement-record system and PROG results.

Keywords: *Quantitative evaluation of Generic Skills, Utilizations of PROG, Voluntary feedback by the students themselves*

Introduction

Sendai KOSEN [2] is a National Institute of Technology located at Sendai, Miyagi, and consists of two campuses, Hirose and Natori. In Sendai KOSEN, high-quality engineering education is provided. In Hirose Campus, which consists of three departments: Information Systems, Information and Telecommunication Systems, and Intelligent and Electronics Systems, especially, we provide high-quality and high-level education on information technology.

With the rapid development of ICT, diversity and complexity of society is increasing, and the changing speed of social infrastructure is becoming faster. Under such circumstances, in addition to the expertise and technical skills acquired at colleges and universities, it is important to nurture students with GSs, consisting of fundamental competencies and literacy skills to make good use of their expertise and skills. The reformation program of educational environment at Sendai KOSEN [3] was adopted as an Acceleration Program for University Education Rebuilding (AP) [4] in 2014, and it was a driving force to tackle the nurturing and evaluating of students' GSs in addition to the education of information technology.

A continuous survey of students' GSs starting from academic year of 2014 has been conducted for 5 years. This means that the survey from students' admission to their graduation at Sendai KOSEN has been completed and the results clarified our students' growth characteristics of GSs in the educational curriculum at Sendai KOSEN. In this paper, we first report the GSs growth characteristics of Hirose Campus students. For the utilization of the evaluation results of the GSs survey, furthermore, we propose the "students' voluntary improvement cycle method of GSs" as a method to encourage students to effectively develop their GSs.

Objective Evaluation of Generic Skills

In order to quantify GSs, there are two representative methods, that is, direct evaluation by teachers and students using rubrics, and indirect evaluation using external assessments. We have conducted a five-year continuous survey of our college students' Generic Skills using PROG, which is an assessment of GSs. PROG is an objective test, so we can use it to compare the scores of an examinee with an average score of all examinees. It means that the examinees can recognize their own strong/weak points by comparing their scores to the average scores of their classmates at school (and also to those of other university students). An outline of PROG is described below.

The PROG test was originally developed by KAWAI-JUKU [5] and the test consists of two parts: the Literacy part, which evaluates the examinee's ability to apply knowledge to solve new or inexperienced problems, and the Competency part, which evaluates the examinee's coping abilities with their surroundings, including decision making or action principle characteristics. Evaluation components of PROG test were defined by reference to key-competencies determined by DeSeCo project [6] of OECD. The evaluation contents of the Literacy part were classified into six categories, and those of the Competency part were classified into three categories that consist of 9 contents and 33 components.

The questions of the Literacy part are similar to those of Synthetic Personality Inventory (SPI) [7], while, in the Competency part, a number of questions are given in a questionnaire format, to examine the characteristics of the examinee's behaviors. The scores of components in the Competency part were evaluated, by comparing the answers of the examinees with statistically processed exemplary answers from many Japanese businesspersons who were classified into the high level. The scores of PROG test are quantified with values from 1 to 7 (or 5, depending on the components), indicating that larger numbers are better results.

Results (Growth Characteristics of Generic Skills)

Table 1 indicates the grades of students who took the PROG in each academic year. A continuous survey of students' GSs started from the academic year of 2014 and five years have passed since then. Now we can assess how the students' GSs changes as their grade progresses in Sendai KOSEN, Hirose Campus.

Figure 1 shows yearly changes of overall scores of Literacy and Competency parts for the follow-up survey of the same students from their 1st year to 5th year (line which colored pink in Table 1). It is obvious from Fig. 1 that their abilities of both Literacy and Competency steadily grew with the progress of their grade. However, the Competency scores did not increase in one year from 2nd to 3rd grade, and the Literacy ones also did not increase in one year from 3rd to 4th grade.

On the other hand, Figure 2 shows yearly changes of overall scores of Literacy and Competency parts for the 5-year comparative survey from 1st year students to 5th year students in the same year 2018 (line which colored light blue in Table 1). For the Literacy part, their abilities strongly grew in two years from 1st to 3rd grade, while their abilities did not show strong growth in two years from 3rd to 5th grade. For the Competency part, in contrast, it shows strong growth in upper grades, while it does little in lower grades. It was found out that for our students in Hirose Campus, the Literacy abilities grew first until 3rd grade, and the Competency abilities grew after the 3rd grade.

Table 1. The grades of students who took the PROG test in each year

Grade	Academic Year 2014	2015	2016	2017	2018
1st	○	○	○	○	○
2nd	○	○	○	○	○
3rd	○	△	○	○	○
4th	○	○	○	○	○
5th	○	△	○	×	○

○ : Students of every department took the PROG test
△ : Only students of some departments took the PROG test
× : Students did not take the PROG test

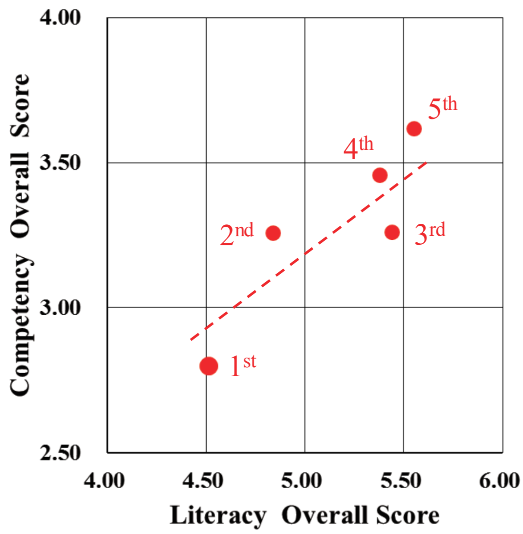


Fig. 1. Yearly changes of overall scores of Literacy and Competency parts for the follow-up survey of the same students from their 1st years to 5th years.

From the results of both the follow-up survey of the same students and the 5-year comparative survey in the same year, it was revealed that the education curriculum at Sendai KOSEN was helping the sufficient growth in both students' literacy and competencies. However, on the other hand, it has become clear that at some grades the students showed little growth in the abilities of the literacy or competency. Since we have clarified the growth characteristics of our students, our future works are the analysis of relation between contents of education

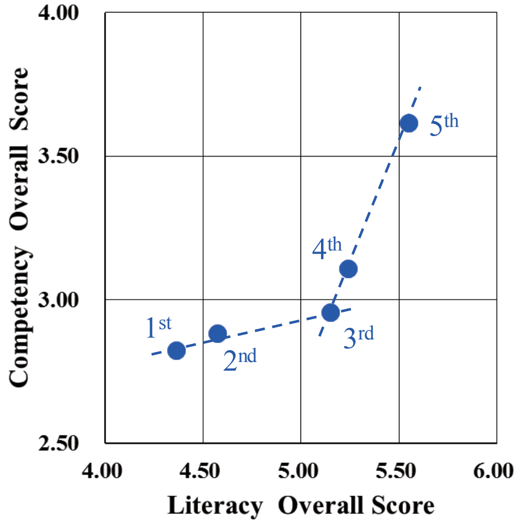


Fig. 2. Yearly changes of overall scores of Literacy and Competency parts for the 5-year comparative survey from 1st year students to 5th year students in the same year 2018.

and the GSs growth characteristics, improvement of the curriculum and lessons.

How to take Advantage of Objective Evaluation Results of Generic Skills (A Proposal of Student' voluntary Improvement Cycle Method)

We will propose "a students' voluntary improvement cycle method of GSs" as a utilizing way of the objective assessment method of GSs. The proposed method is a combined system of our college's learning-achievement-record system and visualized PROG results.

First, we describe our college's learning-achievement-record (LAR) system shown in Figure 3. LAR system is a system in which a student evaluates and records several evaluation items for 1) fundamental knowledge, 2) internationality and ethics, 3) problem solving ability, solution ability and engineering design ability, 4) communication ability and 5) abilities required in their department. Students can recognize how much they have grown by evaluating their own abilities at the beginning and the end of academic year. In addition, students can clarify their goals in each grade by entering them into the system by themselves, and teachers can support the students' growth by commenting on their goals.

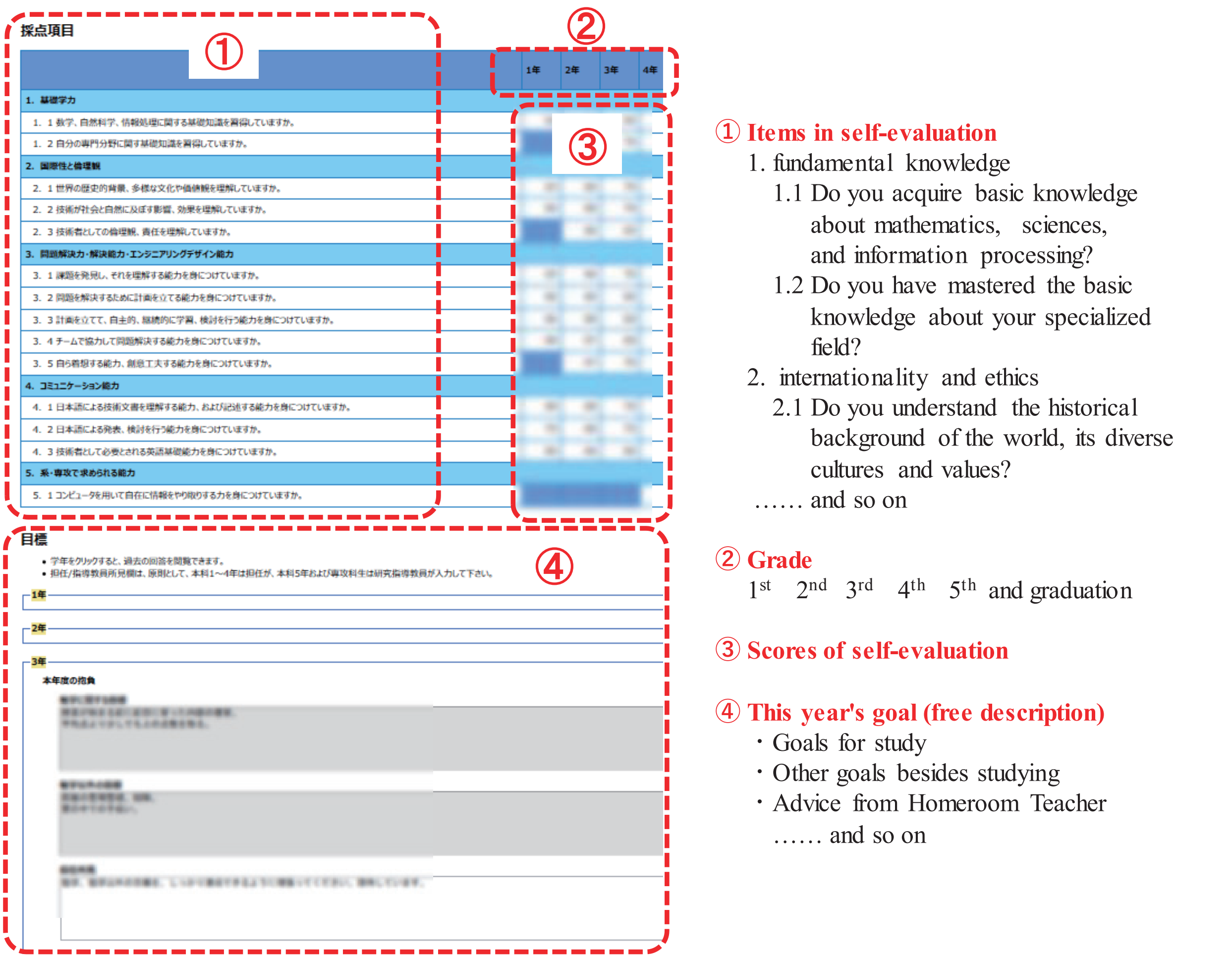


Fig. 3. Our college's learning-achievement-record (LAR) system

By adding input function of PROG scores and graph function of the yearly change of PROG scores to the LAR system, the students can easily recognize their growth because their growth characteristics are visualized as in Figure 4. Furthermore, by adding a function of comparing one's scores with those of other examinees, which is one of the advantages of the objective evaluation method (PROG), the students can compare their scores to the average value of their classmates, students in the same grade and other schools including universities. By visually recognizing their own growth characteristics and comparing their scores with the average value of the students in the same age, they can clearly recognize their strong and weak points. This means that it is difficult for students to accurately recognize their own GSs because GSs indicate the behavioral characteristics and intentions. It is very helpful that, hence, they can recognize the growth of their objectively evaluated GSs and notice their own strong and weak points. Students can recognize their abilities and strengths/weaknesses clearly, and can live daily lives with enhancing their strengths further or improvement of their weaknesses in mind. Such a conscious life is expected to foster GSs more effectively and efficiently than living unaware of them. By repeating the cycle of continuing a conscious life for one year, taking the PROG test, recognizing the growth, and re-setting of their goals in the following year, students will voluntarily improve their lives and realize the GSs growth cycle.

This proposed "a students' voluntary improvement cycle method of GSs" is in specification design phase, and is being developed towards its implementation and operation.

Conclusions

A continuous survey of students' Generic Skills has been conducted since the academic year of 2014 at Sendai KOSEN. Five years have passed since the survey started, and the survey from admission to graduation at Sendai KOSEN has been completed. Our students' growth characteristics of GSs in the educational content at Sendai KOSEN became clear from this five-year continuous survey. It is obvious from the follow-up survey of the same students from their 1st year to 5th year that their abilities of both Literacy and Competency grew steadily with the progress of the grade. On the other hand, from 1st year students to 5th year students in the same year 2018, their abilities of Literacy grew strongly in two years from 1st to 3rd grade, while their abilities of Competency showed strong growth in two years from 3rd to 5th grade.

Furthermore, we propose a "students' voluntary improvement cycle method of GSs" that utilizes the objective evaluation results of the survey. In the proposed method, students will voluntarily realize the GSs growth cycle by repeating the cycle of continuing a conscious

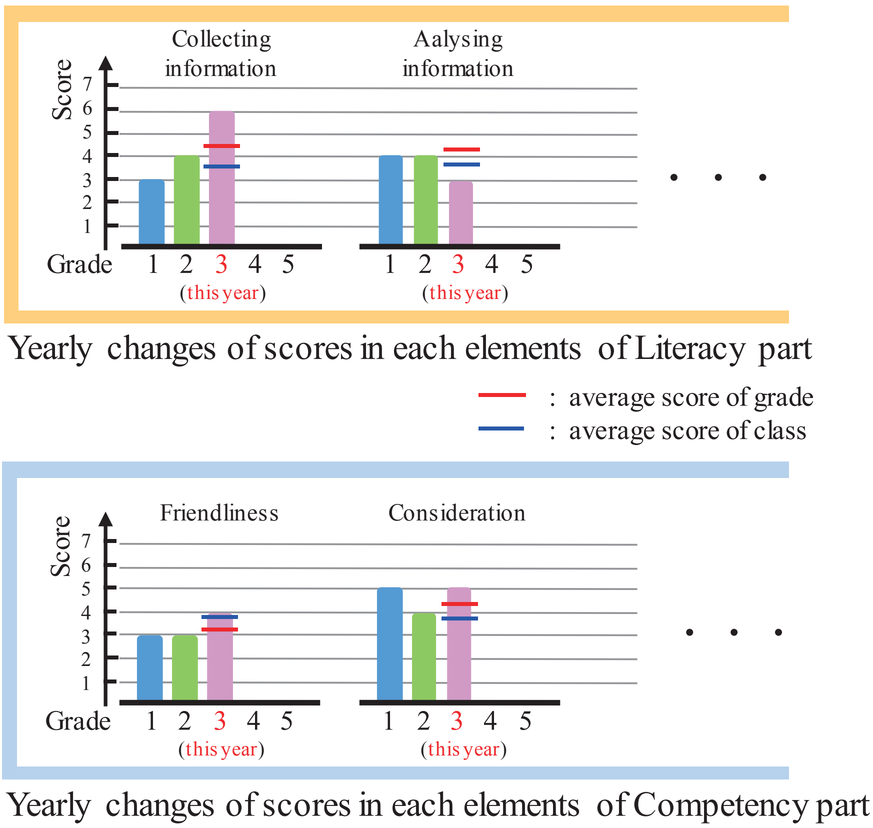


Fig. 4. Image of a students' voluntary growth system of GSs

life for one year, taking the PROG test, recognizing their growth, and re-setting their goals in the following year.

We will tackle the following points as our future tasks. For an improvement of the school curriculum, we analyze in detail the students' growth characteristics and our educational contents, and will realize the improvement of the curriculum and classes. In addition, for a feedback to the students, it is very important to develop and operate the proposed method as soon as possible. Furthermore, it is considered that there is an optimal distribution of GSs in each work content. Therefore, it can be used for career support by analyzing the necessary Generic Skills for each work content and incorporating it into the proposed method.

Acknowledgements

This survey was supported by the Acceleration Program for University Education Rebuilding, Ministry of Education in Japan. We are deeply grateful to the president, teachers and support staff of our college for their contribution to this project. In addition, we appreciate Mr. Kondo at RIASEC Inc. for his helpful cooperation in the analysis of data.

References

[1] About Progress Report on Generic Skills (PROG) test: https://www. kawaijuku.jp/jp/research/prog/ (URL: In Japanese)

[2] About National Institute of Technology, Sendai college (Sendai KOSEN), https://www.sendai-nct.ac.jp/english/ (URL)

[3] A. Takahashi, Y. Kashiwaba, et al: A3 Learning System: Advanced Active and Autonomous Learning System, International Journal of Engineering Pedagogy (iJEP), Vol.6, No.2, pp.52-58 (2016).

[4] About Acceleration Program for University Education Rebuilding (AP): http://www.mext.go.jp/a_menu/koutou/kaikaku/ap / (URL: In Japanese)

[5] About KAWAI-JUKU: http://www.kawai-juku.ac.jp/ (URL: In Japanese)

[6] About DeSeCo Project at OECD: http://www.oecd.org/education/skills-beyondschool/definitionandselectionofcompetenciesdeseco. htm (URL)

[7] About Synthetic Personality Inventory (SPI): https://www.spi.recruit. co.jp/ (URL: In Japanese)

USING THE EVIDENCE-BASED REFLECTIVE PRACTICE TOOL TO ENHANCE PROFESSIONAL PRACTICE

Mark Wan and Chong Siew Kee

Singapore Polytechnic, Singapore

mark_wan@sp.edu.sg | chong_siew_kee@sp.edu.sg

Abstract

This paper documents the experience of a teacher-researcher using an Evidence-Based Reflective Practice Tool (based on the framing of Sale, 2015) that applied an Evidence-Based Teaching (EBT) approach to enhancing specific aspects of the student learning experience (e.g., engagement, self-directed learning) over 2 academic years. It firstly frames EBT in this research context (e.g., the utilization of high effect methods of teaching and the application of cognitive scientific principles to the design and facilitation of learning events). Secondly, it outlines what Evidence-Based Reflective Practice entails, and what differentiates it from the more generic framing of reflective practice in the literature. From this theoretical base, examples of using the tool are presented to illustrate how it has enhanced the design, analysis and evaluation of practice over the two-year long research project. Most importantly, it demonstrates how the use of the tool, with deliberate practice over time, can enable teaching professionals to design and evaluate lessons with greater predictive capability of success outcomes and accurate diagnosis of areas that might require future pedagogic improvements. Finally, while recognizing that no tool (guiding heuristic) can fully capture or accommodate the complex and variable events of classroom interactions and learning, it offers the possibility of enhanced sensory acuity in relation to one's pedagogic decisions-making and, therefore, better inferences and interpretations on how to improve practice.

Keywords: *intrinsic motivation, evidence-based reflective practice, self-directed learning, flipped classroom, evidence-based teaching*

Introduction

The notion that professionals (including teachers) should carefully reflect on their practice; what they actually do as *practice*, on what basis, and the actual impact on stakeholder (e.g., student learning, patients health) makes perfect sense. After all, this is what we would expect professionals to do in any field of practice. Treadwell (2007) makes the big point:

> Our ability to reflect on our own practice underpins all professionals associations. (p. 195)

For example, Evidence-Based Practice has been well documented and developed in medical practice. Sackett (1997) refers to it as:

> the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients.

It is interesting to note that this has not always been the case, as Thomas's (1979) depiction of the medical profession, before the drive for evidence-based practice, starkly illustrates:

> It is hard to conceive of a less scientific enterprise among human endeavours. Virtually anything that could be thought up for treatment was tried out at one time or another, and, once tried, lasted decades or even centuries before being given up. It was, in retrospect, the most frivolous and irresponsible kind of experimentation, based on nothing but trial and error, and usually resulting in precisely that sequence. (p.159)

In the context of teaching, Reflective Practice is not new and owes much to the work of Schön (1983; 1987). Other distinguished writers in the field include Brookfield (1995) and Clouder (2000). However, Hattie (2009) argued that:

> The current penchant for "reflective teaching" too often ignores that such reflection needs to be based on evidence and not post-hoc justification. (p.241)

In reflecting on one's practice, the usefulness of the outcomes in terms of enhanced teaching proficiency and gains in student attainment depend on what constitute the content and processes that are analysed and evaluated in such reflection. In situations where teachers lack a sound understanding of what constitutes effective teaching and learning, there is likely to be little useful diagnosis of a learning event and ways to improve it.

This paper documents the experience of the teacher-researcher in using the approach advocated by Sale

(2015) and a tool he has developed that employs a systematic evidence-based approach to conducting reflective practice. The tool was first used during a 2-year Ministry of Education, Singapore, Tertiary Education Fund research project titled, Enhancing Students Intrinsic Motivation: An Evidence-Based Approach. It is presently being used in a project titled, Enhancing students Self-Directed Learning: An Evidence-Based Approach.

The first part of this paper outlines what constitutes the basis of Evidence-Based Teaching (EBT) and the specific features that differentiate the Evidence-Based Reflective Practice Tool (EBRPT) from less structured approaches. In the second part of the paper, examples of how the tool was used by the first author are presented and analysed in the context of EBT. These will be further calibrated to the student feedback that was collected in tandem with its use. It can be seen that there are *evidence-based* connections between what has been intended in terms of learning outcomes by the teacher, and what the students themselves are actually experiencing. Finally, the paper concludes that the *thoughtful* use of the EBRPT facilitates a heightened diagnostic and predictive capability for learning events in terms of effectiveness (e.g., attainment opportunities, engagement).

Evidence-Based Teaching

It is now firmly established that there is a strong evidence-base relating to how best to design and facilitate the various practices we call *teaching* that can significantly enhance student learning opportunities and attainment levels. This change is an inevitable result of our increasing knowledge relating to how humans learn, what teaching methods and practices work best and why, and an unpacking of what the best teaching practitioners do and how. Much of this significant research on learning has already been documented in the literature (e.g., Bransford, 1999; Marzano, 2007; Mayer & Alexander, 2010; Hattie & Yates, 2014).

Collectively, the research evidence is now providing us with a heightened pedagogic understanding of the various facets of highly effective teaching and, when this is used creatively in context, it will optimize attainment for a wider range of student groups. In most basic terms we can now start to talk about professional practices in teaching from a more validated empirical base, much as we have long done for the more established professions (e.g., medicine and engineering). For example, Darling-Hammond & Bransford (2005), from surveying the research findings, concluded that:

> There are systematic and principled aspects of effective teaching, and there is a base of verifiable evidence of knowledge that supports that work in the sense that it is like engineering or medicine. (p.12)

Willingham (2009) frames this heightened understanding of human learning in terms of 'Cognitive Scientific Principles'. These are universal ways in which the human brain takes in, processes, and uses information to learn effectively. He uses an analogy with engineering to illustrate how this works in practice:

> Principles of physics do not prescribe for a civil engineer exactly how to build a bridge, but they do let him predict how it is likely to perform if he builds it. Similarly, cognitive scientific principles do not prescribe how to teach, but they can help you predict how much your students are likely to learn. If you follow these principles, you maximize the chances that your students will flourish. (p.165)

Similarly, Sale (2015) outlined and illustrated 10 cognitive scientific principles (Core Principles of Learning) that underpin effective learning design and teaching. For brevity in this context, the 10 Core Principles of Learning are only listed (the interested reader can refer to the original text for extended explanation and illustration):

1. Motivational strategies are incorporated into the design of learning experiences
2. Learning goals, objectives and proficiency expectations are clearly visible to learners
3. Learners prior knowledge is activated and connected to new learning
4. Learning is enhanced through multiple methods and presentation modes that engage the range of senses
5. Content is organized around key concepts and principles that are fundamental to understanding the structure of a subject
6. Good thinking promotes the building of understanding
7. Learning design utilizes the working of memory systems
8. The development of expertise requires deliberate practice
9. Assessment is integrated into the learning design to provide quality feedback
10. A psychological climate is created which is success orientated and fun

It is important to fully understand that while each core principle of learning focuses attention on a key area or process relating to how humans learn and the specific implications for planning instruction, they are not discrete or separate in that they should be considered independently of each other. In fact, they are mutually supporting, interdependent and potentially highly synergistic. As Stigler & Hiebert (1999) highlighted:

> Teaching is a system. It is not a loose mixture of individual features thrown together by the teacher. It

works more like a machine, with the parts operating together and reinforcing one another, driving the vehicle forward. (p.75)

Fully calibrated with this heightened understanding of human learning, is the accumulation of extensive empirical research that is uncovering which instructional strategies and teaching methods tend to work best, in terms of advancing student attainment opportunities, and on what basis. Perhaps most publicized in this area is the work of Hattie (2009). Hattie synthesized over 800 meta-analyses of the influences on learning and most significantly, he was interested not just in what factors impacted learning, but the extent of their impact - referred to as *Effect-Size*. Effect size is a way to measure the effectiveness of an intervention to ascertain a measure of both the *improvement* (gain) in learner achievement for a group of learners and the *variation* of learner performances expressed on a standardised scale. By considering both *improvement* and *variation* it provides information to which interventions are worth having. Some examples of effect sizes are provided in Table 1.

Hattie firstly identified the typical effect sizes of schooling without specific interventions, for example, what gains in attainment are we likely to expect over a one-year academic cycle? Typically, for students moving from one year to the next, the average effect size across all students is 0.40. Hence, for Hattie, effect sizes above 0.40 are of interest. As a baseline an effect size of 1.0 is massive and is typically associated with:

- Advancing the learner's achievement by one year
- Improving the rate of learning by 50%
- A two-grade leap in GCSE grades

Table 1: Examples of effect sizes in learner attainment from Hattie's meta-analysis

Influence	**Mean Effect Size**
Feedback Students getting feedback on their work from the teacher, their peers or some other sources. Note: some feedback has more effect than others. For example, peer assessment is 0.63 and self-assessment is 0.54	0.73
Meta-cognitive strategies Students can systematically think about (plan, monitor and evaluate) their own thinking and affective processes (e.g. beliefs, emotions, dispositions) to develop effective learning to learn capability and self-regulation	0.69
Challenging goals Students having a clear frame on, and see purpose in, what they are learning, as well as experience realistic challenge in meeting goal expectations	0.56
Advance organizers Giving students an overview (in an appropriate format and level of understanding) of what is to be learned in advance of the lesson, to help make meaningful connections between their prior knowledge and the new material to be presented.	0.41

However, as Hattie notes, it is important to balance effect size with the level of difficulty of interventions. For example, providing 'advance organizers' (summaries in advance of the teaching) have an effect size of 0.41, which is average, but they only take up a few minutes at the beginning of the lesson, and potentially offer the equivalent of moving up a year in terms of a student's achievement.

He goes on to make relative comparisons of intervention use, which enables us to go beyond identifying the effect sizes for an innovation (deliberative intervention involving strategy/method use for a group of students) and ascertain whether the effects were better for students than what they would achieve if they had received alternative innovations.

Of significance is the fact that it is not just the effect size of one intervention that is important, but how several effective methods can be strategically and creatively combined to produce powerful instructional strategies that significantly impact student attainment. As Hattie (2009) pointed out:

> …some effect sizes are 'Russian dolls' containing more than one strategy. For example, 'Feedback' requires that the student has been given a goal and completed an activity for which the feedback is to be given; 'whole-class interactive teaching' is a strategy that includes 'advance organisers' and feedback and reviews. (p.62)

The Evidence-Based Reflective Practice (EBRP)

As Sale (2015) wrote:

> An evidence-based approach to reflective practice must first and foremost be grounded in the thoughtful application of validated knowledge relating to human learning and what research has established in terms of the most effective teaching practices (i.e. a strong Pedagogic Literacy). (p.181)

What this mean is that both 'reflection on action' and 'reflection in action' (Schön, 1983; 1987), must be based on evidence-based cognitive scientific principles and what teaching methods are most appropriate for enhancing learning opportunities for a given student group, the learning outcomes to be met, and the situated context (e.g., resource availability). Also, EBRP specifically applies critical, creative and metacognitive thinking on the impact of a lesson on student learning, using cognitive scientific principles as the basis for understanding the effectiveness of the various lesson components (e.g., methods employed) and features (e.g. communication style). This enables teaching faculty to frame more valid and useful inferences and interpretations about the lesson and make, as far as is possible, an accurate ***diagnosis*** of their lessons. Teachers should also be better able to ***predict*** the likely outcomes from their lesson planning.

In summary, EBRP employs evidence-based criteria for both:

- the diagnosis of learning events (e.g., lessons, workshops) to identify what has worked effectively and what has not worked so well, and on what basis
- the design and facilitation of learning events that have a high predictive capability of being effective (e.g., attainment opportunities, engagement).

My Evidence-Based Reflective Practice Tool (EBRPT)

The blank template for the EBRPT is contained in Appendix A. In this section, I present my reflection on my use of the tool over the duration of this project. It is to be emphasized that is it not about routine 'form-filling' after every lesson, nor making insertions in all sections. It provides a guiding heuristic for focusing perception and thinking around important elements of the design and facilitation of learning experiences (e.g., methods, activities and specific teacher behaviours). This enables both a better critical appraisal of a lesson, and predictive capability of effectiveness and efficiency in lesson design and planning.

Use of autonomy supportive style strategies (ASS).

I maintained ASS across key focal areas – especially in terms of maintaining the established good rapport. I found out that I must gain the student's trust to make them believe what I am doing is beneficial to them. Sometimes I will invite them to come out to the board and attempt question, I always assure them that we are learning together. I do not mean to pick on them or to embarrass them and I never challenge them even they give the wrong answer. I always use encouraging word like 'good try' to encourage them. Sweet and chocolate are one of the best motivation tools. They love it. I tried to create a psychological climate that is success orientated and fun.

Use of high effect strategies/methods.

I applied a few high effect strategies and found just-in-time teaching and getting frequent feedback from students to be most effective in my case. ICT tools such as Kahoot were also frequently used to engage the students. Kahoot activated the students' prior knowledge when they applied their understanding of the video content to attempt the questions. A lot of educators were mindful about the overuse of Kahoot. When I was recording my observations of Kahoot uses in EBRPT, I found that I have used Kahoot in various ways. For example, I input short video as question instead of plain text. This helped to provide variations in the MCQ and helped students to visualise the questions. I also asked my students to create Kahoot quizzes instead of me setting the MCQ. Sometimes I got my students to play Kahoot in a group setting. This allowed them to learn from each other and the competition helped to stimulate students' motivation and performance. This reminded me to use ICT tools meaningfully to enhance aspects of the learning process and not to use technology for technology's sake. I also need to be innovative in my use of ICT tools.

Collecting feedback through exit poll and WhatsApp helped me to understand my students better and improve on my lesson design. The students will also make use of the exit poll and WhatsApp to ask questions or voice their concerns when they realised you took their feedback seriously and acted on the feedback. For example, they will write down the concepts that they were still unclear about and I will do a video to address that.

Utilizing Core Principles of Learning.

EBRPT has helped me to ensure that I presented and explained the learning goals/outcomes to my students. This part was often overlooked when I was not practising EBRP as I was always racing against time to complete the lessons.

EBRPT also reminded me to activate students' prior learning which may be missed as we often jumped straight into new content. I found that there were good engagement and response to learning activities when students' prior learning were activated. For example, students have learnt the simulation program "Multi-Sim" from last semester. They were competent in using the simulation program to design and build the lab assignment "MOD 24 counter".

EBRPT has also helped to improve my lesson design. The key concepts were explained and illustrated in the online tutorial and reinforced in the practical tasks and related Q&A/ discussion. I also ensured that the learning activities and related discussion provided sufficient variation to maintain a high level of interest and engagement. The learning activities need to be challenging, but achievable in order to result in a high level of behavioural engagement. My observations were that students appeared to show interest throughout, and this was supported by the lively discussion around the key concepts.

The Student learning experience in their own words

This research used a mixed-methods approach, which incorporated a methodological component whereby volunteer students (at least 3 from each class) acted as "co-participants" in the research project. These students took on the responsibility of ongoing dialogue with the research team, which involved:

- 3 meetings with the Principal Investigator and Research Associates
- Chatting to their classmates over the duration of the project as to their key learning experiences
- Keeping personal nots of significant experiences that they felt were important concerning their learning.

The following are the actual transcripts collected by the Principal Investigator and Research Associates for this project.

- So far Mark's classes have been interesting, in the way he talks and acts in class. He always has added humour in the way he teaches, making his lessons not dry.
- Mark teaches by the concept, and not always going into too much specifics and not always by the slide-by-slide presentation. Mark doesn't over elaborate, but he keeps to key concepts, and not too long-winded.
- Mark's teaching style is different – he uses relatable examples, does not beat around the bush. He constantly makes relevant connections between engineering with the students' lives. He also encourages student to ask questions, to a point insisting that students ask questions to ensure they clarify doubts in class.
- Once he starts explaining, Mark explains until students understand, and remains persistent with explanations.
- Students are appreciative that he shows videos for the next lessons to prepare them ahead. When asked if it is enjoyable in class, students largely agree, due to the way he talks – very casual, friendly, humorous.
- A student felt that they learnt a lot just in just a one-hour session with the teacher. She got to do a whole paper during the session – as the class size is small. The teacher could concentrate on the student and had the student to write the answers on the board. She felt that she learnt better. This session was initiated by the teacher himself for the students without them asking him for one.
- When asked if the teacher has tried other forms of engagements in class, and if he has "upped" his game, students shared that he has been focused on the MST papers recently. Students were aware that he had received a teaching award recently. They saw the award announcements in the food court's TV screens.
- Students recalled that one Sunday, when their friends were doing their self-study in SP, the teacher sent a message (they are all in one WhatsApp group) to the students to ask if anyone needs help with their revision in school as he is around the Dover area. He took a picture and posted it on the message to let the students know that he can come around if they need help. Students were impressed to know that he is happy to help them even outside of his Monday to Friday teaching days. He also sends videos to motivate the students via the WA group.
- Students felt that they are thinking more because they have become more curious and they truly want to know more generally.
- Students felt that everyone in class likes the teacher– again, saying that he is the BEST teacher for them, and that no one teacher is even near the way he teaches. Students felt that they absorb faster in this class. The teacher's stance of "I will come to you" instead of the opposite, had students speaking very fondly of him.

Summary

Many of us believe that experience leads to mastery and have heard the phrase that 'practice makes perfect', but research shows that experience is not enough. For example, Berliner (1987) argued:

> …experience will probably only instruct those who have the motivation to excel in what they do and the metacognitive skills to learn from their experience…we believe that individuals with that kind of motivation to learn and in possession of a set of strategies for learning from experience are literally transformed by their experience. (p.61)

The EBRPT provides the 'set of strategies' (guiding heuristics) that make possible the use of experience as a powerful resource for professional learning. Of course, teaching professionals themselves must provide the motivational input for this to be effective.

Furthermore, coupled with ongoing focused student feedback, as was the case in this research, we can analyze, make sense of, and evaluate our practices to systematically improve our teaching from a valid evidence-base. This does, of course, involves us looking at our self honestly and being open to the feedback we receive. Willingham's (2009) reflection makes the summary point:

> Education makes better minds, and knowledge of the mind can make better education. (p.165)

Acknowledgements

Special thanks to Dennis Sale who guided and mentoring us in applying the evidence-based teaching approach and also the Evidence-based Reflective Practice Tool throughout this research.

References

Berliner, D. C. (1987). Ways of thinking about students and classrooms by more and less experienced teachers. In J. Calderhead (Ed), *Exploring Teachers' Thinking.* Cassell, London.

Branford, J. et al. (1999). How people learn: *Brain, mind, experience & school*. Washington, D.C: National Academy Press.

Brookfield, S. D. (1995). *Becoming a Critically Reflective Teacher. San Francisco*, CA: Jossey-Bass

Clouder, L. (2000). Reflective Practice in Physiotherapy Education: A critical conversation. *Studies in Higher Education*, 25(2), 211-223. doi:10.1080/713696142

Darling-Hammond, L., & Bransford, J. (2005) Preparing *Teachers for a Changing World: what teachers should learn and be able to do*. San-Francisco, CA: Jossey-Bass

Hattie, J. (2009). *Visible Learning*. Routledge, New York.

Hattie, J., & Yates, G. C. R. (2014). *Visible Learning and the Science of How we Learn*. Routledge, New York.

Lincoln, Y. S. (1990). The Making of a Constructivist: A Remembrance of Transformations Past. In E. G. Guba (Ed), *The Paradigm Dialog*. Sage, London.

Marzano, R. J. (2007). *The Art and Science of Teaching: A Comprehensive Framework for Effective Instruction*. ASCD.

Mayer, R.E., & Alexander, P. A. (2010). *Handbook of Research on Learning and Instruction*. Routledge, London.

Sackett, D.L. et al. Evidence based medicine: what it is and what it isn't. BMJ 1996; 312 :71

Sale, D. (2015). *Creative Teaching: An Evidence-Based Approach.* Springer, New York

Schon, D. (1983). *The reflective practioner: How professionals think in action*. New York: Basic Books.

Schon, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. San Francisco: Jossey-Bass.

Stigler, J. W., & Hiebert, J. (1999). *The Teaching Gap*. Free Press.

Thomas, L. (1979). *The medusa and the snail: More notes of a biology watcher*. New York: Viking Press

Treadwell, M. (2017). *The future of learning*. The Global Curriculum Project, New Zealand.

Willingham, D. T. (2009). *Why don't students like school: A cognitive scientist answers questions about how the mind works and what it means for the classroom*. San Francisco: Jossey-Bass.

Appendix A: Evidence-Based Reflective Practice Tool

In the Learning Experience was there:	**Evidence of effectiveness:** What specific Strategies, Methods and/or Resources were employed, and how effective were they? (Based on your observation and any other feedback if available (e.g., peer observation, student feedback)
Use of Autonomy Supportive Style Strategies? ○ Clear Expressive Facilitating Language ○ Provides Explanatory Rationales ○ Acknowledges & Accepts Negative Affect ○ Displays Patience ○ Explores and allows Student Choice in the overall instructional strategy ○ Two-way feedback to support understanding and skill development	
Use of High Effect Strategies/Methods? ○ Appropriate for learning outcomes ○ Appropriate for student profile ○ "Russian Doll" design & facilitation (e.g., combinations of high effect methods; combinations of effective e-tools; combination of both)	

In the Learning Experience, was there: ***Utilizing Core Principles of Learning?***	**Evidence of Effectiveness** What specific Strategies, Methods and/or Resources were employed to enhance this aspect of the learning process, and how effective were they? (Based on your observation and any other feedback if available (e.g., peer observation, student feedback)
Communication to Students of the Learning Goal/Outcomes, Purpose and Expectations?	
Activation of Prior Learning and connections to new knowledge presented?	
Emphasis on Key Concepts and Principles that underpin understanding of this topic?	
Use of activities that involved Good Thinking to facilitate understanding?	
Variation in the modes and methods of information presentation and interaction?	

DEVELOPMENT OF A NEW EDUCATIONAL PROGRAM BASED ON LOCAL ISSUES IN THE MAIZURU KOSEN

Y. Kobayashi*,[a], T. Ishii[a] and Y. Utsumi[a]

[a] National Institute of Technology, Maizuru College, Japan

* kobayashi@maizuru-ct.ac.jp

Abstract

Last year, the National Institute of Technology (NIT), Maizuru College, launched the Kosen 4.0 project with the goal of developing an educational program to foster advanced problem-solving skills of engineers with a local contribution by incorporating important local issues into education. The nuclear power plants near the NIT, Maizuru College, consist an important local issue, especially in relation to disaster prevention. There are many nuclear power plants relatively close to the college, such as Takahama (15 minutes by car), Ohi (30 minutes by car), and Mihama (60 minutes by car), all operated by the Kansai Electric Power Company. In particular, it is possible to visit nuclear power plant of the sodium-cooled fast breeder reactor "Monju" located in the Tsuruga, which is operated by the Japan Atomic Energy Agency. By getting students to deal with the issues of these nuclear power plants, engineering education will be carried out based on the approach to real social issues and the knowledge and techniques required to solve these issues, thus the purpose of educational effects can be achived. In addition, the keen interest in nuclear energy issues of the foreign students who attend the NIT can lead to international contributions. Last fiscal year, which comprised the beginning of the development of the educational program, we conducted five lectures and 12 tours to the nuclear power plant so that students and faculty members could understand these issues. Since the facilities are close to our school, we were able to conduct the tour after school hours and in the interval between lectures, without changing the regular curriculum. After the tour, a questionnaire was conducted with 321 participants (67 first graders, 41 second graders, 56 third graders, 51 fourth graders, 83 fifth graders, two advanced-course students, and 21 faculty members). The questionnaire results revealed a favorable attitude from most students regarding the tour. Therefore, this paper reports on the activities being carried out in the Maizuru Kosen project and presents the results of the questionnaire.

Keywords: *local issue, social doctor, problem-solving skills, nuclear power, active learning*

Engineer education in KOSENs

The basic idea of this project is to foster a social implementation type engineer who goes a step beyond technical college and develops an educational institution to cultivate former engineers. The social implementation type engineer implies a KOSEN student who can make advanced products required by the society, going a step beyond an ordinary engineer who can only manufacture common products. The ultimate engineer is required to take on the role of rectifying social diseases or solving social problems. In other words, an engineer is a doctor in society. As a result of thinking about the method of nurturing this social implementation type engineer, we started to nurture students through social issues. In other words, the education that has been imparted so far is only as practice, not as a real social problem. In the future, students will be motivated, and their social implementation ability can be extracted by practicing on social issues. High social implementation ability should be fostered in proportion to the importance of the task.

There are 57 public and private KOSENs in Japan, most of which are located outside the most populated cities of each prefecture. If you consider only the operation of KOSENs and student acquisition, it is better to set up KOSENs in populated areas. However, in reality, it is different. There is a reason for the existence of KOSENs, which are higher education institutions established to be responsible for regional contribution. Therefore, KOSENs are required to not only cultivate exceptional engineers but also contribute to the region.

The KOSEN 4.0 initiative project implemented in fiscal 2018 at our school was conceived to simultaneously fulfill the aims of "human resources development" and "local contribution." "Development of a social implementation type engineer training program by solving the local problem on nuclear including disaster prevention" is the mission of the two important KOSENs. Maizuru KOSEN and Matsue KOSEN are located near the nuclear power plant, and the scale of the power plant near Maizuru is very large. It takes 15 minutes by car to Takahama Nuclear Power Plant, 30 minutes to Ohi Nuclear Power Plant, 60 minutes to Mihama Nuclear Power Plant operated by the Kansai Electric Power Company, and 90 minutes to Monju, the fast breeder reactor of the Japan Atomic Energy Agency. Despite people's varied opinions on nuclear power, it is a complex and important issue that is technically, politically, and internationally relevant as energy is the basis of the country. The purpose of this project is to simultaneously realize the development of a social implementation engineer with high ability to solve the problems facing the next generation and contribute to the development of the area by incorporating this problem into education. In addition, we believe that since there are problems in each area where technical colleges are located, by analyzing such important problems, the positive results of the educational development program that we conducted in one school can spread to other schools. In addition, issues in Japan are often important issues in the home countries of foreign students studying in a KOSEN, and problem-solving type engineer education is truly important for them. Figure 1 shows the neighborhood of Maizuru KOSEN.

Figure 1. Location of Maizuru KOSEN and nearby power plants

Approach of the first year

In 2018, the first year of the development of the educational program, five special lectures and 12 tours of the nuclear facilities were conducted to help students and teachers understand issues related to nuclear energy. Table 1 shows a list of special lectures. Figure 2 shows the training provided for faculty members in cooperation with the Japan Atomic Energy Agency.

Because the facilities for training and visiting were close to our school, we were able to conduct tours after school and between lectures without changing the curriculum. After the tours and training, a questionnaire survey was conducted on 321 participants (67 first graders, 41 second graders, 56 third graders, 51 fourth graders, 83 fifth graders, 2 senior students, 21 teachers) . The survey results indicated favorable responses from most of the students who participated in the tours. Figures 3 and 4 show the training sessions for the students. Figure 5 shows the percentage of questionnaire responses. Efforts such as the development of teaching materials and joint research on nuclear power, disaster prevention, and social implementation could be increased from the previous 3 cases to 20 cases. The breakdown includes 13 for research and development and 7 for teaching material development. The number of trainees in the nuclear disaster prevention-related tours, practical training, and courses has increased from 200 to 679. In addition, we were able to impart nuclear education to five foreign students.

Table 1. Presentations and lecturers giving special lectures

	Subject	Lecturer
1st (2018.10.19)	Engineer education with disaster prevention skills at Akashi Kosen - The goals of the activities and projects so far	NIT, Akashi College, Professor Yasunobu Nabeshima
2nd (2018.11.28)	About nuclear disaster prevention of Maizuru City	Hiroya Chihara (Maizuru City)
3rd (2018.12.11)	Important things for KOSEN students as a graduate from Fugen's initiatives	Yoshitsugu Morishita (Japan Atomic Energy Agency)
4th (2019.01.24)	Toward social implementation of regional disaster prevention system in Maizuru City	Matsuoka Shigeru (Satellite positioning reaserch and Application center) Suzuki Naoyasu (HOUWA System design) Yoshio Sanoki (ITOCHU TechnoSolutions Corporation)
5th (2019.03.18)	Past, present and future of nuclear energy in this region	Masaomi Mori (Japan Atomic Energy Agency)
	KOSEN 4.0 Initiative Results	Yohei Kobayashi (NIT, Maizuru College)

Figure 2. A workshop for teachers

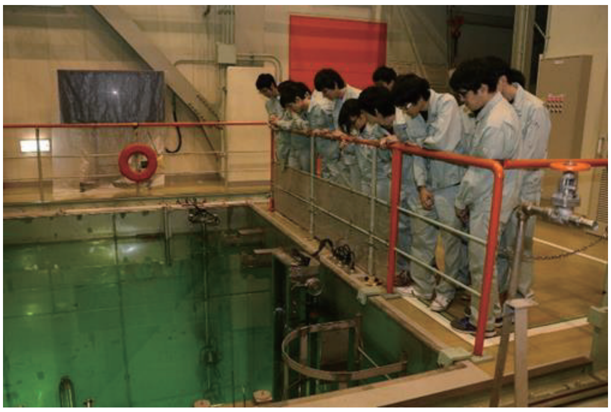


Figure 3. A workshop for students

Figure 4. Students receiving explanations at the training center

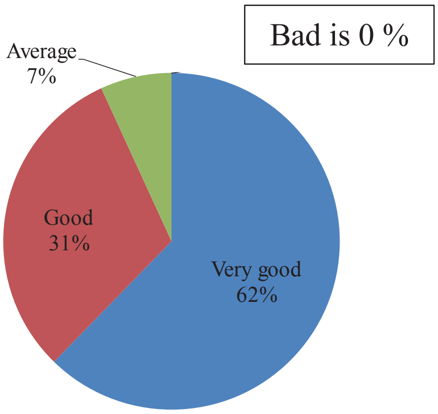


Figure 5. Questionnaire results

Conclusions

We would like to examine the results of the first year and consider effective methods for training social implementation engineers in the future.

ISATE 2019
International Symposium on Advances in Technology Education
17 – 20 September 2019, Shunan City, Tokuyama, JAPAN

TEACHING STUDENTS SELF-DIRECTED LEARNING TO SUPPORT EDUCATION FOR SUSTAINABLE DEVELOPMENT

Sin-Moh CHEAH

Singapore Polytechnic, SINGAPORE

smcheah@sp.edu.sg

Abstract

Goal 4 of the United Nations Sustainable Development Goals is to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". Central to promoting lifelong learning is equipping students with Self-Directed Learning (SDL) skills such as metacognition and related motivational and volition skills (e.g. perseverance, grit). The Diploma in Chemical Engineering has used the Conceive – Design – Implement – Operate (CDIO) Engineering Education framework (www.cdio.org) and design thinking to redesign an integrated curriculum that supports both education for sustainable development (ESD) and SDL. In this curriculum framework, students learn via real world projects in which they Conceive, Design, Implement and Operate chemical product solutions using low-cost local materials and appropriate technology. In this process, they learn key subject content knowledge, thinking and learning skills as well as developing an experiential appreciation on how the knowledge and skills they acquire in their curriculum modules can be used to support sustainable development, other than to earn a career in the chemical processing industry. In this paper, we share a new initiative that aims to develop students' SDL skills, and further support ESD via chemical product design. This involves progressive learning tasks that provide ongoing deliberate practice and feedback around these central curriculum aims. This initiative is facilitated in stages, over the entire course duration, using this integrated CDIO approach. In Year 1, we introduced a model of SDL that is explicitly taught to students. Central to this model is the systematic development of metacognition and a growth mindset. Strategies of direct instruction, modelling and stories (both from faculty and student experiences) reinforce the key learning strategies and skills and that successful learning is attainable with sustained effort. In Year 2, such skill development will be reinforced and extended through modules on chemical product design, leading to a Capstone Project in Year 3. This paper shares current work done in Year 1, presenting preliminary findings on our students' learning experience using the SDL model; follow by plans for Year 2. It concludes with an appraisal of what has been learned for enhancing pedagogic practice in this challenging curriculum area.

Keywords: *CDIO, self-directed learning, education for sustainable development, chemical product design*

Introduction

The United Nations Sustainable Development Goals are a collection of 17 global goals as part of Resolution 70/1 of the UN General Assembly (UN, 2015). Of interest in the chemical engineering education is Goal 4: "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". In particular, Section 4.7 of Goal 4 read "By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development".

It is not possible for a 3-year diploma to address all these issues, so we put the emphasis for our curriculum on education for sustainable development (ESD). It aims to help students develop the attitudes, skills, perspectives and knowledge to make informed decisions and act upon them for the benefit of themselves and others, now and in the future (UNESCO, 1997). ESD helps the citizens of the world to learn their way to a more sustainable future.

However, there is no universal model of ESD; and nuanced differences according to local contexts, priorities and approaches exist even when there was overall agreement on the concept (De Rebello, 2003). As noted by Lange (2004), sustainability education is not easy and few educators have training in how to do it. One challenge associated with sustainability education is its interdisciplinary nature, which is uncomfortable for both the educator and many students who are more used to discipline-based instruction in education settings.

Sterling (2004) identified a range of educational responses to sustainability as shown in Table 1, and advocated the third approach, which he termed "sustainable education." This constitutes an order of learning higher than that of ESD. He explained the concept as one that is not just a simple add-on of sustainability concepts to the curriculum, but a cultural shift in the way we see education and learning, based on a more ecological or relational view of the world. Rather than a piecemeal, "bolt-on" response which leaves the mainstream otherwise untouched, it implies systemic change in thinking and practice, informed by what can be called more ecological thinking and values – essentially a new paradigm emerging around the poles of holism, systemic thinking, sustainability, and complexity.

Table 1. Three Levels of Education and Sustainability

Education *about* sustainability	First-order learning Emphasis is on content/knowledge-based learning within the dominant paradigm Assumes that meaning of sustainability can be clearly identified and taught as a separate subject Essentially 'learning as maintenance' of current paradigm
Education *for* sustainability	Second-order learning Emphasis is on 'learning for change' that includes content, but goes further to include values and capability bias Deeper learning: involves critical and reflective thinking about sustainability Assumed that we know clearly what values, knowledge and skills 'are needed' for change and while challenging the existing paradigm leaves it mainly intact
Education *as* sustainability (Sustainable Education)	Third-order, transformative learning Emphasis is on process and quality of learning, which is seen as an essentially creative, reflective and participative process Knowing is seen as approximate, relational and provisional, and learning is continual exploration through practice Shift is towards 'learning as change' which engages the whole person and learning institution Process of sustainable development or sustainable living is essentially one of learning, while context of learning is essentially that of sustainability

Sterling (2004) further contended that the role of higher education "…should not be predicated only on "the integration of sustainability" into higher education, because this invites a limited, adaptive, response …we need to see the relationship the other way around – that is, the necessary transformation of higher education towards the integrative and more whole state implied by a systemic view of sustainability in education and society." Vare & Scott (2007) further made the point that, "sustainable development, if it is going to happen, is going to be a learning process – it certainly won't be about 'rolling out' a set of pre-determined behaviors". A common approach to develop key competencies for sustainable development is the used of project-based learning (e.g. Cörvers, et al, 2016; Brundiers & Wiek, 2013; Nation, 2008)

ESD in Existing DCHE Curriculum

Cheah (2015, 2014) had earlier written about using chemical product design to engage students using the CDIO Framework to redesign the Diploma in Chemical Engineering, which resulted in the curriculum model that supports education for sustainable development as shown in Figure 1. In this case, our students will be able to use their knowledge and skills to produce innovative chemical processes, products or systems that improve the life of the less-privileged. We also use Design Thinking to enhance the "conceive" stage as shown in Figure 2. Appropriate technologies, a term attributed to Schumacher (1973), are usually characterized as small scale, energy efficient, environmentally sound, labor-intensive, and controlled by the local community (Hazeltine & Bull, 1999). The goal of appropriate technology is to raise the standard of living for the developing communities without condescension, complication and environmental damage. Appropriate technologies are therefore most suited to support the "Implement" and "Operate" stages.

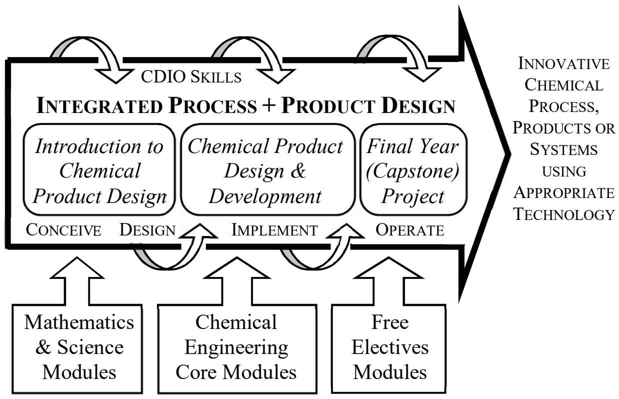


Figure 1. DCHE curriculum model for ESD using CDIO

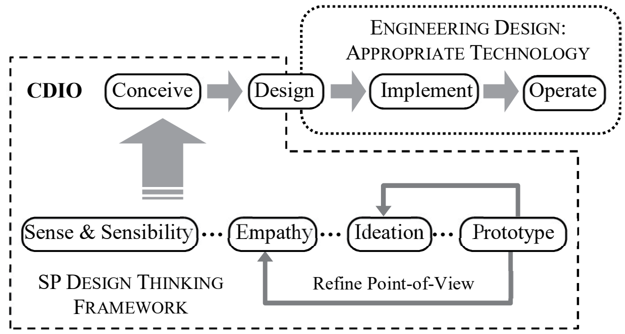


Figure 2. CDIO enhanced with Design Thinking

Cheah (2015, 2014) had further shows the correspondence between the ideals of sustainable development espoused in the Brundtland Report, which explained it as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN, 1987). Specifically, as shown in Figure 3, we draw parallels between the three circles of design thinking and three circles of sustainable development.

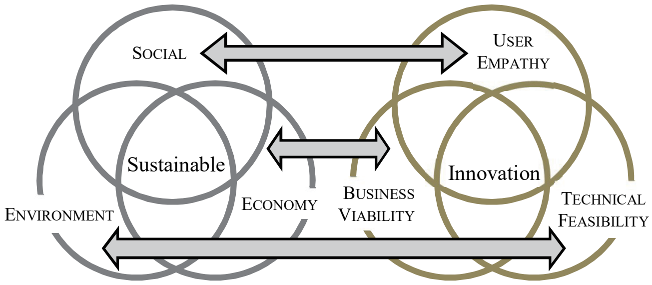


Figure 3. Relationship between elements of design and sustainable development

Self-directed Learning and Sustainable Development

Knowles (1975) described self-directed learning (SDL) broadly as "a process in which individuals take the initiative, with or without the help of others, to diagnose their learning needs, formulate learning goals, identify resources for learning, select and implement learning strategies, and evaluate learning outcomes". SDL skills is one of the key competencies in sustainable development (Norden, 2016; Barth, et al, 2007; Lander, 2010), and can best be developed through project-based learning (e.g. Eggermont, et al, 2015; Johnson, et al, 2015).

Revamping the DCHE Curriculum to Integrate Self-Directed Learning

The DCHE curriculum undergone a major revamp in 2017 that results in a spiral curriculum (Bruner, 1960). The work done had been described elsewhere by Cheah & Yang (2018). For the purpose of this paper, we will focus on one aspect of the revamp, and that is the introduction of a model of SDL that is being explicitly taught to students. The original intention is to promote lifelong learning among our graduates. The most significant research in this area is that of Boyer et al (2014), who carried out an extensive meta-analytic review of SDL research over 30 years that cut across 5 countries and across multiple academic disciplines; and concluded that SDL is a useful tool to promote lifelong learning skills.

The SDL model, as shown in Figure 4, also incorporates key concepts of growth mindset (Dweck, 2006) and metacognition (Schraw, 1998). Growth Mindset refers to the belief that intelligence can be developed. Students with a growth mindset understand they can get smarter through hard work, the use of effective strategies, and help from others when needed. It is contrasted with a fixed mindset: the belief that intelligence is a fixed trait that is set in stone at birth. Metacognition (Schraw, 1998) refers to the awareness and understanding of one's own thought processes. Being meta-cognitive means to be aware of one's thinking, emotion/feeling & behaviour, and evaluating how well we are using the range of specific thinking skills, and taking necessary corrective action to plan, monitor, and assess one's learning process and performance.

The desired outcome is that, having developed the SDL skills, students are able to transfer their learning out other contexts, hence becoming a lifelong learner. Concepts of growth mindset and the teaching of SDL skills started in Year 1 in selected core modules and progressively developed in later years, as shown in Figure 5.

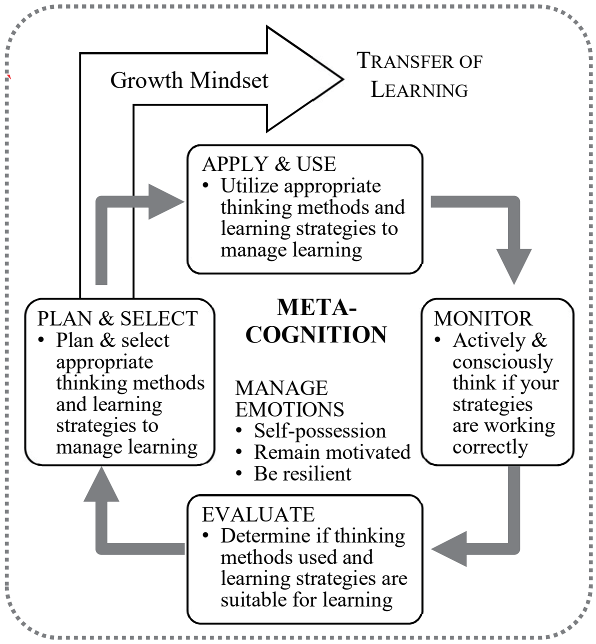


Figure 4. DCHE Self-Directed Learning Model

We take the opportunity afforded by the curriculum revamp to integrate SDL into 2 product design modules of Figure 1, namely *Introduction to Chemical Product Design* (taught in Stage 2A, i.e. Year 2 Semester 1) and *Chemical Product Design & Development* (taught in Stage 2B, i.e. Year 2 Semester 2). Students are expected to be able to manage their own learning (i.e. self-directed) when they reach Year 3 and work on their final year capstone project.

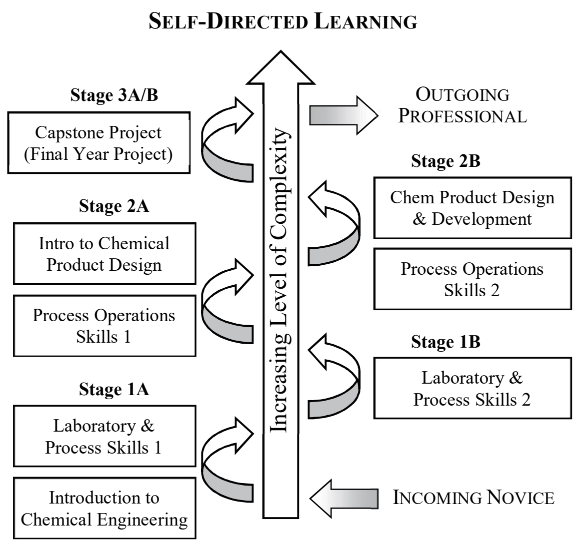


Figure 5. Progressive Learning via Spiral Curriculum

Quite obviously, the 2 modules *Introduction to Chemical Product Design* and *Chemical Product Design & Development* will be taught using project-based learning as the key pedagogy and the CDIO Framework. Stewart (2007) had showed that SDL readiness was a key enabler for achieving learning outcomes from project-based learning, which are often open-ended, ambiguous and requires knowledge beyond what had been covered in the curriculum. Other skills that may include in project-based learning includes those that contribute to the institution's desired graduate attributes and/or professional identity such as ethical reasoning, cross-cultural awareness, etc. With this approach, we hope to achieve the following 2 aims with regards to education for sustainable development:

- Provide students with opportunity to contribute to sustainable development via their Final Year Project while studying in SP
- Prepare graduates with competencies in carrying out lifelong learning to continue to contribute to sustainable development well beyond their formal education in SP

Development is still undergoing for the integration of SDL into project-based learning. Table 2 summarizes our planned use of questioning as scaffolds to assist students in developing SDL skills at various stages of product design and development, based on CDIO.

Table 2. Ideas on where SDL can be used in CDIO

CONCEIVE: Defining customer needs; considering technology, enterprise strategy, and regulations; developing concepts, techniques and business plans
Example task(s) to be performed by students: • Carry out research for more information on the issues as stated in the project brief Example activities in the SDL model: • Plan & Select: What are the sources of information e.g. library or Internet, and choice of media (e.g. print – journals, technical reports, white papers, etc; or video e.g. documentaries)? • Use, Evaluate & Monitor: Are the information sufficient? What other information are needed? • Metacognition: Are there personal biases in selecting which information to include?

DESIGN: Creating the design; the plans, drawings, and algorithms that describe what will be implemented.
Example task(s) to be performed by students: • Put together a design sketch of pilot plant to address the identified problem • Carry out the necessary engineering calculations Example activities in the SDL model: • Plan & Selected: Which design code (e.g. API) to use? What are the materials of construction? What parameters to measure and control? What instruments to use? • Use, Evaluate & Monitor: Is the correlation used the most suitable one? Is the safety factor sufficient? • Metacognition: Any key step in the Gantt Chart that is overlooked? Is the planned duration overly optimistic? What is the assumption behind the optimism?

IMPLEMENT: The transformation of the design into the product, including manufacturing, coding, testing and validation.
Example task(s) to be performed by students: • Put together a pilot plant to carry out the desired process • Plan test protocol Example activities in the SDL model: • Plan & Select: What is the design of experiment, the dependent and independent variables, and acceptance criteria? • Use, Evaluate & Monitor: Are the results consistent with theoretical prediction? What are difficulties observed? • Metacognition: Has the full implications for the trade-off being considered? Has anything been compromised?

OPERATE: Using the implemented product to deliver the intended value, including maintaining, evolving and retiring the system.
Example task(s) to be performed by students: • Test run the pilot plant • Prepare the operating manual, conduct user training Example activities in the SDL model: • Plan & Select: Training duration, availability of participants, training materials (e.g. online?) • Use, Evaluate & Monitor: Is the plant performing as per design? If not, what is/are the issue(s) and how can the required performance be achieved? Has some required spare parts omitted, or insufficient quantity specified? • Metacognition: Can some of the observed operating difficulties be predicted and corrected?

Student Experience of Teaching using SDL Model

The survey was administered to all 7 classes of our Year 1 chemical engineering students who took the module, with a total of 130 students. 81 responses were received. However, some responses were not accepted as they are deemed invalid or with incomplete entry. Notable are the following questions posed:

A. Name one or more parts of the Self-Directed Learning Model you remember.
B. Did the workshops for P5 and P6 helped you to appreciate the use of the Self-Directed Learning Model in gaining new knowledge? Why?
C. Which one of the following best describes your learning experience with the Self-Directed Learning Model so far?

Questions A and B are open-ended. For Question C, students are required to select 1 of 8 responses from a drop-down list, comprising the following:

- It helps me to work out how to learn in a systematic manner
- It is useful when I need to learn something new/ complex

- I am not too sure yet as I do not have sufficient practice using it at this moment in time
- I think only some parts of it are useful to me
- It is too complex to make use of
- I do not see how it can be applied
- I have my own way of learning, which I think is good enough for me
- I do not see its relevance in helping me learn

The findings relevant to these questions are shown in Figures 6 to 8 (where N = no. of valid responses). In general, students are able to identify with the key steps in being a self-directed learner, and quite a number are able to mention metacognition as an important factor. However, despite the high positive responses, only about 73% of respondents found the 3 workshops useful (with 75 valid respondents). This may be due to the opinions of some students who are still ambivalent about the importance of SDL (with 80 respondents). Only about 56% of students reported understanding the potential benefits of SDL, while about 16% do not think so – 2.50% thought that it was too complicated, another 2.50% had no idea how to apply it, 6.25% felt that their own way of learning is superior, and 5.00% reported seeing no relevance of SDL in helping their learning.

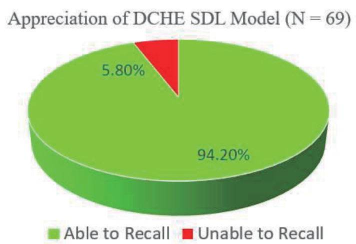


Figure 6. Student responses to Question A

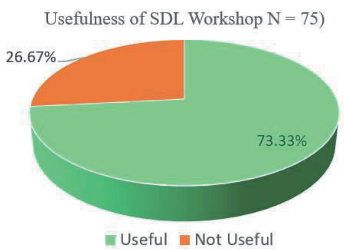


Figure 7. Student responses to Question B

Discussion

The results showed that much remained to be done to improve students' SDL skills. We obviously need to improve the effectiveness of the SDL workshops. We need to review the activities to provide more explicit examples of areas where SDL skills can be utilized. We also need to uncover some of the study techniques used by the students, as some of them may still be relying on rote memorization that may be somewhat 'effective' in Year 1. More importantly, we will be monitoring the students performance in *Introduction to Chemical Product Design* now that they are in Year 2. To this end, the author is working closely with the lecturer teaching the module to monitor the students learning experience.

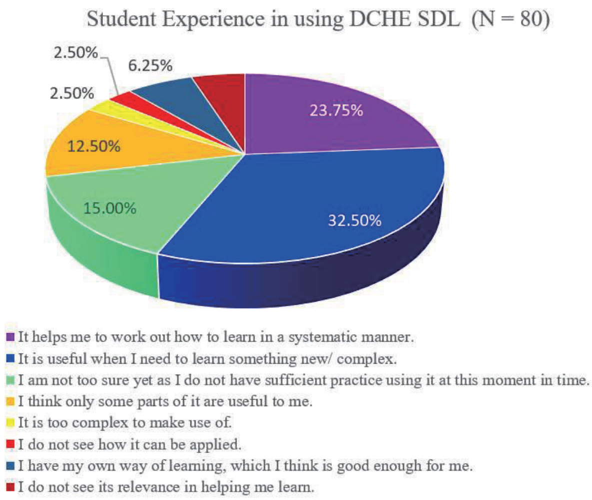


Figure 8. Student responses to Question C

The longer term plan is to tweak our project-based curriculum towards a learner-driven one (Herranen, et al, 2018) where students are able to take control over their learning process in managing their final year project, and hence contribute more effectively towards sustainable development. To this end, we also need to introduce multi-disciplinary topics into project work, which is challenging given an already packed curriculum. Lastly, our own lecturers need to be trained in delivering curriculum based on ESD. Nolet (2009) had argued for the development of "sustainability literacy" for educators, who can understand the broad, complex nature of sustainability. Warren et al (2014) suggested a competency framework for educators that embraces 4 thinking skills – futures, values, systems and strategic. This can be a potential area of professional development for our lecturers.

Conclusions

We presented a model to integrate SDL into chemical engineering education, which is taught using project-based learning so that students are aware of the key competencies that they need to develop. We will be able to provide more updates as we continue with our SDL implementation effort in the curriculum.

References

Barth, M., Godemann, J., Rieckmann, M. & Stoltenberg, U. (2007). Developing Key Competencies for Sustainable Development in Higher Education, *Int'l J. of Sustainability in Higher Education*, Vol.8 No.4, pp.16-430

Boyer, S.L., Edmonson, D.R., Artis, A.B. & Fleming, D. (2014). Self-Directed Learning: A Tool for Lifelong Learning, *J. of Marketing Education*, Vol. 36(1) 20-32

Brundiers, K. & Wiek, A. (2013). Do We Teach What We Preach? An International Comparison of Problem- and Project-Based Learning Courses in Sustainability, *Sustainability,* Vol.*5*, pp.1725-1746

Bruner, J.S. (1960). *The Process of Education*, Cambridge MA, Harvard University Press

Cheah, S.M. & Yang, K. (2018). CDIO Framework and SkillsFuture: Redesign of Chemical Engineering Curriculum after 10 Years of Implementing CDIO, *Procs of the 14th International CDIO Conference*, Jun 28 – Jul 2; Kanazawa, Japan.

Cheah, S.M. (2015). Engaging Today's Millennials using Curriculum Based on Chemical Product Design, *Proc of the* 9th *International Symposium on Advances in Technology Education*; Sep 16-18; Nagaoka, Japan.

Cheah, S.M. (2014). CDIO as Curriculum Model for Education for Sustainable Development, *Proc of the 10th International CDIO Conference*, June 16-19; Universitat Politècnica de Catalunya, Barcelona, Spain.

Cörvers R., Wiek A., de Kraker J., Lang D.J., & Martens P. (2016). Problem-Based and Project-Based Learning for Sustainable Development, in *Sustainability Science*, Heinrichs H., Martens P., Michelsen G., & Wiek A. (Eds); Springer, Dordrecht

De Rebello, D. (2003). What is the Role for Higher Education Institutions in the UN Decade of Education for Sustainable Development? *Report on the International Conference on Education for a Sustainable Future*. Prague, Czech Republic.

Dweck, C. (2006). *Mindset: The New Psychology of Success*, New York: Ballantine Books.

Eggermont, M., Brennan, R.W. & O'Neill, T. (2015). The Impact of Project-based Learning on Self-Directed Learning Readiness, *7th Int'l Conference on Engineering Education for Sustainable Development*, Jun 9-12; Vancouver, Canada

Hazeltine, B. & Bull, C. (1999). *Appropriate Technology: Tools, Choices and Implications*, San Diego: Academic Press

Herranen, J., Vesterinen, V-M. & Aksela, M. (2018). From Learner-Centered to Learner-Driven Sustainability Education, *Sustainability*, Vol.10, pp.1-14

Johnson, B., Ulseth, R., Smith, C. & Fox, D. (2015). The Impacts of Project-based Learning on Self-Directed Learning and Professional Skill Attainment, *Proc of IEEE Frontiers in Education Conference*, Oct 21-24; El Paso, TX

Knowles, M.S. (1975). *Self-Directed Learning*. New York: Association Press.

Lander, L. (2010). Self-Directed Learning and Sustainability Education: Can Self-Directed Learning Save the Planet? *Procs of the 24th International Self-Directed Learning Symposium*, Cocoa Beach, FL

Lange, E.A. (2004). Transformative and Restorative Learning: A Vital Dialectic for Sustainable Societies, *Adult Education Quarterly*, 54, pp.121-139

Nation, M.L. (2008). Project-Based Learning for Sustainable Development, *Journal of Geography*, Vol.107, No.3, pp.102-111

Nolet, V. (2009). Preparing Sustainability-Literate Teachers, *Teachers College Record*, Vol.111, No.2, pp.409-422

Norden, B. (2016). *Learning and Teaching Sustainable Development in Global-Local Context*, Lund University

Schraw, G. (1998). Promoting General Metacognitive Awareness, *Instructional Science*, Vol.26, pp.113-125

Schumacher E.F. (1973). *Small is Beautiful: Economics as if People Mattered*, Blond & Briggs Ltd, London

Sterling, S. (2004). Higher Education, Sustainability, and the Role of Systemic Learning. *Higher Education and the Challenge of Sustainability: Problematics, Promise and Practice*, Corcoran, P.B. and Wals, A.E.J. (Eds.), Kluwer: Dordrecht, 47-70.

Stewart, R.A. (2007). Investigating the Link between Self-directed Learning Readiness and Project-based Learning Outcomes, *Eur J. of Engineering Education*, Vol.32, pp.1-21

UN (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development*, United Nations General Assembly Resolution 70/1, 25 September 2015.

UN (1987). *Report of the World Commission on Environment and Development*, United Nations General Assembly Resolution 42/187, 11 December 1987.

UNESCO (1997). *Educating for a Sustainable Future: A Trans-disciplinary Vision for Concerted Action*. United Nations Educational, Scientific and Cultural Organization.

Vare, P., & Scott, W. (2007). Learning for a Change: Exploring the Relationship between Education and Sustainable Development. *J. of Education for Sustainable Development*, 1:2, 191-198.

Warren, A.E., Archambault, L.M. & Foley, R.W. (2014). Sustainability Education Framework for Teachers: Developing Sustainability Literacy through Futures, Values, Systems, and Strategic Thinking, *J. of Sustainability Education*, Vol.6, pp.1-14

Establishment of Glocal Education and Research Center for Agricultural Engineering in NIT (KOSEN), Miyakonojo College
- Educational Trials for Local Contribution and International Activity -

N. Takagi*, H. Shiraiwa*, Y. Ueno*, A. Takahashi*, M. Iwakuma*, K. Matsukawa*,

D. Kaewdook**, P. Sudwilai**, N. Kamata*** and K. Jitjumnong***

* National Institute of Technology (KOSEN), Miyakonojo College, Japan

** Thai-Nichi Institute of Technology, Faculty of Engineering, Thailand

*** King Mongkut's University of Technology Thonbri,

Faculty of Industrial Education and Technology, Thailand

* takagi@cc.miyakonojo-nct.ac.jp

Abstract

Agriculture industry as an essential field of Japan's economic structure, contribute outstandingly to the development of national economy and stabilization of national life through their role of providing stable supply of foods indispensable to our daily life. However, the economic and social environment surrounding agriculture is currently understanding major changes. There is an increasing concern that the inevitable shrinkage of the domestic market and deterioration of rural areas due to Japan's rapidly declining and aging population will have a great impact on agriculture and food production. National Colleges of Technology, called KOSEN originally has a curriculum emphasizing scientific experiments, workshop training and practical manufacturing skills. If KOSEN educates the engineering students who know the basic knowledges of agriculture, eventually it will become human resources to support agriculture upon completing the agri-engineering education to be held at KOSEN. In 2017, to achieve local contribution in south Kyushu and solution of problem of local communities such as agriculture and depopulated areas, Miyakonojo College who is member of KOSEN have established "glocal education and research center for agricultural engineering" that can train a high creative engineer. This paper introduces major efforts on educational agriculture program and global activity involved "glocal education and research center for agricultural engineering".

Keywords: *Agri-engineering*, *Global activity*, *Glocal Education and Research Center for Agricultural Engineering*

1 Introduction

Today, Japan is facing the decreasing birthrate and aging population as well as the rapid change of the industrial structure by the Fourth Industrial Revolution, and the value of a leading role that education in KOSEN plays also has been on the rise more than ever.

Under these circumstances, the Ministry of Education, Culture, Sports, Science and Technology launched the "KOSEN 4.0" Initiative Project[1). This project is a single-year publicly offered type to enlarge the three columns: the development of human resources heading new industries in each KOSEN, contribution to the local community, and the encouragement to expand and accelerate internationalization. The project has an aspect of the additional budget aid dedicated to the preparation for the Fourth Mid-term Goals starting from 2019 (the 31st year of the Heisei period), which also requires the reform of school curricula concerning each department, the reorganization and so forth. The National Institute of Technology (KOSEN), Miyakonojo College (referred to as Miyakonojo College below) applied for the project under the following title: "The Development of the Educational System to Encourage Internationality and Social Implementation: Based on Agricultural Engineering Education Associated with the Local Needs." As a result, Miyakonojo College has got accepted as one of the 37 projects worth supporting in 2017 (the 29th year of the Heisei period) which were conducted by 31 KOSENs across the country.[2)]

This report introduces Miyakonojo College's approaches to "KOSEN 4.0" Initiative Project in 2017 (the 29th year of the Heisei period) and mentions the establishment of the Glocal Education and Research Center for Agricultural Engineering and its goals[3)]. Then, this report states how much Miyakonojo College has prepared for the remote communications system for agricultural curriculum and international education, referring to the result of questionnaires filled in by students at Miyakonojo College and visitors on the campus tour day.

2 The Establishment of the Glocal Education and Research Center for Agricultural Engineering and its Target Levels

The Glocal Education and Research Center for Agricultural Engineering (Fig. 1) is based on the fusion of contribution to the local community and education on internationality.The center aims to develop human resources that can play their full part from the global and local point of view at the same time. Miyakonojo College established the rules and regulations for the center on August 7, 2017. The center consists of eight staff members including the center manager, associate professor Natsuki TAKAGI and the vice center manager, professor Tamao MATSUZAKI, and as to paperwork in general, the Educational Affairs Division and the General Affairs Division are in charge of it to secure work efficiency. The center raises the three items as the specific goals:

(1) Set the number of studies and developing materials that is including collaboration for classes concerning internationalization, agricultural engineering and social implementation at 16 in 2017, 4 studies and developing materials in 2016.

(2) Set the number of students who attend the international exchange activities at more than 150 in 2017 (the average in 2014 to 2016 is 50).

(3) Set the number of joint study on agriculture and/or social implementation at 4 in 2017 (one study in 2016).

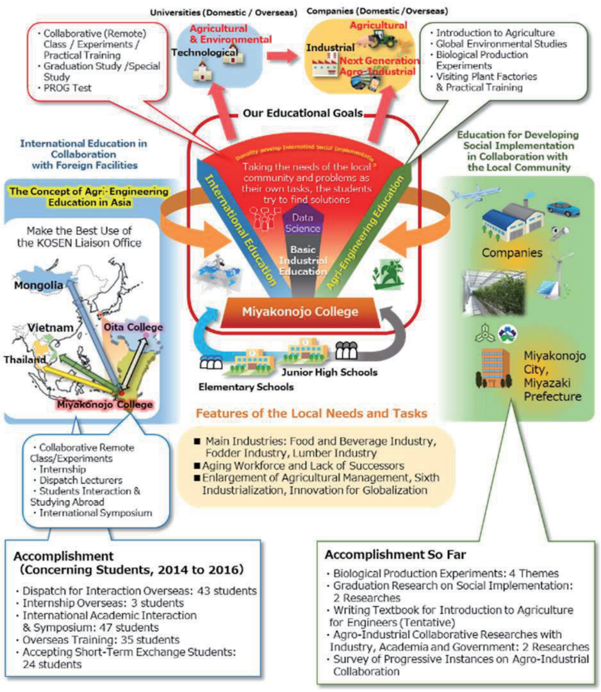


Fig.1 The positioning of the Glocal Education and Research Center for Agricultural Engineering

3 The Preparation Status of the Remote Communications for International Education

When the global activity and education are put into action, a matter of travel expenses appears inevitably, which another research report [4)] refers to as well. Therefore, the center decided to consider the use of remote communications because it would reduce costs except for the initial involvement for communicative equipment. So far, Miyakonojo College has prepared for the remote communications with a telecommunications application 'Skype' in Mongolia and Thailand where the Liaison Office of KOSEN National Institute of Technology, Japan is located, and performed communication tests nine times in collaboration with Mongolian University of Science and Technology, IET in Mongolia and King Mongkut's University of Technology Thonburi in Thailand. Fig. 2 shows the remote communications being conducted between Miyakonojo College and a facility in a Thai mountainous area. With the facility's permission to have access to information on its communicative equipment in advance, we have carried out the communication smoothly. However, a number of problems surfaced up: it was realized that careful preparation, including chairpersons in each venue, was necessary to succeed in performing the communication simultaneously. In addition to this, detailed explanations to all the student staff members and hands-on practice were desirable.

Fig. 2 The remote communications with the facility in a Thai mountainous area (the screen in the back shows the Thai side)

Besides, we asked students at each school to fill in the questionnaire, making use of the interaction through the remote communications tests. Chapter 3 mentions the result of five questions from the questionnaire filled in by 98 Miyakonojo College students who attended the remote communications tests (Fig. 3 to Fig. 7). As it is mentioned in Chapter 2, the target number of students who attend the international activity is 150, and these 98 students correspond to about 65 percent of the target number.

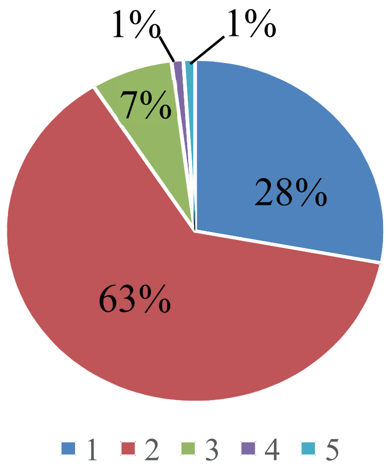


Fig. 3 The result of the question: How did you feel about the interaction on the remote communications?

(1) How did you feel about the interaction on the remote communications? 1. Very good 2. Good 3. Not good or bad 4. Not so good 5. Not good

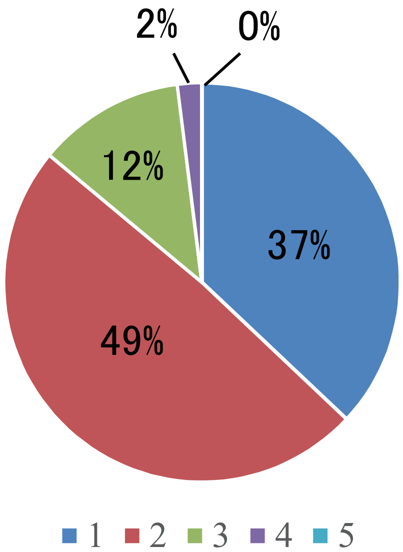


Fig. 4 The result of the question: Did you get interested in interacting with foreign people (workshops) and so on?

(2) Did you get interested in interacting with foreign people (workshops) and so on?
1. Highly interested 2. Interested 3. So-so 4. Not interested so much 5. Not interested at all

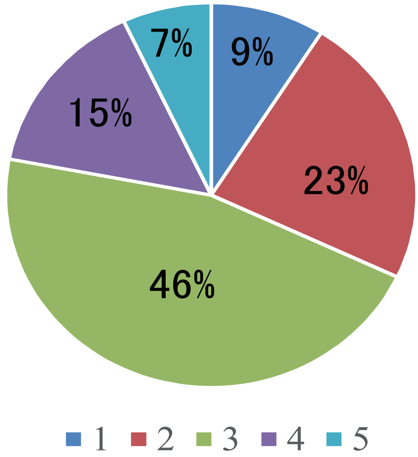


Fig. 5 The result of the question: Were you able to make yourself understood in English?

(3) Were you able to make yourself understood in English?
1. Very well 2. Well 3. So-so 4. Not so well 5. Not well at all

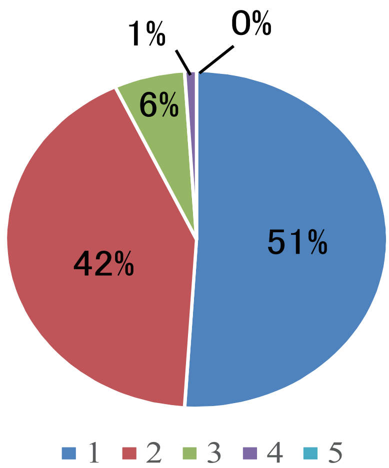


Fig. 6 The result of the question: Did you get motivated to improve your English skills?

(4) Did you get motivated to improve your English skills?
1. Highly motivated 2. Motivated 3. So-so 4. Not so motivated 5. Not motivated at all

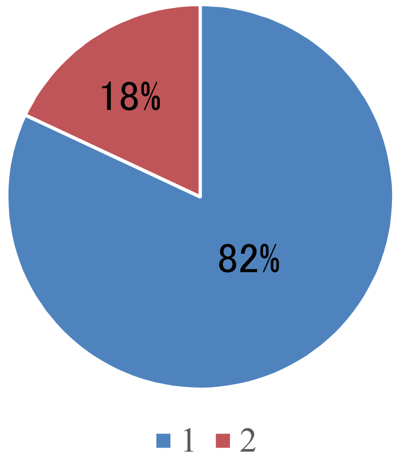


Fig. 7 The result of the question: Do you want to attend this interaction on the remote communications again?

(5) Do you want to attend this interaction on the remote communications again?
1. Yes 2. No

From these results, we have got fairly positive reaction to the overseas exchange interaction on the remote communications despite the fact that the preparation was only in the initial process. As it can be understood from the answer to the question 6 (Fig. 6), the experience of participating in the remote communications overseas led to motivate the students to improve their language skills. Besides, from the result of the question 5 (Fig.7), we have got the answer suggesting the students' high interest in global activity such as the remote communications overseas. It seems that these results show the consciousness of being able to improve ability by training based on regular practice can be found in the students.

4 Examples of the Agricultural Engineering Education and Contribution to the Local Community

In order to consider the development of human resources for a large variety of engineering areas, Miyakonojo College conducted the survey [5) 6)] focusing on the national agricultural and industrial cooperation activities in 2014 to 2015 (in the 26th and 27th years of the Heisei period). Then, we came to the conclusion that, in addition to the conventional education in KOSEN, we needed the education and research that would develop engineers who were able to contribute to the solution of many tasks in industries, particularly in agriculture [7) 8)]. At the same time, hearing the opinions from agricultural workers and referring to the result of the questionnaire above[3)], we have been conducting agricultural practice since 2015 (the 27th year of the Heisei period). We have been growing sweet potatoes, *edamame* or green soybeans, peanuts and so forth on the first to third farms on campus (Fig. 8), taking into consideration the season of starting agricultural practice when planting in April to June, harvesting and cleaning up the farms in July to November, the number of participants as students at Advanced Engineering Course and measures against sequential cropping damage. If you want to learn what agriculture is like, it is important to experience outdoor cultivation (the cycle of plowing, sowing, harvesting and post process in one year) and study about soil property, agrochemicals and bird and beast damage. Fig. 9 shows the agricultural practice of sweet potatoes in 2017. Every July, the participants take the practice of disbudding in the Miyakonojo Winery, Inc. and lectures from experts in the field.

Next, we would like to introduce Introduction to Agriculture [9)]. This is one of the Advanced Engineering Courses, which is treated as a special learning credits class at Miyakonojo College as of now; it was stared as a Web-based interactive class in collaboration with two KOSENs, Oita College and Ichiniseki College in 2017. Fig. 10 shows its textbook (*Kogaku Gijutsusha no tame no Nogaku Gairon* [The Introduction to Agriculture for Engineers] Riko Tosho) [10)]. It was edited for the class by emeritus professor Eisuke HAMADA (the ex-professor at the Department of Chemical Science and Engineering of Miyakonojo College), who was also engaged in writing.

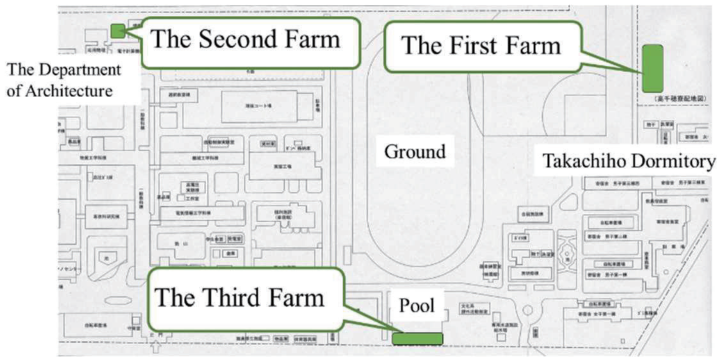


Fig. 8 The location of each farm on campus

Fig. 9 The process of the practice: growing sweet potatoes in 2017

Fig. 10 The practice of disbudding in the Miyakonojo Winery, Inc.

Fig. 11 The textbook of Introduction to Agriculture

農業にIT活用

新富町と都城高専協定

IT技術などを活用して農業振興につなげようと、新富町と同町・こゆ地域づくり推進機構（齋藤潤一代表理事）、都城市・都城高専（桑原裕史校長、856人）は12日、農畜産振興等連携・協力に関する協定を結んだ。今後、同校学生が町内の農家を訪問し、経営近代化へ向けたさまざまな研究に取り組む。

多角的な視点で町内の農業振興を行う同機構が、学術的根拠を探ろうと同校へ協力を依頼し、今回の協定締結が実現した。来年度からは、同校5年生の卒業研究のテーマの一つとして農畜産業を設定。生徒が町内の農家を訪問するなどして、工業的観点から現場の課題解決に取り組む。

同日、同町役場であった調印式には土屋良文町長や桑原校長、同機構の岡本啓二執行理事らが出席。土屋町長は「新富は農業のまち。生徒の学術研究とともに農業を発展させ、農家の所得向上につなげたい」。桑原校長は「この機会を活用して実践的な教育に取り組み、農業発展に寄与したい」と話していた。（吉田聡史）

農業振興に向けて協定を結んだ新富町や都城高専などの関係者

Fig. 12 The newspaper article about the agreement concluded among Miyakonojo College, Shintomi Town and the Koyu Social Life and Work

Finally, we would like to mention the agricultural internship for the first-year students of the Advanced Engineering Courses. This is a part of the activities based on the partnership agreement about agriculture and stockbreeding concluded with Shintomi Town and the Koyu Social Life and Work in 2018; it is promising as the promotion of agriculture in the local community and the practice of developing human resources. Fig. 11 shows the newspaper article about concluding the agreement[11].

5 The Result of the Questionnaires Filled in by Visitors at Miyakonojo College

On the campus tour day of August 11, 2017, we asked junior high school students to fill in the questionnaire, and it was answered by 198 students in the end. Figs. 12 to 15 show each question and its result. Although the respondents were not given full explanation of "KOSEN 4.0" Initiative Project and the Glocal Education and Research Center for Agricultural Engineering beforehand, they gave positive answers to education in KOSEN only by looking at Fig. 1. This is probably because the students who visited Miyakonojo College on the campus tour day had high interest in KOSEN itself. The fact that they showed high interest particularly in studying overseas (Fig. 14) and global activity (Fig. 16) is worthy of attention. It was broadly observed that schools which offered chances of developing language skills and studying overseas were appealing to junior high school students, and that they were eager to make use of such chances. However, the analysis of the questionnaire filled in by parents was left to be a further task because parents' will may have a great effect on the decision of their children's course.

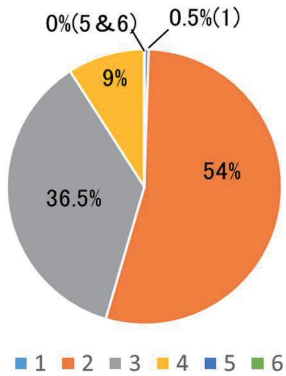


Fig. 13 The result of the question: How do you feel about the reform of Miyakonojo College?

(1) How do you feel about the reform of Miyakonojo College?
1. No answer 2. Very good 3. Good 4. Not good or bad 5. Not so good 6. Not good

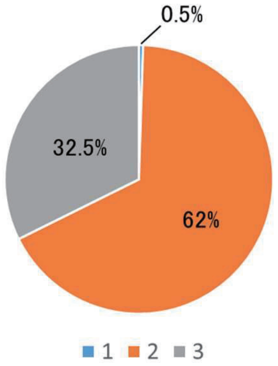


Fig. 14 The result of the question: Do you want to study abroad or take part in international activity?

(2) Do you want to study abroad or take part in international activity?
1. No answer 2. Yes 3. No

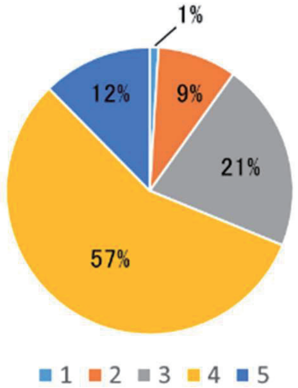


Fig. 15 The result of the question: In which area do you want to work in the future?

(3) In which area do you want to work in the future?
1. No answer 2. In the local community 3. In Kyushu area 4. In Japan 5. Overseas

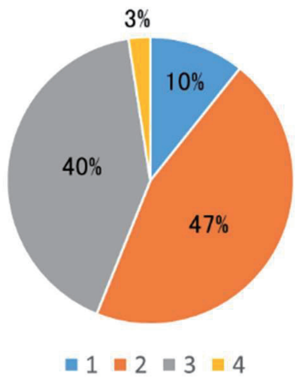


Fig. 16 The result of the question: What do you want to make effort to do if you enter Miyakonojo College?

(4) What do you want to make effort to do if you enter Miyakonojo College? 1. Contribution to the local community 2. Global activity 3. Developing your basic skills 4. Others

6 Conclusion

Miyakonojo College has established the Glocal Education and Research Center for Agricultural Engineering for the following goals: first, we aim to solve tasks as agricultural ones in particular based on the needs of the local community and contribute to the local community. Second, paying attention to the development of the Fourth Mid-term Goals, we strive to develop the educational system to raise creative, skillful engineers with international sensibility who can contribute to the solution of social problems. It is also required for the center to achieve the goals of "KOSEN 4.0" Initiative Project and perform the examination and evaluation of the organization itself repeatedly so that the center can serve from the standpoint of the possibility of sustainable development. Besides, as further tasks, we have to establish the committee for external evaluation and the system of evaluating the management by outside experts.

In the same period, we concluded the general partnership agreement with Miyakonojo City in February of 2017 and Mimata Town in the same year of March, which served as a spur to the activity of the Glocal Education and Research Center for Agricultural Engineering. We would like to make our partnership with those involved closer so as to increase the number of applicants for Miyakonojo College, the rate of students who work in the local community after graduation, and the acquisition of large competitive funds (subsidies for scientific studies).

Acknowledgments

In conducting the remote communications overseas, we received helpful advice from teachers of the English Department. We would like to express our deepest thanks.

References

1) The Ministry of Education, Culture, Sports, Science and Technology: "*Kongo no Kokuritsu Kotosenmongakko no Jujitsu ni kansuru Setsumei kai.*" 2016.
2) The KOSEN National Institute of Technology, Japan: http://www.kosen-k.go.jp/
3) The Glocal Education and Research Center for Agricultural Engineering: "*Heisei 29 Nendo "KOSEN 4.0" Initiative Kosen kara no Innovation Chosen Report.*" 2018.
4) TAKAHASHI Akihiro, NAKIYAMA Yasuhiro, SHI Yasuyuki and others. "*Global Kyoiku to Gakusei no Ishiki Chosa.*" Research Report of The National Institute of Technology (KOSEN), Kagoshima College, Vol. 47, 2012. 5-12.
5) The Techno Center for Collaborative Research and Education of the National Institute of Technology

(KOSEN), Miyakonojo College: “*Noko Renkei ni Muketa Senshinteki Torikumi Jirei: Kyushu Keniki wo Chushin toshita Chosahokoku*.” 2014.
6) The Techno Center for Collaborative Research and Education of the National Institute of Technology (KOSEN), Miyakonojo College: “*Kosen Kyoiku ni okeru Nogyo Kogaku Curriculum no Gutaiteki Kento: Miyakonojo KOSEN deno Shikoteki na Jikken Kyozai Kaihatsu*.” 2015.
7) TAKAHASI Akihiro, HAMADA Eisuke, SATO Asaji and others. “*Nokorenkei no Senshinteki Jirei to Kosenkyoiku eno Nigyokyoikudonyu no Kento*.” Research Report of The National Institute of Technology (KOSEN), Miyakonojo College, Vol. 50, 2016. 55-61.
8) TAKAHASI Akihiro, SATO Asaji, SHIRAIWA Hiroyuki and others: “*Kosen Kyoiku ni okeru Agri Engineering Kyoiku no Kento*.” Research Report of The National Institute of Technology (KOSEN), Miyakonojo College, Vol. 51, 2017. 62-73.
9) TAKAHASHI Toru, KIKUGAWA Hironori, KARUBE Shu and others. “*Agri Engineering Kyoiku no Tenkai: Kogaku Gijutsusha no tame no Nogaku Gairon*.” Research Report of The National Institute of Technology (KOSEN), Oita College, Vol. 54, 2017. 16-20.
10) TAKAKI Koichi, TAKAHASHI Toru, HAMADA Eisuke: *Kogaku Gijutsusha no tame no Nogaku Gairon*. Riko Tosho, 2018.
11) Miyazaki Nichinichi Shinbun, March 14 of 2018.

PRELIMINARY DEVELOPMENT OF A SELF-DIRECTED LEARNING INDEX FOR POLYTECHNIC STUDENTS

A. Vedamuthu[*,a], J. Periasamy[b]

[a] Republic Polytechnic/Centre for Educational Development, Lecturer, Singapore
[b] Republic Polytechnic/School of Engineering, Senior Lecturer, Singapore

*andrew_v@rp.edu.sg

Abstract

It is essential to develop Self-Directed Learning (SDL) skills in students to assist them to become lifelong learners in the ever-changing world. This study reports on the development of a SDL index that could be used to identify SDL abilities in students enrolled in a polytechnic in Singapore where learner-centred instructional approaches, such as, Problem-Based Learning, Cognitive Apprenticeship, Project-Based Learning and Interactive Seminars are utilized. Three pilot studies (Phases 1 – 3) were carried out prior to this study which involved the testing of reflective items whilst Phase 4 examined the formative items.

889 students, who were enrolled in various diploma programmes, voluntarily participated in the online survey comprising 46 items. Structural equation modelling and the variance-based approach, also known as, the partial least squares structural equation modelling, was used to analyse the data and develop a model of seven factors, namely, Assess Task, Evaluate Expertise, Plan Approach, Monitor Progress, Adjust Strategies, Learning Motivation and Collaborative Communication. The R-squared value of the dependent latent variable SDL is a respectable 0.650 when all seven factors predict SDL with Collaborative Communication being a mediating factor between Learning Motivation and SDL. The higher t-statistics between the path of Learning Motivation and SDL shows that Learning Motivation is a stronger predictor of SDL compared to Collaborative Communication and that Learning Motivation also predicts Collaborative Communication albeit, to a lesser extent. This leads one to infer that the greater the motivation is for a student to learn, the higher the engagement in self-directed learning.

The authors propose that the seven-factor SDL model should be further modified by examining indicators that were highly correlated to one other. The SDL model could be refined by re-evaluating the wordings of these items so that they could either be improved to enhance comprehension or removed completely to avoid redundancies.

Keywords: *Self-Directed Learning, Index Development, Structural Equation Modelling, Partial Least Squares, Problem-Based Learning, Cognitive Apprenticeship, Project-Based Learning, Interactive Seminars*

Introduction

SDL is becoming important in the education environment as the changing employment landscape necessitates lifelong learners. Learners who are trained to be self-directed learners "will be better prepared as employees to anticipate their organization's needs, tailor their learning to meet their own unique learning styles, and acquire the necessary skills, knowledge, and abilities to create value for their organizations" (Artis & Harris, 2007; Cron, Marshall, Singh, Spiro, & Sujan, 2005; Tobin, 2000).

In view of this, it is important to develop an instrument that identifies SDL skills so that learners can be taught to become better self-directed learners. Several attempts to develop generic and domain specific SDL instruments have been undertaken (Guglielmino, 1977; Cheng, Kuo, Lin, & Jane, 2010). However, there is a need to develop an instrument to measure self-directed learning amongst learners engaged with student-centric instructional approaches, such as, Problem-Based Learning (PBL), Cognitive Apprenticeship (CA), Project-Based Learning (PjBL) and Interactive Seminars (IS). This study attempts to bridge that gap.

Knowles (1975, p.18) describes self-directed learning to be, "a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating their learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes." Mayer and Ambrose (2010, p. 191) have proposed a principle that encompasses this process: "To become self-directed learners, students must learn to assess the demands of the task, evaluate their own knowledge and skills, plan their approach, monitor their progress, and adjust their strategies as needed. This principle lays out the key metacognitive skills that are critical to being an effective self-directed (also called "lifelong") learner. Additionally, Nagpal, Priyamkhija, James & Gyanpakash (2013) and Donaghy (2006) suggest that students engaged in self-directed learning acquire knowledge by deciding on who to collaborate and communicate with and what to learn from that collaborative communication aptly supporting Knowles'

(1975) description that self-directed learning could take place with the help of others and effecting collaborative communication as a mediating variable. Knowles (1975, p.18) also suggests that self-directed learners ‘need to take the initiative”. Literature suggests that several motivational factors can arise and be measured when learners take the initiative to learn: (1) Learners can vary in their certainty that they will succeed in understanding the task (Atkinson, 1957; Bandura, 1977). (2) Learners can be different in anxiety about failing in the task (Atkinson, 1957) (3) Learners can perceive this task as a challenge (Czikszentmihalyi, 1975). (4) The task may or may not evoke the learner’s interest (Schiefele, 1991). All these motivational factors are shown to affect learning. Thus, Learning Motivation can also be deemed a variable that predicts self-directed learning.

Methodology

The SDL scale of Phase 3 was elaborated to produce a more refined model for this study. A total of 46 formative items were constructed across seven factors by the two researchers with background in psychology, statistics and student-centric instructional approaches, such as, PBL, CA, PjBL and IS. These items were pilot tested with a group of ten students who mapped the items onto an SDL framework that was specially prepared for them. The items were further modified based on the interviews with the students. Finally, an expert in PBL and linguistics assisted with the rewording of the items to ensure conventional guidelines regarding clarity, length, directionality, lack of ambiguity and avoidance of jargon, were adhered to. This assured content validity in the design of test items. In the development of survey items from Phase 3 to Phase 4 of this study, it was endeavoured to maximise the variance explained by the self-directed learning factor, i.e., R-squared by including three factors that are integral to assessing self-directed learning, namely, Assess Task, Evaluate Expertise, and Adjust Strategies.

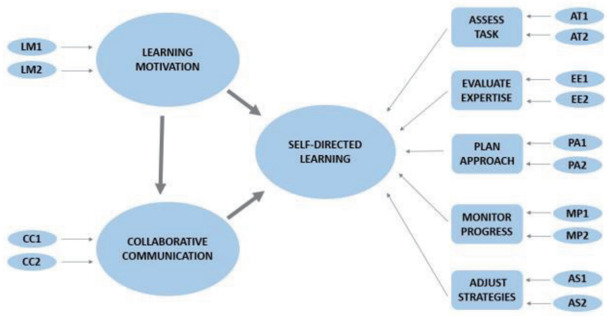
All ratings were made on Likert 5-point scales and ranged from 1 (strongly disagree) to 5 (strongly agree). 968 randomly selected students voluntarily participated in the study. Upon data cleansing, 889 records were subjected to further statistical analysis. No items had skewness or kurtosis more than an absolute value of 3. Exemplars of the SDL index are given in Table 1 below.

Table 1: Seven factors of self-directed learning

Domain	Exemplars (Survey Items or indicators)	Number of indicators
Learning Motivation	I am eager to learn new information	10
Assess Task	I figure out what I know about the learning activity	4
Evaluate Expertise	I am aware of how much time I need to complete the learning activity	5
Plan Approach	I plan goals to complete the learning activity	7
Monitor Progress	I keep track of the learning goals that I need to achieve	8
Adjust Strategies	I adjust my learning to suit different situations	3
Collaborative communication	I learn the content better through my interactions with my classmates	9

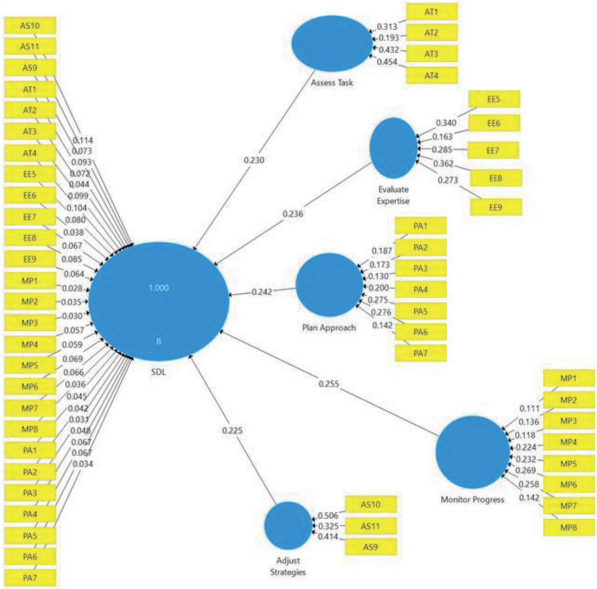
SmartPLS 3 (Ringle, Wende & Becker, 2015), a software for partial least squares structural equation modelling (PLS-SEM) was used to analyse the data. The proposed model in Figure 1 was developed using the repeated indicator approach in SmartPLS 3 in a two-stage approach since SEM offers a solution to the two-stage approach by simultaneously testing the validity of the scales used in the measurement model and its links among the structural model (Lowry & Gaskin, 2014).

Figure 1: Proposed SDL Model



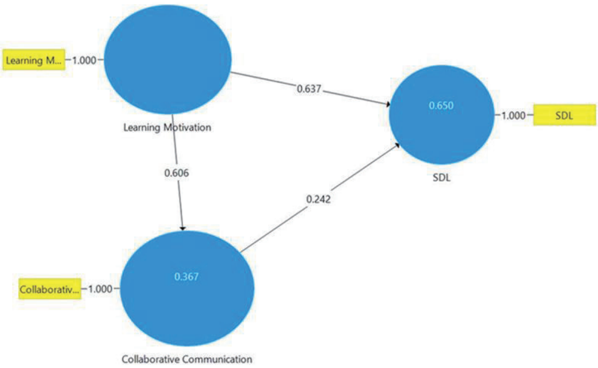
The recommended minimum amount of data was satisfied with a final sample size of 889, providing a ratio of well over 80 cases per variable. Figure 2 illustrates the weight of each indicator onto its respective first order latent variable: Assess Task (AT), Evaluate Expertise (EE), Plan Approach (PA), Monitor Progress (MP) and Adjust Strategies (AS), using the repeated indicator approach. The arrows point from the indicator to the latent variable as the indicators are formative. The second order factor in this model is self-directed learning and the paths are from the first order latent variables to SDL as SDL is formed by these latent variables.

Figure 2: Repeated Indicator Approach – Outer Weights and Path Coefficients



Two more latent variables, Learning Motivation (LM) and Collaborative Communication (CC) were added to the model to predict SDL but since SDL is fully predicted by AT, EE, PA, MP, and AS, the R-squared for SDL is 1 as it has been swamped by the five latent variables from the repeated indicator approach. To overcome this swamped effect, latent variable scores are extracted and used as indicators in the subsequent path model or two-stage approach (Lowry & Gaskin, 2014). Figure 3 illustrates the paths in the two-stage approach.

Figure 3: Two-Stage Approach - Path Coefficients



Results and Discussion

First, the discussion on the outer measurement model (i.e., studying the paths between the indicator and the latent variable) ensues. For the repeated indicator approach, the weights are shown in Figure 2 (e.g., the weight of the indicator AT1 onto AT is 0.313 etc.) and the weights are respectable for formative indicators. A bootstrap with 5000 subsamples gives the values of the t-statistics for these weights and provides evidence of the significance of the weights of each indicator within each latent variable. All items on the latent variable should have a significant t-statistic in order to demonstrate adequate validity. As shown in Table 3, the data meet this criterion. The variance inflation factors (VIF) were examined for each path indicator and these values are all less than 5 indicating there were no multi-collinearity issues.

Table 2 T-statistics for Validity

Factor (Latent variable)	Survey Item or indicator	t-statistic	VIF
Assess Task	AT1	5.791*	1.409
	AT2	4.061*	1.274
	AT3	8.708*	1.197
	AT4	9.144*	1.253
Evaluate Expertise	EE5	7.047*	1.353
	EE6	3.213*	1.427
	EE7	6.095*	1.325
	EE8	8.611*	1.365
	EE9	6.290*	1.398
Plan Approach	PA1	4.460*	1.521
	PA2	4.231*	1.476
	PA3	2.717*	1.870
	PA4	3.928*	1.854
	PA5	5.727*	1.896
	PA6	5.998*	1.709
	PA7	4.058*	1.252
Monitor Progress	MP1	3.620*	1.321
	MP2	4.202*	1.265
	MP3	3.371*	1.559
	MP4	6.287*	1.489
	MP5	6.573*	1.678
	MP6	7.405*	1.467
	MP7	7.436*	1.498
	MP8	4.848*	1.222
Adjust Strategies	AS9	8.399*	1.501
	AS10	10.778*	1.477
	AS11	7.322*	1.278

*$p < 0.001$

Second, a discussion on the structural model ensues. Table 3 summarises the paths between the latent variables. The path coefficients are roughly equal in weights, which is the acceptable norm. The t-statistics for path weights from the first order factors (AT, EE, PA, MP, AS) to the second order SDL factor are also significant with very strong t-statistic values. The VIF were examined for each path and these values are all less than the widely accepted value of 5. Hence there are no multi-collinearity issues with the first order factors.

Table 3 Summary of Path Coefficients and Significance Levels

Hypotheses and corresponding paths	Path coefficient	t-statistic	VIF

Assess Task → SDL	0.229	59.636*	2.018
Evaluate Expertise → SDL	0.235	61.298*	2.211
Plan Approach → SDL	0.241	56.523*	2.815
Monitor Progress → SDL	0.255	58.967*	3.618
Adjust Strategies → SDL	0.224	66.479*	1.953

*$p < 0.001$

The path coefficients shown in Figure 3, are also known as the regression coefficients when SDL is predicted by LM mediated by CC. A bootstrap with 5000 subsamples gives the values of the t-statistics for these weights (Table 5), which are significant at the 0.001 level of significance.

The R2 value of the dependent latent variable SDL is a respectable 0.650 when all seven factors predict SDL with Collaborative Communication a mediating factor between LM and SDL.

The higher t-statistics between the path of LM and SDL shows that LM is a stronger predictor of SDL compared to CC and that LM also predicts CC however, to a lesser extent. This leads one to infer that the greater the motivation is for a student to learn, the higher the SDL attributes.

Table 4: Summary of Path Coefficients and Significance Levels Two-stage - Phase 4.

Hypotheses and corresponding paths	**Path coefficient**	**t-statistic**	**VIF**
Learning Motivation → SDL	0.635	23.095*	1.580
Learning Motivation → CC	0.605	16.158*	1.000
Collaborative Communication → SDL	0.242	7.755*	1.580

*$p < 0.001$

Conclusions

The survey instruments in the literature on self-directed learning appear to have a limited transfer to the settings underpinned by the instructional strategies such as, PBL, cognitive apprenticeship, interactive seminars, and project-based learning. Hence this pilot study was undertaken to create a SDL index to explore self-directed learning in polytechnic students when learning takes place in these specific settings. The items were developed around the seven main factors of self-directed learning. The formative indicators were modelled in Smart PLS 3 establishing a valid factor structure. These findings provide a strong empirical support of the emergence of seven factors, namely, Learning Motivation, Assess Task, Evaluate Expertise, Plan Approach, Monitor Progress, Adjust Strategies, and Collaborative Communication explaining a very respectable variation R-squared of 0.650 in SDL. The content validity and predictive validity of these seven factors were also established.

It is thus envisaged that this study has the potential to influence curriculum developers to transform both curriculum, and teaching and learning approaches with the aim of developing self-directed learners who are prepared for the demands of the 21st century workplace by engaging in lifelong learning.

References

Artis, A. B., & Harris, E. G. (2007). Self-directed learning and sales force performance: An integrated framework. *Journal of Personal Selling and Sales Management*, *27*(1), 9-24.

Atkinson, J. W. (1957). Motivational determinants of risk-taking behavior. *Psychological Review*, 64, 359-372.

Bandura, A. (1977). Self-efficacy: Towards a unifying theory of behavior change. *Psychological Review*, 84, 191-215.

Casey, D., Burke, E., Houghton, C., Mee, L., Smith, R., Putten, D. V., & Folan, M. (2011). Use of peer assessment as a student engagement strategy in nurse education. *Nursing & Health Sciences*, *13*(4), 514-520. doi:10.1111/j.1442-2018.2011.00637.

Cron, W. L., Marshall, G. W., Singh, J., Spiro, R. L., & Sujan, H. (2005). Salesperson selection, training, and development: Trends, implications, and research opportunities. *Journal of Personal Selling and Sales Management*, 25, 123-136.

Czikszentmihalyi, M. (1975). *Beyond boredom and anxiety*. San Francisco, CA: Jossey-Bass.

Donaghy, Robert C. (2006). *"It permeates the whole fabric of your life": The experience of scholars who have studied self-directed learning,* Retrieved from http://newprairiepress.org/aerc/2006/papers/16.

Guglielmino, L. M. (1977). *Development of the Self-Directed Learning Readiness Scale.* (Ed. D Thesis) University of Georgia, Athens, GA. Proquest Dissertations and Theses database. (7806004)

Knowles, M. S. (1975). *Self-directed learning: A guide for learners and teachers*. New York, NY: Association Press.

Mayer, R. E., & Ambrose, S. A. (2010). *How learning works: Seven research-based principles for smart teaching.* San Francisco: Jossey-Bass.

Nagpal, K., Priyamakhija, James, L., & Gyanprakash. (2013). Independent Learning and Student Development. *International Journal of Social Science & Interdisciplinary Research, 2*(2), 32-33.

Ringle, C. M., Wende, S., & Becker, J.-M. (2015). *SmartPLS 3*. Bönningstedt: SmartPLS

Schiefele, U. (1991). Interest, learning, and motivation. *Educational Psychologist*, 26, 299-323.

Lowry, B, P. and Gaskin, J. (2014). Partial Least Squares (PLS) Structural Equation Modeling (SEM) for Building and Testing Behavioral Causal Theory: When to Choose It and How to Use It. *IEEE Transactions on Professional Communication, 57*(2),

DEVELOPMENT OF AN AUTHENTIC ASSESSMENT FOR AN ELECTIVE MODULE IN DIPLOMA IN CIVIL ENGINEERING COURSE

T. Law*,[a] and QS. Liu[a]

[a] Singapore Polytechnic, Singapore

*tracy_law@sp.edu.sg

Abstract

Singapore Polytechnic as a vocational training institution is to prepare our graduates to be "life ready, work ready and world ready." We aim to design learning experiences that help students develop the necessary knowledge, skills and attitudes required for professional practice.

This paper aims to develop an authentic assessment for an elective module in the final year of the Diploma in Civil Engineering course with the objective of enhancing the skills and competencies of students, with a glimpse on how engineers work in reality. The students are to apply their critical thinking and problem-solving skills to solve real-life engineering problems, which are usually ill-structured and come with multiple possible solutions, by making reference to guidelines stipulated by the professional bodies.

The assignment is designed with the Messick's (1994) construct-driven approach that the entire assessment is designed to elicit the construct of problem solving and critical thinking skills in the students. The assignment also adopts the five-dimensional framework proposed by Gulikers, Bastiaens and Kirschner (2004) as the overarching framework to design the authentic instruction and assessment. The five-dimensional elements include the assessment task, physical context, social context, assessment form and assessment criteria. The detailed assessment instruction and rubrics will be proposed in this paper.

The limitation and challenges of the proposed authentic assessment are also discussed. Some of the crucial and real issues, such as budget constraints and on-site construction challenges etc., in any engineering projects are excluded in a controlled environment in school. Other issues include the lack of opportunity in giving formative feedback and the concern of fairness in assessing each member in a group project.

Keywords: *Authentic Assessment, Civil Engineering, Assessment Rubric, Five-dimensional framework*

Introduction

The mission for Singapore Polytechnic as a vocational training institution is to prepare our graduates to be "*life ready, work ready and world ready.*" We have to design learning experiences that help students develop the necessary knowledge, skills and attitudes required for professional practice. Traditional assessment methods involving knowledge transmission and rote learning are not sufficient to achieve our mission. This is especially the case for polytechnic engineering education. In the context of engineering practice, the issues involved are often complex, ambiguous and come with open-ended solutions. For example, an engineering design problem for a particular situation (such as a building, a civil structure or a mechanical system) could have multiple workable solutions that require various trade-offs among various desired parameters such as safety, regulations, reliability and cost.

Authentic assessment, as defined by Wiggins (1993), involves "*engaging and worthy problems or questions of importance… tasks are either replicas of or analogous to the kinds of problems faced by... professionals in the field*" (p.229). Hence, authentic assessment is very appropriate for and has become a preferred choice in designing the learning experience in engineering education so that the students can learn and apply the technical skills in context and develop all the necessary professional skills needed in solving real world problems.

In this paper, an authentic assessment were designed for an elective module for the third year students from the Diploma in Civil Engineering course in Singapore Polytechnic. The students are to apply their critical thinking and problem-solving skills to incorporate design features that can enhance the surface water drainage system and beautify the surroundings at a given plot of land, by making reference to guidelines stipulated by the professional bodies.

Literature Review

Authentic assessment is not new in engineering education. It has been widely used worldwide since more than a decade ago. Wellington, Thomas, Powell and Clarke (2002) describe the use of multidisciplinary industry projects to assess how students apply technical knowledge to solve real life problems as well as how they work collaboratively in multidisciplinary teams in Monash University. Wellington et al (2002) note that the traditional education tends to have well-defined questions with definite solutions. However, the problems in the real world are always ill-structured with multiple possible solutions. Engineering students have to be trained and prepared for real-world situations.

The Faculty of Engineering and Surveying in University of Southern Queensland also adopted the problem-based learning (PBL) course to ensure that their graduates learnt to work well in multidisciplinary teams as well as acquired all the professional skills required by professional accreditation bodies (Gibbings and Brodie, 2008). The use of individual self-assessed skills portfolio in the PBL course serves as an effective tool to encourage the achievement of higher level of skills and competences or the development of new skills rather than simply assessing the students on whether they have met the predetermined minimum level of skills. This echoes the divergent assessment mentioned by Hargreaves, Earl and Schmidt (2002) which focuses on the students' understanding rather than on meeting the predetermined standard set by the assessors.

Shuman, Besterfield-Sacre and McGourty (2005) discuss how the six soft skills identified by Accreditation Board for Engineering and Technology can be taught and assessed through engaging students in realistic situations in various US institutions. Shuman et al (2005) also highlight that participating in global community projects to provide engineering solutions to the less fortunate is a good way for engineering students to understand the contemporary issues and appreciate the impact of engineering solutions on society, including globally. All the above literature illustrate that authentic assessment has been widely adopted in engineering education worldwide as the professional skills and competencies will be best developed and appropriately assessed in a simulated real world environment.

To develop an authentic assessment in the context of professional practice, the five-dimensional framework proposed by Gulikers, Bastiaens and Kirschner (2004) gives a very well structured guide for designing authentic assessment particularly in the field of vocational training. The five dimensions of authentic assessment are: (1) the assessment task; (2) the physical context; (3) the social context; (4) the assessment result or form and (5) the assessment criteria. The five-dimensional framework in designing authentic assessment is further validated through a qualitative study among nursing college students and teachers. All participants of the study agreed that the proposed framework captures the essential dimensions and elements in designing authentic assessment. However, the findings in the study suggested that elements such as assessors and organisation issues should be included to complete the framework. Incidentally, these two elements were among the challenges identified by Hargreaves et al (2002) in the technological perspective when implementing authentic assessment. In view of the relevance in vocational training, the five-dimensional framework proposed by Gulikers et al (2004) was used as the overarching framework to design the authentic instruction and assessment in this paper.

Description of the Authentic Assessment

"ABC Waters Design" is one of the elective modules offered in the third year of the Diploma in Civil Engineering course in Singapore Polytechnic. The module aims to provide students with the knowledge of the most current storm-water management system adopted by PUB, the National Water Agency in Singapore. Students will appreciate the planning, design and performance of "Active, Beautiful, Clean" (ABC) water design features, as well as the safety considerations, public health & maintenance of the systems. Students will also learn how these principles act together to achieve a sustainable environment.

There are six ABC Water Design features introduced in the module, namely vegetated swales, bio-retention swales, rain gardens, sedimentation ponds, wetlands and cleansing biotopes. All these features will help, to different extents, to reduce the runoff volume, slow down the flow rate in the drains, cleanse the water and beautify the surrounding areas. Each feature has its own characteristics and the type of features to be implemented depends on the existing ground profile and the intended purpose of having such features (e.g. to slow down the runoff, or to provide temporary detention of the runoff, or to cleanse the runoff to meet certain water quality standards). Sometimes a combination of two or more features has to be implemented on site in order to meet the intended purposes.

Construct of interest

As the students are in their final year, it is important to expose them to real-life engineering problems, which are usually ill-structured and come with multiple possible solutions. The assignment is designed with the Messick's (1994) construct-driven approach that the entire assessment is aimed to elicit the construct of problem solving and critical thinking skills in the students. These are essential skills for engineering graduates to carry out their professional responsibilities in their future workplace. The assignment requires students to integrate and synthesise their prior and current engineering knowledge to come up with solutions that can meet the requirements stipulated by the professional bodies.

The Five-dimensional Framework

The assessment is designed based on the five dimensional framework proposed by Gulikers et al (2004). Each of the five dimensions is discussed in detail in the following.

Assessment Task. An authentic task should similar to the tasks carried out in professional settings. In this task, students are to apply the ABC Waters design concepts to re-design the stormwater management system at a given plot of land to achieve a sustainable urban environment. The task include the following:

1. Assess the existing site conditions such as the natural topography, land use and community involvement
2. Compute the amount of runoff from the site by making reasonable engineering assumptions
3. Select suitable types of ABC Waters design features to be implemented on site so that it can reduce the runoff downstream, improve water quality and enhance community engagement
4. Discuss the possible operational and maintenance challenges of the proposed features

Physical Context. The elements involved in creating the authenticity of physical context include the environment, availability of resources and time which should resemble that of the criterion situation. In this assessment, students are given a specific plot of land within the Singapore Polytechnic campus. Students are to refer to the guidelines in the Code of Practice of Surface Drainage and the Engineering Procedures for ABC Waters Design Features stipulated by PUB. They will be given two weeks to complete the task.

Social Context. The social context created in the assessment should resemble the social processes in similar real-life situations. No engineer can work alone in any real engineering projects. Collaboration is a norm in all engineering practice so all projects will be done in teams. In this assessment, students are to be grouped into teams of 4 or 5 students to complete the task. This assignment is intentionally designed to provide a platform for the students to collaborate and work as a team. However, teamwork and collaboration effort are not formally assessed in this assignment. Instead, a simple peer assessment is used to differentiate the contribution among the team members.

Assessment Form. The results of the assessment should be of multiple indicators to demonstrate the skills or competencies required of the students. The proposed deliverables in this assessment include:

1. Written report (80%)
   Students have to document their findings and argument in writing. They should include all the engineering calculations, analysis and evaluation, as well as recommendations in the report.
2. Oral presentation (20%)
   Students are to present their findings in an oral presentation. This allows the lecturers to assess if the students can articulate their findings coherently and concisely. In addition, students should be able to "*defend their work to ensure that their apparent mastery is genuine*" (Gulikers et al, 2004). This will allow the lecturers to assess the understanding of the individual members in the team.
3. Peer Assessment
   Students will evaluate one another's contribution to the team effort and each team member will have a modifying factor based on the peer assessment. The final score of each individual will be multiplied by this modifying factor (Wellington et al, 2002).

Assessment criteria. A criterion referenced assessment rubrics are made known to the students in the beginning of the project so that they can fully understand how they will be assessed. This is similar to what is being done at the workplace in which employee should be aware how their performance is being evaluated. Table 1 shows the rubrics of this assessment. The written report, which aims to evaluate the key construct of this assignment, i.e. the problem solving and critical thinking skills, is assessed based on the following four criteria:

1. Ability to conduct site observation and evaluation
2. Ability to perform engineering calculations
3. Ability in engineering reasoning and evaluation
4. Ability to manage ambiguities

The oral presentation is assessed based on the students' ability to communicate and convey key ideas. To ensure the reliability of this assessment, i.e. the consistency of grading, the criteria and standards in the assessment rubrics are deliberated in the teaching team to ensure that all assessors share the same understanding of the requirements in the rubrics. A moderation session will also be held before deciding the final grading of the students.

Discussion: Limitations and Challenges

The level of authenticity of any assessment is a continuum. Cumming and Maxwell (1999) highlighted that the performance based assessment is always performed in a controlled environment in school and true authenticity can never be attained until the performance is carried out in a genuine employment situation. The proposed authentic assessment in this paper excludes some of the very crucial and real issues, such as budget constraints and on-site construction challenges etc., in any engineering projects. These issues are relevant to the construct that we are assessing. However, because of the constraints of time and resources, we have to scope the project accordingly. With the presence of other authentic elements in the assessment, the fidelity of the assessment in eliciting the key construct will not be undermined.

While authentic assessment is preferred over pen and paper testing especially in the context of vocational training, there are many practical issues during implementation. Hargreaves et al (2002) brought up the many issues in the technological perspective that time and resources are always the challenge in implementing authentic assessment. "ABC Waters Design" is a compressed module which is to be completed in half a semester, i.e. 7 weeks. The lecturers need to cover sufficient content before the students can kick-start on this project. Hence the students will likely be given at most 2 weeks to complete the entire project. The timeframe is considered very short when compared to projects in real industrial practice. If more time is allowed, the project could be divided into phases and the lecturers could have given formative feedback to the group during some kind of interim report or presentation.

Table 1 Rubrics for the Written Report and Oral Presentation

	Criteria	1-2	3-4	5-6	7-8
Written Report (80%)	Ability to conduct site observation and evaluation (15%)	Site observation is superficial and lacks details. Able to identify few key areas of concern on site.	Site observation is somewhat detailed. Able to identify some key areas of concern on site.	Site observation is thorough and covers most of the aspects. Able to identify most of the key areas of concern on site.	Site observation is thorough and covers every single detail. Able to identify all the key areas of concern on site, including the less obvious potential issues.
	Ability to perform engineering calculations (20%)	Few formulae are applied appropriately in accordance to the Code of Practice. Calculations are rarely correct.	Some formulae are applied appropriately in accordance to the Code of Practice. Calculations are mostly correct with some errors.	Most formulae are applied appropriately in accordance to the Code of Practice. Calculations are mostly correct with few errors.	All formulae are applied appropriately in accordance to the Code of Practice Calculations are perfectly done with no errors.
	Ability in engineering reasoning and evaluation (30%)	Able to identify a design but unable to provide any supporting evidence.	Able to identify a design with some supporting evidence.	Able to carry out thorough analysis and explain the decision making process with substantial amount of supporting evidence	Able to reflect and consider alternatives, as well as evaluate the various options with rigorous analysis and justify the decision making process with strong evidence.
	Ability to manage ambiguities (15%)	Able to make limited assumptions with no justification.	Able to make some assumptions with no justification.	Able to make reasonable assumptions with limited justification.	Able to hypothesise a realistic situation and make reasonable assumptions with justification
Oral Presentation (20%)	Ability to communicate and convey key ideas (20%)	Flow of presentation is unstructured. Information presented is incomplete. Presenter is unable to articulate viewpoints clearly.	Flow of presentation is somewhat structured. Information presented is mostly complete. Presenter is able to articulate viewpoints clearly on some occasion.	Flow of presentation is mostly coherent. Information presented is complete. Presenter is able to articulate viewpoints clearly most of the time	Flow of presentation is coherent Information presented is extensive. Presenter is able to articulate viewpoints clearly all the time.

Wiggins (2011) advocates that authentic assessment should be used as a tool to scaffold students' learning and the results of authentic assessment should support the students' future learning and thus should be formative.

Besides the time constraints, another concern is on the fairness in assessing each member in the team. There are always concerns on how to fairly assess the contribution made by each individual towards the group effort. It is always a challenge to differentiate which team member has contributed most to the group effort with substantial evidence. Peer assessment is often used as a tool or evidence to reward or penalise the contributors and non-contributors. However, Hargreaves et al (2002) highlight some of the practical issues in assessing affective attributes that there are times when "*the peer evaluation had degenerated into snitching and spying*" (p. 85). Students may not be competent to assess their peers fairly and adequately. To address this concern, Wellington et al (2002) suggest that students are required to go through training to understand the importance of peer assessment which aims to build and develop team performance. Also, students should be briefed in advance on the implication of the results of the peer assessment, i.e. it will be translated to a modifying factor to their final grading. By doing so, students are made to be more aware of the intended purpose and the likely consequences of the peer assessment and this can help to reward the true performers.

Conclusions

While there are many practical issues and challenges in implementing authentic assessment, it is evident that authentic assessment creates a very enriching learning experience in the context of vocational engineering training. The proposed authentic assessment in this paper willl definitely enhance the skills and competencies of the final year Civil Engineering students, with a glimpse on how engineers work in reality. With the implementation of authentic assessment in all courses, our polytechnic graduates can be better equipped and prepared for the challenges in the real world.

References

Gibbings, P., & Brodie, L. (2008). Assessment strategy for an engineering problem-solving course. *International Journal of Engineering Education*, *24*(1), 153-161.

Gulikers, J. T., Bastiaens, T. J., & Kirschner, P. A. (2004). A five-dimensional framework for authentic assessment. *Educational technology research and development*, *52*(3), 67-86.

Hargreaves, A., Earl, L., & Schmidt, M. (2002). Perspectives on alternative assessment reform. *American Educational Research Journal*, *39*(1), 69-95.

Joy Cumming, J., & Maxwell, G. S. (1999). Contextualising authentic assessment. *Assessment in education: Principles, policy & practice*, *6*(2), 177-194.

Messick, S. (1994). 1994: The interplay of evidence and consequences in the validation of performance assessments. Educational Researcher 23, 13-23.

Shuman, L. J., Besterfield-Sacre, M., & McGourty, J. (2005). The ABET "professional skills"—Can they be taught? Can they be assessed?. *Journal of engineering education*, *94* (1), 41-55.

Wellington, P., Thomas, I., Powell, I., & Clarke, B. (2002). Authentic assessment applied to engineering and business undergraduate consulting teams. *International Journal of Engineering Education*, *18* (2), 168-179.

Wiggins, G. (1993). Assessment: Authenticity, context, and validity. *Phi delta kappan*, *75*(3), 206-255.

Wiggins, G. (2011). A true test: Toward more authentic and equitable assessment. *Phi Delta Kappan*, *92*(7), 81-93.

Students` Emotions Analysis Using a Reflection Sheet Developed for a PBL Type Course and Compared with a PROG Test Analysis

Y. Kajimura[a] , S. Tanaka[b], T. Hiraishi[c] and J. C. Herbert[d]
[a]NIT, Akashi College/Electrical Engineering, Professor, Akashi, Japan
[b]NIT, Akashi College/Mechanical Engineering, Associate Professor, Akashi, Japan
[c]NIT, Akashi College/Architecture, Professor, Akashi, Japan
[d]NIT, Akashi College/General Studies, Professor, Akashi, Japan

*E-Mail kajimura@akashi.ac.jp

Abstract

In order to evaluate the educational effects of an interdepartmental and mixed-grade course for the Project Based Learning "Co⁺work" Project, this paper describes the analysis results of both reflection sheets for "Co⁺work" and questionnaire surveys based on student collaboration and socialization and competency tests through "Progress Reports on Generic Skills (PROG)." As a result, it can be seen that there was a significant correlation between the average of the emotion values described on the reflection sheet and the score of the PROG. The higher the PROG score students obtain, the smaller the change of the average emotions in the team is, it is suggested that students can control their emotions well if they have a high competency level.

Keywords: competency, interdepartmental, mixed-grade, autonomy, cooperation, PROG, Co+work

Introduction

We are facing rapid social changes due to the recent circumstances in which globalization generates more people who have a wider range and more diverse sense of values and in which the progress of ICT makes it faster to acquire information. This urges people to refresh and renew their own abilities constantly along with these social changes. Thus, an ability to keep learning actively has become much more significant now than ever before. We are also facing complicated problems that involve multidisciplinary issues which require an ability to cooperate with professionals from other fields to tackle this complexity. Rieckmann (2012) also said universities may play very different roles in the future and may be more or less able to cope with global change and the complexity and uncertainty linked to these changes. And, the necessity of regular subjects for the purpose of nurturing generic skills in Japanese undergraduate education are advocated by Yoshihara (2007).

Unfortunately, in Japan, due to the declining birth rate and a growing tendency to have "play alone" single-child families, today's youth have fewer opportunities to interact in groups. At the same time, passive education rather than active learning has remained mainstream in Japan. These situations make it difficult to cultivate competencies in collaboration, autonomy, and creativity. In our college, students rarely have a chance to cooperate with other students enrolled in different departments. They are all enrolled in one of four technical majors which are mechanical engineering, electrical and information engineering, civil engineering, and architecture. Thus, our college started the new course, "Co⁺work," as a compulsory credit to address the problem of that situation from 2016. The course includes three grades of students, 2nd, 3rd, and 4th year students, from each of the four departments. In total, 500 students were enrolled in this course in 2017 and were divided into 62 groups to match up with 62 faculty members. As a result, each group contained 8 or 9 students, and one teacher per group took care of his or her group as a coach. This course aimed to cultivate competency in autonomy, cooperation, and creativity through the interaction of students from the different fields as they tackled the same project. In the present paper, we investigate the relationship between the results of the student's emotion value described in the reflection sheets for the review of "Co⁺work" in every week and questionnaire surveys based on student collaboration and socialization and competency tests through "Progress Reports on Generic Skills (PROG)."

Methods

Reflection sheet in Co⁺work

The National Institute of Technology, Akashi College (NITAC) introduced Co⁺work to develop autonomy, collaboration, and problem-solving skills through experiments for creating goods or services that would make someone happy. And, we used reflection sheets for the review in every week, which were developed for the purpose of having students' record changes in their emotions as they went through each stage of their project (Saeki, et al., 2016). Table 1 shows the schedule of the Co⁺work course, which took place in 90-minute sessions on Thursday afternoons in the fisrt and second semester. Table 2 shows the reflection sheet for the review of Co⁺work in every week. All students must complete this sheet and submit it to the teacher of their own team. The teacher who should coach to their team must check their reflection sheet by understanding the latest status of the team.

Table 1 Schedule of Co^{+}work

Week	Overview
1st	Guidance and team making in the gym
2nd	Ice breaking and brainstorming activities with teammates in the gym
3rd– 6th	Theme setting by each team
7th – 12th	Project progression by each team
13th	Intermediate Presentations Four teams present their projects in one room. Seven minutes for presentations and 8 minutes for questions and comments.
14th – 15th	Reflection by each team. The teacher must have an interview with all students in thier team.
16th– 27th	Project progression by each team
28th	Final Presentations Poster session in the gym
29th – 30th	Reflection by each team. The teacher must have an interview with all students in own team.

Table 2 Review sheet for reflection in Co^{+}work

date	Review by myself	Emotion (select table.4)
Year/month/day	Today's activity	Emotion (select one on table.3)
	Successful thing and UnSuccessful thing	
	Activity plan for next week	
Ex. 2018/4/7	Ex. Determined the role of team members	Exhausting
	Ex. could not share the role of team members well	
	Ex. Decide roles appropriately and start activities	
…..	….	…..

Table 3 shows a list of the words we used for our students to describe their emotions. There are 24 words in total, which consist of 10 words of positive-side emotions and 14 for the negative-side. The word "やばい(Cool)" used to be spoken when people wanted to show a feeling of danger, but currently it turns out to describe an opposite meaning, so we categorize it into the positive. In the present analysis, we attempt to evaluate the changes of emotions of the students empirically. The positive-side words listed in table 1 get +1 and the negative ones take -1. If a word not listed in Table 3 was found or if it remains blank, zero point was given.

Table 3 Words of emotion in Review sheet (No list, No answer, zero point was given)

Emotion (Japanese)	+ or -	points
Fun (楽しい)	Positive words	+1
Interesting (おもしろい)		
Cool (やばい)		
Exciting(ワクワク)		
Admirable(感心した)		
Surprising(驚いた)		
Exciting(ドキドキ)		
Intense(テンション上がった)		
Inspiring(もっとやりたい)		
Enjoyable(嬉しい)		
Disagreeable(嫌だ)	Negative words	-1
Exhausting(疲れた)		
Tiresome(眠い)		
Confusing(わからなかった)		
Dull(退屈)		
Rushed(焦った)		
Boring(つまらない)		
Scary(怖い)		
Nervous(緊張した)		
Mortifying(悔しい)		
Regrettable(惜しい)		
Embarrassing(恥ずかしい)		
Pointless(興味なし)		
Undesirable(やりたくない)		

PROG-Test

Table 4 shows the competency structure used for the Progress Reports on Generic Skills Test (PROG) in PROG Hakusho Project (2016). The PROG was conducted on 26th January 2016 before Co^{+}work was implemented and on 17th January 2017 after Co^{+}work was completed. In accordance with PROG Hakusho Project (2016), the test consists of the following three types of computer adaptive questions:

1) *The bilateral selection format* which presents two ambiguous answer choices positioned side-by-side with hidden values and which forces the quick selection of one's first impression about the answer which they can relate to more closely.
2) *The scenario assumption format (short sentence)* which proposes answers that are generally considered to be positive for conflicting situations that anyone may be experiencing and asks how often the subjects have reacted in a certain way.
3) *The scenario assumption format (long sentence)* which proposes answers that are generally considered positive in response to conflicting situations that can occur in work places, and forces the selection of what actions to take in light of the subject's experience.

The examinees of the PROG are all students of the 2nd year, 3rd year, and 4th year. The results of PROG for the competency before and after "Co^{+}work" implementation had been summarized in the paper (Hiraishi 2016,2017). There is no obvious difference of Competency score between 2nd grade, 3rd grade and 4th grade students in 2016 before introducing Co^{+}work. After implemented Co^{+}work in 2017, competency of 4th grade students at NITAC is obviously higher than 1st grade students at national public university in all main category as shown in Table 4. Three competency of 4th year students more improved than 3rd year students as same as 3rd year students than 2nd year students.

Results and Discussion

Figure 1 shows average (annual, inter-member) emotion value E_t for all teams from 1 to 62. On the reflection sheet, the emotional words shown in Table 3 were entered, and the positive word was added +1, and the negative word was added -1, and the average value of the team was calculated. The horizontal axis is the team number, and the vertical axis is the average value of team emotions averaged over the year. Overall positive emotions prevail. Figure 2 shows week history of the average emotion value in team No. 51 indicated by the circle in Fig. 1. (Maximum value of average (annual, inter-member) emotion value in all teams). This shows their positive emotions in every week. The theme of this team is "Proposing a KOSEN fashion". They finally proposed 4 types of fashion in four seasons and made their activity successful. On the other hand, Figure 3 shows week history of the average emotion value in team 26 (Minimum value of average (annual, inter-member) emotion value in all teams).Although the average of member's emotion value increased at 6th week, the team's emotion did not become positive even if the activity progressed thereafter. The activity theme of this team 26 is to create a historical airplane paper craft model. Figure 4 shows the average (annual, inter-member) amount of change in emotion value for all teams.The amount of change in emotion value means the difference between the team emotion average value at (N) th and (N+1)th week.

Figure 5 shows week history of the average emotion value in team 15 (Maximum amount of change in emotion value in all teams). The theme of this team's activity was to make a rocking chair for someone to rest. The emotions of the whole team are negative at 11 weeks. The reason for this may be that motivation has dropped across the entire team following a severe point at the interim report meeting. Figure 6 shows the distribution of PROG Score (average) on average emotion value E_t (n=496). As this figure shows, there is a positive correlation between positive emotion values and good PROG results. In other words, students who can obtain good results in the PROG can generally control their emotions in the team's activities positively. Figure 7 shows the distribution of PROG Score (average) with respect to the average amount of change in emotion value Ct (n=496). As this figure shows, it can be seen that the larger the change in emotion value, the lower the score on PROG. It is suggested that the high scores of the PROG keep the team's emotional value fluctuation low.

Table 4 Competency Structure of PROG

	Main Categories	Subcategories	Specific Characteristics
Competency	Collaboration	Affinity	Friendliness
			Consideration of others
			Interpersonal interest, sympathy, acceptance
			Understanding, awareness, and tolerance of diversity
			Fostering of personal relationships
			Trust building
		Cooperation	Understanding of roles and collaborative behavior
			Information sharing
			Mutual support
			Consultation, guidance and motivation of others
		Leadership	Dialogue engagement
			Opinion sharing
			Constructive and creative discussion
			Adjustments of opinion, negotiation and persuasion
	Autonomy	Emotional control	Self-awareness
			Stress tolerance
			Stress management
		Creating confidence	Understanding of identity
			Self-efficacy and optimism
			Self-transformation by being open to new learning viewpoints and opportunities
		Sustaining action	Proactive behavior
			Accomplishment
			Making good behavior habitual
	Problem solving	Finding problems	Information collection
			Understanding the essence of the problem
			Cause pursuit
		Planning a solution	Goal setting
			Scenario creation
			Plan evaluation
			Risk analysis
		Implementing the plan	Action taking
			Modification and adjustment
			Verification and improvement

Conclusions

In the present paper, we investigated the relationship between the results of the student's emotion value described in the reflection sheets for the review of "Co$^+$work" in every week and questionnaire surveys (PROG)." As a result, it can be seen that there was a significant correlation between the average of the emotion values described on the reflection sheet and the score of the PROG. The higher the PROG score students obtain, the smaller the change of the average emotions in the team is, it is suggested that students can control their emotions well if they have high competency level. Also we showed 14 effective words adopted in the reflection sheet to choose one's emotions during class work. This paper argued that it would be effective for coaching teachers to gather their student's reflection and comments of emotion on the contents and the tasks and interactions of each class as the semester goes along in order to improve their effects to foster active learning. As we see above, the review sheet from the PBL-style class showed us the students' status and changes regarding emotion along with the contents of classes. It may be a great source for teachers to consider how to coach students or when to intervene with teams. In addition, it may bring up the possibility and influence the fostering of meta-perception by checking with the past events when we look back for a middle or long range.

Acknowledgement

A part of this research is supported by funding from MEXT for the "Acceleration Program for University Education Rebuilding: Theme I 'Active Learning' in Japan."

References

Marco Rieckmann (2012). Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? Futures 44 (2012) pp.127–135.

Keiko Yoshihara (2007). The Development of Generic Skills in Higher Education, The Trend in Westem Countries and Some Issues, pp.163-178, Hyogo University Paper Collection, 31/03/2007.

R. Saeki, T. Hiraishi, Yu Ishida, Yuriko Ishida, Y. Kajimura and N. Takeda (2016). Review Sheets to Record Changes of Students' Emotions, 10th International Symposium on Advances in Technology Education in Sendai, 13-16 September 2016.

PROG Hakusho Project (2016). PROG Hakusho 2016 現代社会をタフに生き抜く新しい学力の育成と評価: Gakugishupan　学事出版, 2016.

Toshiaki Okumura, Koji Kawasaki, Taku Sato, Kazuhiro Wako, Kunihiro Yajima(2017). 仙台高専ジェネリックスキル測定テスト実施報告～平成２６、２７年度比較分析と平成２８年度速報値～, 22th Kosen Symposium in Mie, 28th January 2017.

T. Hiraishi, J. C. Herbert, Y. Kajimura and S. Fujiwara (2017). Educational Effects of PBL "Co$^+$work", 11st International Symposium on Advances in Technology Education, 2017.

T. Hiraishi, J. C. Herbert, Y. Kajimura and S. Fujiwara (2018). Developing Competencies through Co$^+$work and Tobitate Projects, 12nd International Symposium on Advances in Technology Education, 2018.

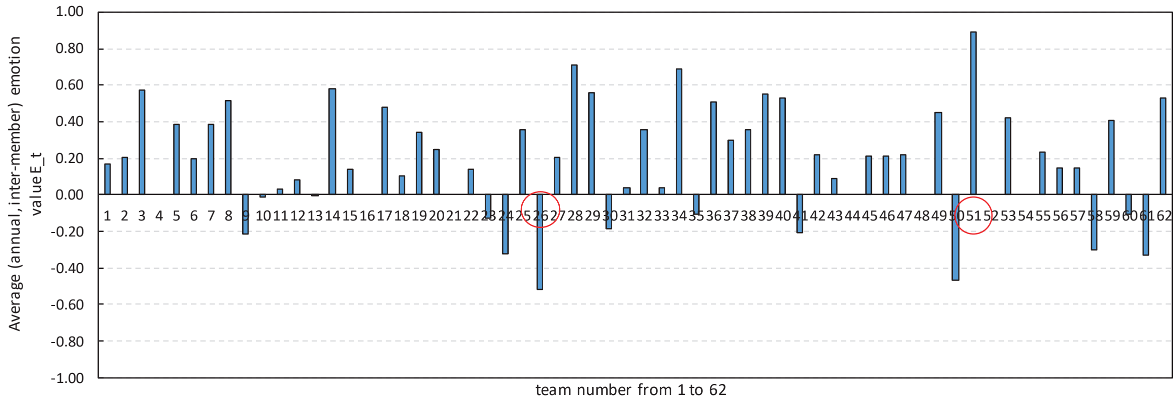


Figure 1 Average (annual, inter-member) emotion value E_t for all teams 1 to 62.

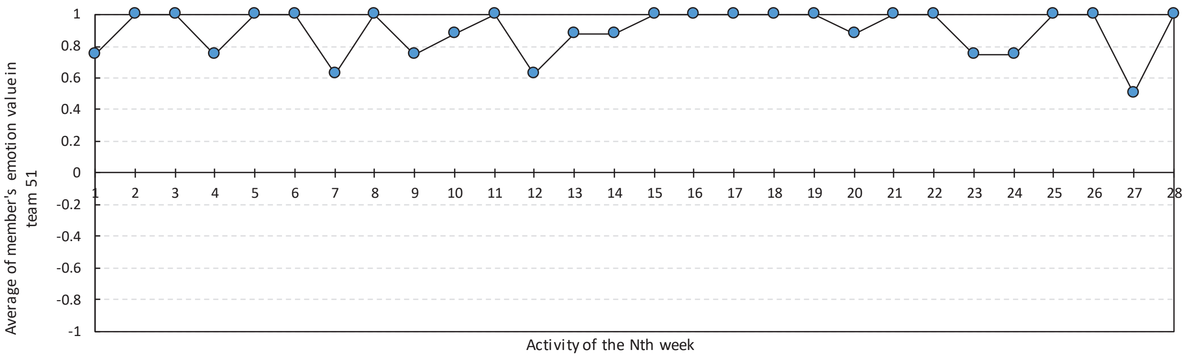


Figure 2 Week history of the average emotion value in team 51 (the highest value of the average (annual, inter-member) emotion values among all of the teams).

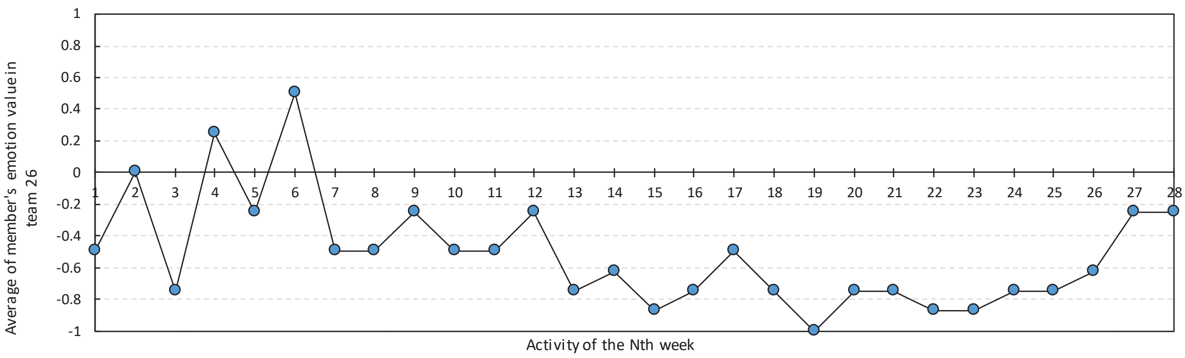


Figure 3 Week history of the average emotion value in team 26 (the lowest value of the average (annual, inter-member) emotion values among all of the teams).

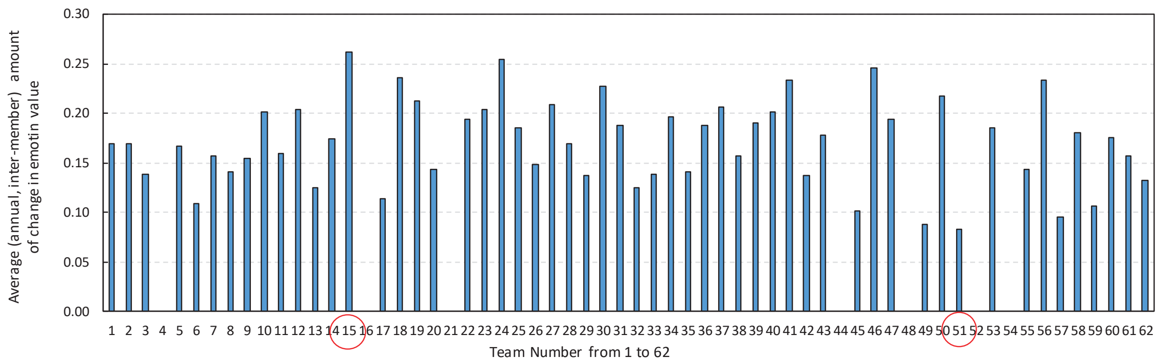


Figure 4 Distribution of PROG Score average on Average emotion value E_t. (n=496)

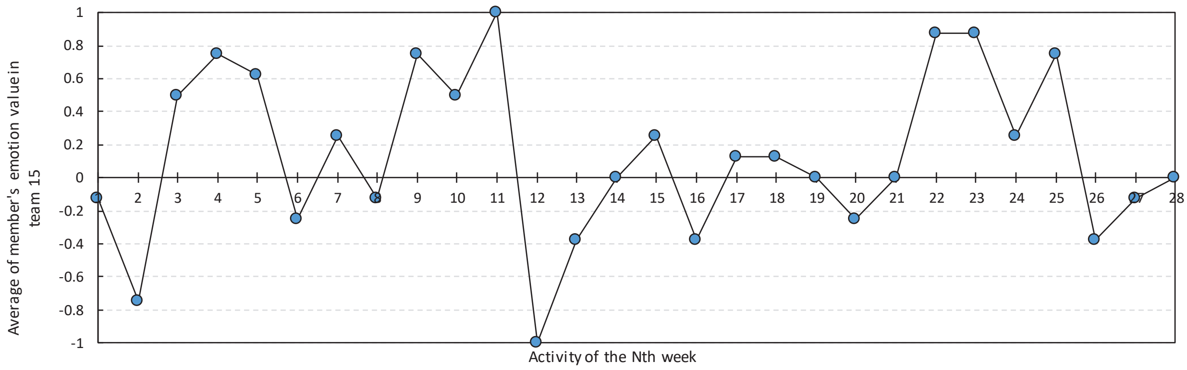


Figure 5 Week history of the average emotion value in team 15 (The largest amount of change in emotion value among all of the teams).

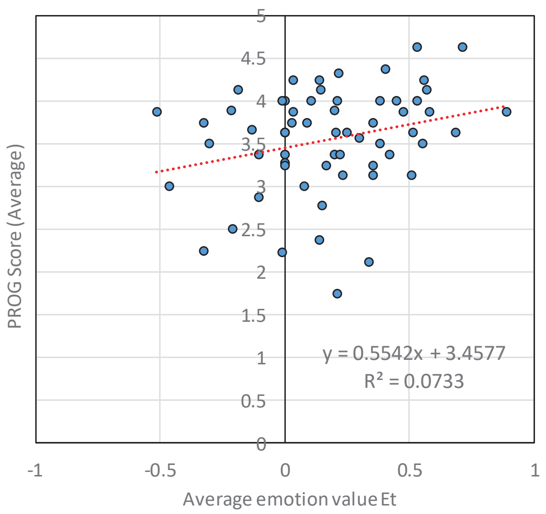


Figure 6 Distribution of PROG Score (average) on Average emotion value E_t. (n=496)

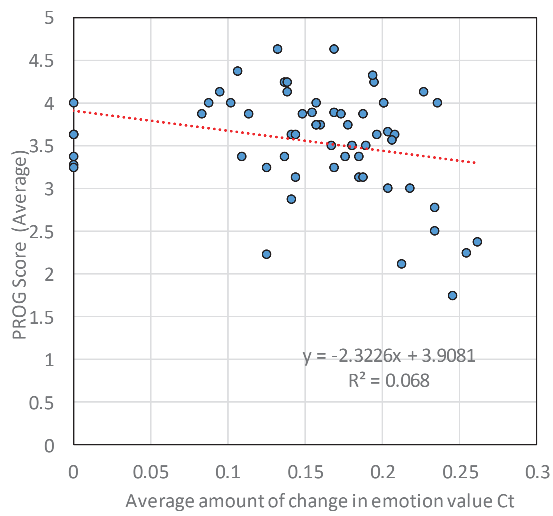


Figure 7 Distribution of PROG Score (average) on Average amount of change in emotion value C_t. (n=496)

THE EFFECTIVENESS OF A LANGUAGE PROGRAM FOR KOSEN STUDENTS IN THE PHILIPPINES

Y. Kuramashi

Tokuyama College/Division of Liberal Arts, National Institute of Technology, Shunan, Japan

*kuramashi@tokuyama.kosen-ac.jp

Abstract

For two weeks in March 2019, 18 students from Tokuyama College (National Institute of Technology), participated in a language program at a private language school in Cebu, the Philippines. The students took a diagnostic test as a pre-test before taking English lessons, and a comprehension test as a post-test on the last day of the lessons. Those tests consisted of grammar, reading, writing and oral interaction (listening and speaking) sections to measure how proficient their English abilities were. The purpose of this paper is to understand how much the students improved their ability of English and to discuss how effective the language program is for KOSEN students. The scores of the pre-test and post-test are analyzed using a *t*-test to observe the improvements of the students in their grammar, reading, writing and oral interaction. The result of the analysis is discussed, followed by possible limitations of this study and educational implications.

Keywords: *EFL, TOEIC, English proficiency, pre-test, post-test, t-test*

Introduction

Since 2000, the number of students who study abroad has been increasing although it had drastically decreased until then. It is said that there are some reasons for this phenomenon and one of them is that students started to make short-term stays more frequently. Kuramashi (2018) pointed out that the destinations of study-abroad programs have change as non-English-speaking countries such as Malaysia, Thailand, and the Philippines, whose common language is English, have been selected. As a result, the travel and stay expenses are quite necessarily low compared with those in typical study-abroad destinations such as the United States, Great Britain, and other English speaking countries.

However, there is always a question: Would studying English in a non-English-speaking country for a short period of time really be effective to improve language abilities? In order to answer this question, this study aims at understanding the effectiveness of a language program in Cebu, the Philippines looking at the improvement of English abilities, especially speaking.

Literature Review

There have been some studies conducted to discuss the effectiveness of learning English in an English speaking country. However, not many studies have been done in order to observe the effectiveness of a short-term language program in a non-English-speaking country.

Kuramashi (2014) reported how effective a one-month language program in the Philippines was by showing the difference in TOEIC® Listening & Reading Test (hereafter "TOEIC") scores before and after the program as a pre-test and post-test. 50 participating university students were divided into four groups and attended four different language schools, taking man-to-man lessons and group lessons. However, since only 36 of them took both the pre-test and post-test, 36 samples were gained and analyzed. As a result, the difference in the total scores between the pre-test and post-test was 75.1 on average, whereas that in the listening scores was 51.7.

Muroi & Muroi (2017) compared TOEIC scores before and after the program gained by 21 participating high school students who joined a two-week language program in the Philippines. The students mainly took man-to-man lessons. The result showed that the listening and total scores significantly improved on average (t=3.737, p<01; t=3.501, p<.01). However, the reading score did not show a statistically significant improvement.

Kuramashi (2018) also observed the improvements in the listening and reading abilities of university students who joined a one-month program in the Philippines in summer. In this research there were 200 samples including 130 participating students (experimental group) and 70 non-participating students (control group) from 2015 to 2017. This study attempted to do a one-way ANOVA to compare the gaps in the listening and reading scores between the two groups. Consequently, the gap in score of the experimental group was significantly larger than that of the control group.

As discusses above, there have been a few studies aimed at clarifying how effective language programs in non-English-speaking countries are. Besides, there are few studies statistically analyzing the improvements in speaking abilities statistically. From this point, the current study focuses on whether or not such language programs would potentially give a positive impact on English abilities, especially on speaking abilities.

Materials and Methods

From March 17 to March 31 in 2019, 18 students from Tokuyama College (hereafter called "KOSEN") took English lessons at a language school in Cebu, the Philippines. The following is the general schedule of the program.

Table 1 General schedule of the program

	Morning	Afternoon
Day 1	Depart from Japan	
Day 2	Orientation, diagnostic test	Shopping
Day 3	4 hours of man-to-man lessons	Immersion with local university students
Day 4	4 hours of man-to-man lessons	4 hours of group lessons
Day 5	4 hours of man-to-man lessons	4 hours of group lessons
Day 6	4 hours of man-to-man lessons	Technical visit to a local company
Day 7	Off	
Day 8	Off	
Day 9	4 hours of man-to-man lessons	Technical visit to a local company
Day 10	4 hours of man-to-man lessons	Immersion with local university students
Day 11	4 hours of man-to-man lessons	4 hours of group lessons
Day 12	4 hours of man-to-man lessons	4 hours of group lessons
Day 13	4 hours of man-to-man lessons	comprehension test, graduation ceremony
Day 14	Activity (island hopping)	
Day 15	Arrive in Japan	

Subjects

The subjects of this study are 18 KOSEN students at: 3 third-year, 12 second-year, and 3 first-year students at the time of the program. Their English proficiencies were quite various.

Pedagogy

The school designed a special program for the students, which included 4 man-to-man lessons and 2 group lessons almost every day and technical visits to local companies twice. The man-to-man lessons were 50-minute lessons taught by teachers assigned exclusively for the program. As both the man-to-man lessons and the group lessons basically covered grammar, vocabulary, pronunciation, daily conversation, and others, the man-to-man lessons routinely utilized a unique teaching method called "Callan Method." This is a type of method the concept of which derives from Audiolingualism. Therefore, it includes plenty of oral drillings with abundant oral inputs and outputs involved. The classes taught with this method were offered twice a day.

Pre-test and post-test

The language school offered a diagnostic test and comprehension test, which this study calls "pre-test" and "post-test" respectively hereafter. The participating students took the pre-test on the first day and the post-test on the last day as seen in Table 1.

Those tests contained five sections: grammar, reading, writing, listening, and speaking. However, the scores of the listening and speaking sections reported by the school were basically similar. This is because the language school regards listening as part of speaking; in other words, they think practical speaking is based on the learner's comprehension to the questions and comments given by others. From this point of view, the listening section is held as a part of speaking test, which involves interaction between examiners and examinees. Following the school's view toward language learning, this paper views the listening and speaking sections as one section and relabels "oral interaction."

In addition, these sections in the pre-test and post-test were basically identical in terms of format, but the vocabulary words and contents used were slightly different. The tests were employed as a measurement to determine the students' English abilities before and after the program.

This paper focuses solely on the analysis of the pre-test and post-test. For the analysis, *SPSS Statistics 23* was utilized. The next section discusses the results of a descriptive statistics and a paired *t*-test using the two sets of data.

Results and Discussion

Table 2 indicates the means and standard deviations of the scores from four sections as well as the minimum and maximum values.

Table 2 Descriptive statistics (n=18)

	min	max	mean	SD
G1	6	10	8.67	1.19
R1	5	11	7.56	1.46
W1	2.0	11.0	7.06	2.43
OI1	4.5	9.5	6.58	1.41
G2	5	10	7.72	1.13
R2	6	11	8.78	1.11
W2	3.5	10.5	8.44	1.69
OI2	5.5	10.5	7.83	1.22

Note. G=grammar section, R=reading section, W=writing section, OI=oral interaction section, 1=pre-test, 2=post-test.

According to Table 2, it seems that all the means except that of the grammar section improved more or less. Besides, all the standard deviations went down.

Next, a paired *t*-test was conducted to compare the means of each section of the pre-test and post-test and observe if there is a statistically significant difference between these means.

Table 3 Paired *t*-test between pre-test and post-test (n=18)

	mean	*SD*	*t*	*df*	*p*
G2-G1	-.944	1.162	-3.449	17	.003
R2-R1	1.222	1.700	3.051	17	.007
W2-W1	1.389	1.8986	3.104	17	.006
OI2-OI1	1.250	2.1369	2.482	17	.024

As seen in Table 3, the reading, writing, oral interaction sections showed a statistically significant difference between the pre-test and post-test especially in the reading section (t=3.051, p<.01) and writing section (t=3.104, p<.01). Although the result of the oral interaction section showed a statistically significant improvement (t=2.482, p<.05), it was not as powerful as the reading and writing sections.

It is surprising that not only oral interaction but also writing and reading have improved significantly. It can be said that the language program might have led the student to improve their overall English abilities at least regarding reading, writing, and interaction. To speak further, the lessons offered by the language school could have given a significant impact on the students' English abilities within a quite short period of time.

In fact, the teachers assigned for this program were well-educated and well-trained to teach English. The students seemed to enjoy lessons every day, particularly man-to-man lessons. Even a simple drilling gave them a great joy with the teachers' passion to teach English. The quality of the teachers could have led the students to successfully improve their proficiency.

The grammar section also showed a statistically significant difference (t=-.944, df=17, p<.05), but the t-value was negative. The cause of this is that the mean value of the pre-test was lower than that of the post-test. In general, it is rather impossible that a learner's language abilities decline in such a short period of time. However, it is also impossible to figure out a potential problem behind the result.

Limitations

There are mainly two limitations in this study to discuss. First, the pre-test and post-test contained grammar, reading, writing, listening, and speaking sections. However, since the listening section is conducted as a part of the speaking section, a possible improvement of the students' listening skills was not measured as precisely. As discussed earlier, the language school has a solid policy under which listening and speaking are strongly connected to form an interaction and be tested together. Therefore, it is absolutely not appropriate to request them to design a listening test separately. To solve the limitation, listening abilities ought to be measured somehow outside of their official curriculum.

Second, the tests utilized by the school are not a standardized test so that the result of this study should be cautiously observed and will not be generalized. While the purpose of the pre-test is to diagnose participants' proficiency level and have a class placement, that of the post-test is to observe their comprehension level after a program. Therefore, those tests were originally not designed for research purposes. Knowing the limited time and human resources available in the program, it is quite impossible to use a standardized test like TOEIC to measure participating students' English proficiencies. Although there may be no ideal measurement, it is desirable to develop a more effective measurement for the further research.

Conclusions

This study attempted to understand the effectiveness of learning a language at a short-term language program in the Philippines. The result of a t-test between the pre-test and post-test showed that the participating students' English abilities of reading, writing, and oral interaction had had a statistically significant improvement. In spite of possible limitations of the pre-test and post-test, it can be said that the language program could have positively influenced the students' English proficiency.

Even though the purpose of this study was to visualize the students' improvement throughout the language program, there seemed to be many more advantages in this program that should be put into focus. Before the program, not all the students were confident about their proficiency level. After two weeks, their total satisfaction and confidence improved. At the graduation ceremony they were requested to give a speech in front of the teachers, coordinators, and other staff members without any prior notice. As a consequence, it was just amazing that they gave a tremendous speech with their faces full of confidence. Even the students who had seemed uncomfortable to speak English and communicate with English-speaking people at first were not excepted. This wonderful outcome allows us to assume that the students not only improved their English abilities but also gained so many things that could be applied to their future English learning.

KOSEN students are not necessarily motivated learners of English. They are busy learning maths, physics, and other subjects in their academic fields. Therefore, it is always a big challenge to figure out how they are motivated to learn a language and how effectively the language is taught. The classes taught by the teachers in the Philippines are providing a useful method for this challenge.

In conclusion, learning English in a non-English-speaking country like the Philippines is merely one of the choices to improve English abilities. However, it may be an efficient and effective chance for KOSEN students to improve not only their English abilities but also their motivation to learn English. For a better understanding of the quality and effectiveness of language programs in the Philippines, it is desirable that further research will be done both quantitatively and qualitatively.

Acknowledgements

I would like to thank all the staff members for their hard work and tremendous effort on this program. My special thanks go to Ms. Tsushima (vice president of JICC) and Ms. Sevilla (Institute Head), who organized the program and kindly helped on this research providing the data of the diagnostic test and comprehension test.

References

Kuramashi, Y. (2014). Developing a Language Study Abroad Program in Cebu. *Bulletin of Baiko Gakuin University*, 47, 43-58.

Kuramashi, Y. (2018). Developing a Language Program in the Philippines. *Bulletin of Baiko Gakuin University*, 51, 13-26.

Kuramashi, Y. (2019). The Effectiveness of Short-term Language Programs for University Students in the Philippines. *CASELE Research Bulletin*, 49, 1-10.

Murrell, H., Kuramashi, Y., & Mizuta, A. (2015). Outside the Classroom: A study of Students' Attitudes toward the Learning Environments on Campus and their Effects on Learning Achievements. *Baiko Studies Language and Culture*, 6, 81-94.

Muroi, M., & Muroi, A. (2017). A Report on an Intensive Language Course in Cebu, the Philippines -High School Students Using ICT to Prepare-. *Bulletin of Seisen Jogakuin College*, 14, 61-67.

MINING MAJOR PROJECT REPORTS FOR INSIGHTS

Kai Song, Goh [*, a], and Li Chin, Ho [a]

[a] Temasek Polytechnic School of Informatics & IT/Diploma in Big Data & Analytics, Singapore

*gohks@tp.edu.sg

Abstract

At Temasek Polytechnic, the Major Project (MP) subject is positioned as a capstone subject where students apply the knowledge and skills accumulated in other subjects they have previously completed. MP provides students with opportunities to synergise and to apply what they have learnt into authentic and practical application areas. Increasingly, more diploma teams are also preferring students to take on industry-related MP, engaging industry partners in the co-creation of the scope and requirements of the MP taken by students. One of the deliverables of MP is a Final MP Report, detailing the work done. This is submitted to the MP supervisor upon the completion of the subject.

Currently, students' MP reports is a largely untapped resource. Due to operational limitations as well as the nature of the subject, each MP report is typically read by only a handful of staff who are either assigned the role of a MP supervisor, or as a member in the MP Evaluation Panel. As MP becomes more industry focused, MP undertaken by students becomes more reflective of the industry demands on our graduates. It is hence vital for diploma teams to tap on MP report to get a better sense of what these industry demands are.

In this research, we apply text mining techniques to analyse MP reports submitted by students from different diploma courses of study. We share the text pre-processing steps undertaken to prepare the reports for mining and present the various visualizations produced. Using the visualizations, we outline the insights that can be derived through the text mining process. We share how these insights could be used to identify emerging areas of work and discover trending demands in terms of new skillsets; we also share how this information could be used to help diploma teams identify gaps in the current curriculum and areas for future development. Lastly, we share how the mining of MP reports across diplomas can help the school to detect patterns of convergence across diplomas.

Keywords: *learning analytics, text mining, major project, curriculum design, industry partnership, industry sensing, competencies and outcomes, data visualization*

Introduction

The application of text mining in education is not a novel idea. Text mining has been applied to analyse students' forums posts (Kelley, Lindell and Gavrin (2018), Tucker, Pursel, and Divinsky (2014)), qualitative feedback in course surveys (Xu and Reynolds (2012), Robinson, Yeomans, Reich, Hulleman and Gehlbach (2016), Shankararaman, Gottipati, Lin and Gan (2017)), and students' submitted work (White and Joy (2004), Robles and Gonzalez-Barahona (2013), Bakaric and Sisovic (2015), Gibson and Kitto (2015), Kovanović et al. (2018)). The objectives of these researches includes plagiarism detection (White and Joy (2004), Robles and Gonzalez-Barahona (2013)), teacher and course evaluation (Kelley et al. (2018), Xu and Reynolds (2012) Shankararaman et al. (2017)), assessing students' learning (Gibson and Kitto (2015), Kovanović et al. (2018)) and students' performance prediction (Robinson et al. (2016), Bakaric and Sisovic (2015), Tucker et al.(2014)).

In recent times, researchers have also begun to apply text mining methods to study alignment of curriculum to workforce requirements. McLaughlin, Lupton-Smithand Wolcott (2018) mined descriptions in job adverstiments to determine alignment between educational outcomes of pharmacy course with job demands. Similarly, Gottipati and Shankararaman (2014) utilized, among several methods, text mining, for curriculum analysis of Information Systems course.

In this research, we performed text mining on students' Final MP Reports to determine the areas of work students undertook in their MP. By creating various data visualizations from the Final MP Reports, we were able to provide diploma teams with insights on the areas of work undertaken by students and identify areas of convergence across diplomas.

Our questions for this research are as follows:

RQ1: Can text mining students' Final MP Reports uncover emerging areas of work undertaken by students during their MP?

RQ2: Can text mining students' Final MP Reports uncover areas of gaps in the current curriculum?

RQ3: Can text mining students' Final MP Reports uncover areas of convergence across different diplomas?

Background

At the School of Informatics & IT (IIT), students take on their MP during their final year of study. Increasingly, diploma teams are engaging industry partners to co-create MP requirements. Such arrangement not only provide students with authentic learning opportunities, but also provides diploma teams with the invaluable opportunity to sense the needs of the industry. Such insights are useful in helping diploma teams identify gaps in the course and ensure that students are well-equipped to handle the demands of the industry when they join the work force upon graduation.

For each MP, a member of staff at IIT would be appointed the MP supervisor. Aside from working with industry partners to scope the project, MP supervisors are also in charge of grading the student's work and to act as the resource persons for the students under their charge. Due to the workload involved, each staff is typically assigned to between five to ten students. This means that most staff members typically only read between five to ten Final MP Reports. Consequently, most staff members only see a small percentage of the reports for their diploma. The exception would be staff who are appointed as members of the MP evaluation panel. Due to the need for benchmarking across all projects within the same diploma, these staff would be required to go through all MP completed by students from their diploma. However, evaluation committee rarely spans across different diplomas and this means that the scope of view by a single staff is often limited to only MP within the single diploma. Staff rarely have the opportunity, or the impetus to look at projects from other diplomas.

This is a pity because Final MP Reports contain a wealth of information. Final MP Reports typically include the problem statement detailing the background of the project, the current situation and the proposed solution, it also contains technical details such as the architecture of the solution implemented, the technology and techniques utilized as well as challenges faced and how these challenges were overcome.

The problem statements and project background in Final MP Report are useful in helping diploma teams appreciate how core skills taught in other subjects were applied to different business domains to improve business functions; it also contains leads which diploma teams can follow to identify potential opportunities for industry collaboration.

The details on solution architecture and technology and techniques utilized in Final MP Reports contained information that would allow diploma teams to adjust their own curriculum coverage, enrichment activities or even certification courses to better prepare students for their MP and for joining the workforce upon graduation. Knowing what technology and techniques students used during their MP also keeps diploma teams up to date with the changing demands in terms of skillsets required of our students; which in turn, help diploma teams identify new focus areas for professional development for lecturers.

One of the key qualities of the TP Student Profile is for every student to be a Lifelong Learner. Looking through the Final MP Report would allow diploma teams to find anecdotes of students displaying this desired quality where they outlined how they were able to overcome challenges through self-directed learning.

Dataset and Methods

Our dataset for this research consists of Final MP Reports submitted by students from 3 different diplomas offered at IIT. These are the Diploma in Business Intelligence and Analytics (BIA) (n = 40), Diploma in Big Data Management and Governance (BIG) (n = 43) and Diploma in Financial Business Informatics (FBI) (n = 50).

The first step in preparing the reports for mining was to convert the Final MP Reports to a unified format. Reports submitted were in either Word 2016, Word 2013 or PDF format. We converted all reports into Word 2016 format. This step was necessary for the text mining platform we had selected. We had selected Voyant Tools, an online text mining platform and we discovered that building a corpus with mixed format documents resulted in unexpected behaviour, due to differences in encoding by the various formats.

Next, we renamed the reports to anonymize them. Reports were renamed using the diploma short name appended with a running number. For examples, reports submitted by students from the Diploma in Business Intelligence and Analytics were renamed BIA (1), BIA (2), BIA (3) and so on.

The reports were then read into Voyant Tools. A separate corpus was built for each diploma. Voyant Tools automates many of the text pre-processing work such as case standardization and term tokenization. It also has built-in regular expression support, therefore removing the need for stemming.

The only intervention required on our part was to append the stop list with a list of MP specific stop words such as "supervisor", "weekly", "reflection", "meeting", "minutes", as well as institution and diploma specific stop words such as "temasek", "polytechnic", "diploma", "business", "analytics".

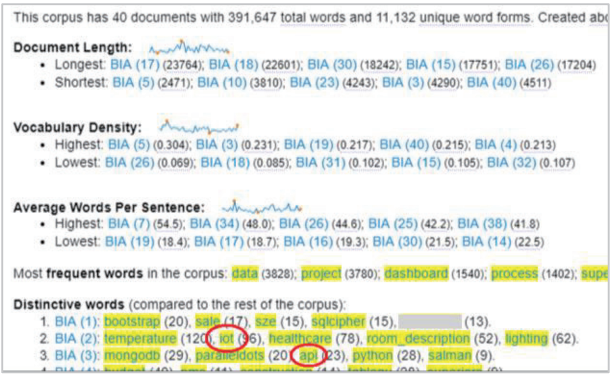
With the corpora built, we proceeded with the high-level exploration of the documents. Two visualization in Voyant Tools were particularly useful at this stage. The first, the Cirrus plot, which is a word cloud. Figure 1 shows the Cirrus plot for reports submitted by students from BIG.

Figure 1: Cirrus plot for BIG reports

This simple visualization presents the frequency of terms in the corpus. Terms that appeared more often would be bigger in the plot. It provides a good starting point and an easy way for us to identify terms that should be added to the stop list.

Like the Cirrus plot, the Summary plot, shown in Figure 2, was another useful tool in providing an overview of the corpus. The Summary plot showed summary statistics on document length, highlighting the longest and shortest documents as well as the top and bottom documents in terms of vocabulary density. One particularly useful feature in the Summary plot was the most frequent words as well as the by-document distinctive words. The former provided an idea of the typical work undertaken by students in their MP while the latter allowed us to identify unique tasks assigned to each individual student.

For example, we can see that BIA (2) contained the term "IoT", and BIA (3) contained the term "api". These terms provide us with the leads for further exploration in the next step.


This corpus has 40 documents with 391,647 total words and 11,132 unique word forms. Created ab

Document Length:
- Longest: BIA (17) (23764); BIA (18) (22601); BIA (30) (18242); BIA (15) (17751); BIA (26) (17204)
- Shortest: BIA (5) (2471); BIA (10) (3810); BIA (23) (4243); BIA (3) (4290); BIA (40) (4511)

Vocabulary Density:
- Highest: BIA (5) (0.304); BIA (3) (0.231); BIA (19) (0.217); BIA (40) (0.215); BIA (4) (0.213)
- Lowest: BIA (26) (0.069); BIA (18) (0.085); BIA (31) (0.102); BIA (15) (0.105); BIA (32) (0.107)

Average Words Per Sentence:
- Highest: BIA (7) (54.5); BIA (34) (48.0); BIA (26) (44.6); BIA (25) (42.2); BIA (38) (41.8)
- Lowest: BIA (19) (18.4); BIA (17) (18.7); BIA (16) (19.3); BIA (30) (21.5); BIA (14) (22.5)

Most **frequent words** in the corpus: data (3828); project (3780); dashboard (1540); process (1402); supe

Distinctive words (compared to the rest of the corpus):
1. BIA (1): bootstrap (20), sale (17), sze (15), sqlcipher (15), (13).
2. BIA (2): temperature (120), iot (96), healthcare (78), room_description (52), lighting (62).
3. BIA (3): mongodb (29), paralleldots (20), api (23), python (28), salman (9).

Figure 2: Summary plot for BIA reports

Once we identified the key terms of interest, we moved on to other visualizations in Voyant Tools that gave us more in-depth view. We started with the Collocates plot. This visualization creates a network graph based on terms of interest and other terms that occur in proximity with it in the corpus. An example of a Collocates plot for the term "python" is shown in Figure 3. Using this visualization, we were able to identify the Python packages used by students in their MP and get an idea of what their codes did.

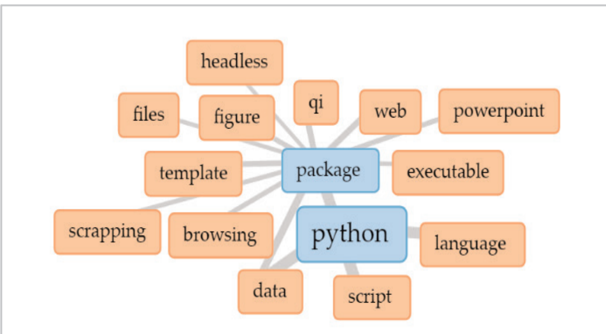


Figure 3: Collocates plot for "python" for BIG reports.

With a specific term of interest, we were able to look at the term in relation to documents in the corpus using the MicroSearch visualization. This visualization displays the distribution as well as frequency of the search term in the corpus. Each document is represented as a block, the length of the block is scaled according to the length of the document while the search term is represented as red dots within the blocks. In the example shown in Figure 4, we searched for the term "vba" among Final MP Reports submitted by students from FBI.

Based on the visualization, we can identify the projects that made used of 'vba' and also how pervasively this particular technique was used in the various projects.

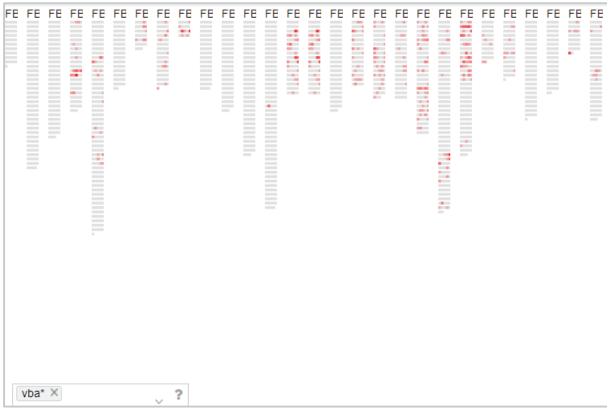


Figure 4: MicroSearch for "vba" in FBI reports

Once we established a list of interesting terms for each corpus, we moved on to the next visualization that allowed us to explore this list, in relation to each document in the corpus.

The Mandala plot used the relative frequency of each search term and position documents in relation to the search terms. Terms that appear more frequently would have greater pull on documents that contained them. The more frequently the term appeared in a document, the closer the document would be positioned to the term.

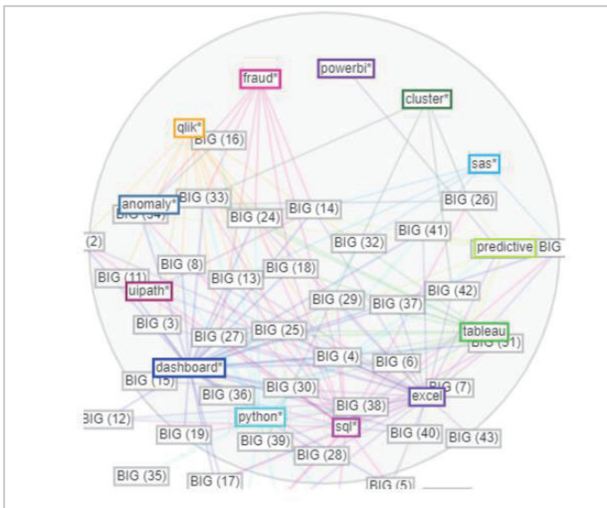


Figure 5: Mandala plot for BIG reports.

Figures 5, 6 and 7 shows the Mandala plot for Final MP Reports for BIG with the terms “fraud”, “powerbi”, “cluster”, “sas”, “predictive”, “tableau”, “excel”, “sql”, “python”, “dashboard”, “uipath”, “anomaly” and “qlik”.

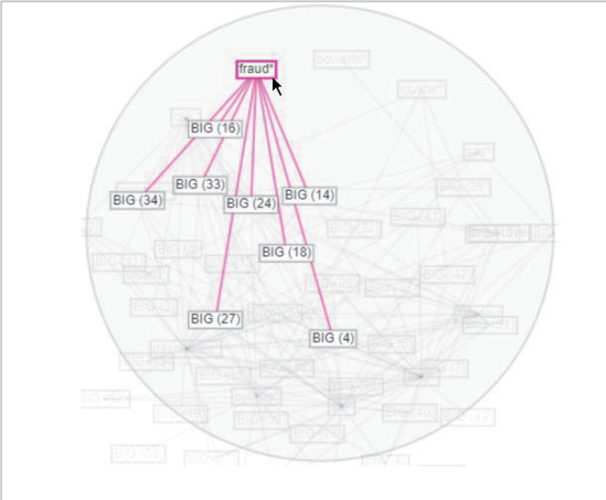


Figure 6: Mandala plot for BIG reports, focused on the term “fraud”

Hovering over a term in the Mandala plot focused the visualization on it. This allowed us to identify the documents that contained the search term. In Figure 6, we looked at the term “fraud” and were able to identify students who performed some form of fraud analytics in their MP. Since proximity of documents to terms represents the relative frequency, we could therefore identify that BIG (16) contained the term “fraud” more than the other reports.

Hovering over a document in the Mandala plot offered us with a different perspective. It showed us the subset of identified terms there were in the document we were investigating. In Figure 7, we focused on BIG (18) and discovered that the student MP involved SQL, Qlik or Tableau dashboard and the project was in the area of fraud analytics.

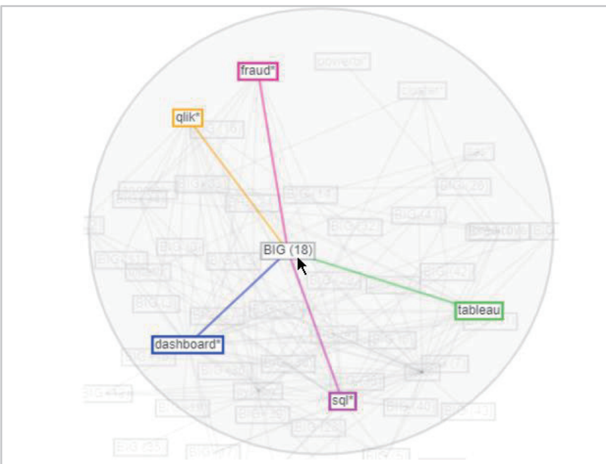


Figure 7: Mandala plot for BIG reports, focused on BIG (18)

Aside from visualizing key technical terms, we were also able to visualize terms that are of special interest. Figure 8 shows a Trends plot for the terms “problem” (and its variants) used together with the term “solve” (and its variants).

The Trends plot divides each document into 10 equal-sized segments and displays the relative frequency of the search term in each segment. Each document is represented as a line in the Trends plot. Based on the Trends plot, we were able to see that problem-solving related terms were used more frequently in the latter segments of most Final MP Reports.

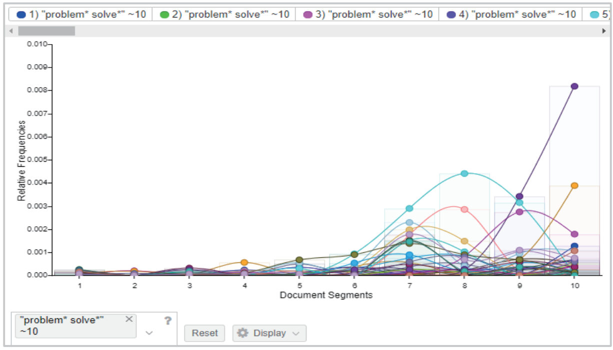


Figure 8: Trends plot for BIG reports for “problem” and “solve”

Results and Discussions

In this research, we looked at Final MP Reports submitted by students from three different diplomas of study. Our research showed that text mining, specifically text topic discovery combined with appropriate data visualization techniques, is indeed a feasible option for us to gain insights on the emerging area of work undertaken by students for their MP.

Using corpus level visualization such as the Cirrus and Summary plots, we were able to identify terms of interest in the corpus. These terms then provided us with leads to further explore the corpus.

Term level visualizations such as the Collocates plot allowed us to identify terms that co-occurred with the terms of interest while term and document level visualizations such as the MicroSearch and Mandala plots allowed us to visualize the occurrence of these terms in relation to the documents in the corpus.

The support for regular expression in these visualizations also made it possible for us to generalize our search terms and support multi-word terms.

With regard to our research questions:

RQ1: Can text mining students’ Final MP Reports uncover emerging areas of work undertaken by students during their MP?

Yes. For example, based on Final MP Reports submitted by BIG students, we were able to pick up the terms ‘rpa’ (robotic process automation) and ‘uipath’. This is an emerging area of work assigned to students.

RQ2: Can text mining students’ Final MP Reports uncover areas of gaps in the current curriculum?

Yes. We were able to pick up key terms on the techniques and technology used by students for their MP. We are positive that the insights gained via text mining, coupled with domain knowledge of someone who is familiar with the curriculum, would allow for the identification of gaps in the curriculum.

RQ3: Can text mining students' Final MP Reports uncover areas of convergence across different diplomas?

Yes. Comparison of key terms across corpus allowed for this to be done easily. For example, we discovered that across the three diplomas studied, the term 'dashboard' featured quite prominently in the submitted Final MP Report indicating that most students from all three diplomas worked on some form of dashboard for their MP.

Limitations

Voyant Tools utilized a term-by-document matrix to represent the corpus instead of the less sophisticated bag of words representation. This reduces some of the inherent limitations of text mining, however, some other limitations exist.

The lack of functionality for synonym handling in the pre-processing phase meant that we had to be mindful of term variants when identifying terms of interest during the initial exploration stage. In addition, the unavailability of parts-of-speech tagging may also prove to be a challenge for some terms of interest that have different meaning (e.g. 'apple' the fruit or 'apple' the company).

The visualizations we used relied on the term frequency, this meant that our analysis was limited to a quantitative-based approach and not the qualitative understanding of the Final MP Reports. Consequently, even though we were able to accurately identify the number of students who made use of certain techniques or technology in their MP, we were not able to determine if students reported that they were adequately prepared to use these identified technique or technology.

Nevertheless, we felt that text mining of Final MP Reports provided us with a positive first step in tapping more on the Final MP Reports.

Conclusion

In this research, we explored the feasibility of applying text mining techniques to students' Final MP Report. We found that text mining provided us with an easy and quick way to gain valuable insights from the submitted reports that can help us identify emerging areas of work assigned for the MP. We also found that it was possible to identify areas of convergence across different diplomas when we looked across different corpora. Finally, augmented with domain knowledge of the various curriculum, it is also possible for text mining to uncover areas of gaps in the existing curriculum.

One possible area of further research would to be apply other text mining techniques to gain more insights from submitted Final MP Reports. One such example would be the application of sentiment analysis to learn about the overall experience of students during their major project. Such insights, coupled with structured data such as student demographic data, results and survey responses may be useful in predicting important outcomes such as student satisfaction and likelihood of leakage.

Acknowledgements

We are grateful for the support of the various diploma Course Chairs for their support in the use of their Final MP Reports for our research.

References

Bakaric, M. B., Matetic, M., & Sisovic, S. (2015). Text mining student reports. *Proceedings of the 16th International Conference on Computer Systems and Technologies - CompSysTech 15*.

Gibson, A., & Kitto, K. (2015). Analysing reflective text for learning analytics. *Proceedings of the Fifth International Conference on Learning Analytics and Knowledge - LAK 15*.

Gottipati, S., & Shankararaman, V. (2014). Learning Analytics Applied to Curriculum Analysis. *Proceedings of the AIS SIG-ED IAIM 2014 Conference*.

Kelley, P., Gavrin, A., & Lindell, R. S. (2018). Text Mining Online Discussions in an Introductory Physics Course. *2017 Physics Education Research Conference Proceedings*.

Kovanović, V., Joksimović, S., Mirriahi, N., Blaine, E., Gašević, D., Siemens, G., & Dawson, S. (2018). Understand students self-reflections through learning analytics. *Proceedings of the 8th International Conference on Learning Analytics and Knowledge - LAK 18*.

McLaughlin, J., Lupton-Smith, C., & Wolcott, M. (2018). Text mining as a method for examining the alignment between educational outcomes and the workforce needs. *Education in the Health Professions,1*(2), 55.

Robinson, C., Yeomans, M., Reich, J., Hulleman, C., & Gehlbach, H. (2016). Forecasting student achievement in MOOCs with natural language processing. *Proceedings of the Sixth International Conference on Learning Analytics & Knowledge - LAK 16*.

Robles, G., & Gonzalez-Barahona, J. M. (2013). Mining student repositories to gain learning analytics. An experience report. *2013 IEEE Global Engineering Education Conference (EDUCON)*.

Shankararaman, V., Gottipati, S., Lin, J. R; & Gan, S. (2017). Extracting implicit suggestions from students' comments – A text analytics approach. *Proceedings of 25th International Conference on Computers in Education (ICCE 2017),* 261-269.

Tucker, C. S., Pursel, B. K., & Divinsky, A. (2014). Mining student-generated textual data in MOOCs and quantifying their effects on student performance and learning outcomes. *Computers in Education Journal*, *5(4)*, 84-95.

White, D. R., & Joy, M. S. (2004). Sentence-based natural language plagiarism detection. *Journal on Educational Resources in Computing,4(4)*, 1-20.

Xu, Y., & Reynolds, N. (2012). Using Text Mining Techniques to Analyze Students' Written Responses to a Teacher Leadership Dilemma. *International Journal of Computer Theory and Engineering*, 575-578.

EXPLORATORY LEARNING ANALYTICS: TRANSLATING SHAPES OF EDUCATIONAL DATA INTO EARLY INTERVENTION WARNING SIGNALS IN YEAR ONE COURSE

Jin Sze Samantha, Sow

Temasek Polytechnic, School of Informatics & IT,
Diploma in Big Data & Analytics, Singapore

sowjs@tp.edu.sg

Abstract

Learning analytics is the use of learner-produced data and model analysis to discover information for predicting and advising people's learning. Computational aspects and statistical analysis are readily expanding the horizons of learning analytic practitioners. This paper proposes how higher education institutions can harness digital data using simple models to identify at-risk students to allow timely pedagogical interventions at an early stage for likelihood of success.

This paper extends this proposition to analyze different aspects of learning behaviors and patterns of a year one Logic and Mathematics course by mining multiple course tracking predictors such as term A (weeks 1-8) and term B (weeks 11-16) grades, frequency and duration spent on modular content, time stamp of content accessed, completion levels of online quizzes, total number of online content assessed and usage of fragmented activities within the learning management system (LMS). Using mined educational data, data modeling techniques are used to detect trends and patterns of students' online learning behaviours. Concurrently, we use a correlation matrix model to generate insights into the predictor attributes with achieved grades using mined data from TP Examination and Assessment (TPEAP) system. We want to explore statistically the predictor attributes which we can rely on as an early and accurate indicator of grades prediction and learning so educators can recommend better learning strategy for the students for this course.

This study will discuss analysis of educational data and their insights as early warning signals for teachers. Such preemptive warnings can trigger timely (i) pedagogical interventions and (ii) classroom intervention for teacher-to-student teaching remedies to increase the likelihood of learners' success and successful attainment of learning goals.

Keywords: *learning analytics; educational data mining; student's intervention; data analytics;*

Introduction

Data is everywhere and if data is mined accurately and appropriately, there are a myriad of opportunities for deeper insights. Data mining refers to the process of knowledge extraction of valid and useful information (Fayyad, Piatesky, Smyth and Uthurusamy, 1996) from huge volumes of data in databases, data warehouses or other information repositories (Han and Kamber, 2006). Data mining techniques are used to discover hidden patterns and relationships which lead to decision making (Klosgen, W. & Zytkow, J. 2002).

One way to tap the potential of data mining is to typecast algorithms into what they can be utilized for in data rich areas. Another way is to examine the various functions of a college in order to identify the needs that can translate themselves into data mining projects. For instance, there are several interesting data mining projects which addressed practical questions in a college:

- What students are more likely to drop out from the course (Dekker et al., 2009)?
- How students choose to use different learning resources and obtain different outcomes (Beck et al., 2008)?
- What type of courses can be offered to attract more students (Luan 2002, Minaei Bidgoli et al. 2003)?
- What are the main reasons for student transfers?

Higher education systems have wide applications for data mining because they carry intensive data mining duties such as: scientific research which relates to knowledge creation, teaching which involves knowledge transmission, and institutional research which pertains to the use of knowledge for decision making. (Luan J., 2002).

Background

Educational data mining is a sub-domain of data mining that recognizes unique patterns within data in academic databases (C. Romero & S. Ventura, 2010) to better understand students and their learning (Siemens, G. & Baker, R. 2012) and to assist in academic related decision-making processes.

The process of raw data conversion from educational systems into useful information could potentially have a greater impact on educational research and practice (C. Romero & S. Ventura, 2010). The availability of data allows researchers to conduct studies to resolve educational issues. In Temasek Polytechnic, students' information is digitalised, processed and stored in several IT database systems which provides a data rich environment for data mining. There exists an examination system which consolidates assessment and examination information of students in the institution. Another database contains students' pre-enrolment information and current grades progression. Finally, the learning management system by itself is a database comprising e-learning content and students' online activities records.

Methodology

Sources of student data:

This study will consider data collected during the April 2018-19 semester of freshmen from the school of IIT in Temasek polytechnic. The educational dataset used in our study is extracted from 3 separate individual databases, namely TP Examination and Assessment database, Online learning Management System and Student's Profiles database.

Data pre-processing:

In this study, an open-source data analytics software tool developed by KNIME AG, Knime is used for data modeling and visualization. In the data pre-processing stage, the three datasets are joined into a single dataset using student's unique identification number as a relational key.

Dirty data such as invalid, inconsistent, duplicate or missing values are discarded from this study. After left-outer joins, 6 records are discarded as they are not linked to any student's unique identification number suggesting the student has either deferred or withdrawn from the course. An existing problem lies in the non-standardization of data format across the databases, especially for the unstructured raw student profile dataset. The unstructured data is bad for analysis as attributes are not clearly separated by delimiters which makes it extremely time-consuming to clean, transpose and transform for analysis using KNIME software. The resulting data file is "students-data-attributes.csv" and includes 530 records. The attributes used are shown in Table 1, where all the attributes are joined in a single dataset.

Data Attributes:

The data attributes used in this study can be generally categorized into assessment attributes, student demographics attributes and online learning attributes. Assessment attributes which are related to grades evaluation for the subject LOMA in April 2018-19 semester (i.e. written test grades in weeks 0-8 (M_1), assignment grades in weeks 9 – 18 (M_2), final scores grades (MT)) are extracted from the online system TP Examination and Assessment (TPEAP) database. To complement the assessments attributes, class, course demographics and previous mathematics scores variables (i.e. diploma course, tutorial groups and pre-admission maths) are extracted in excel data format from the student profiles database. Finally, student's online learning attributes (i.e. time stamp of content access, total number of online sessions, duration of content access) are extracted from the learning management system (LMS).

To work with data mining techniques, we recognise the data types of data attributes mined earlier. Table 1 consists of bothq continuous numeric data exhibiting skewness (i.e. M_1, M_2, MT and Duration_mean) and discrete data (i.e. Content_HR_mean and Count_P1/P2/P3/P4). Data quality of categorical data is checked (Table 3) against inconsistencies, blanks and missing values.

Attribute	Description (Domain)
Adm No	student's encoded identity (numeric)
Tutorial Grp	student's class groupings (nominal: T01 to T21)
Course_code	student's diploma course (nominal: 6 diplomas)
Pre-admission maths	student's pre-admission mathematics qualifications (nominal[a])
normalized entry aggregate	student's normalized entrance numeric scores (numeric: 6 to 26)
maths_prep	attends maths bridging program (binary: yes or no)
Content_date	time of access to the online content (date)
Acad Week	the academic 0 – 18 weeks (numeric: 0 - 18)
Count_P1/P2/P3/P4	number of times student access the online learning portal from week 0–4/week 5-9/week 10-14/week 15-18 (numeric)
Duration_P1/P2/P3/P4	time in minutes of access to LOMA online learning portal from week 0–4/week 5-9/week 10-14/week 15-18 (numeric)
Count_mean	average number of times student access the online learning portal (numeric)
Duration_mean	average time in minutes of access to online learning portal (numeric)
Content_HR_mean	Average count of items access in online learning portal (numeric)
M_1	period 1 (Term A) of written test scores (numeric:0-30)
M_2	period 2 (Term B) of assignment scores (numeric:0-40) excluding project scores and online quiz scores
M_3	online quiz scores from week 0 - 18 (numeric:0-10)
M_4	project scores in week 19 (numeric:0-20)
MT	Final score (numeric:0-100)
Total Grd	Final score (nominal: A, B, C, D, F)

a: O: Taken O Level mathematics, N-O: Did not take O Level mathematics, I: Taken International O level mathematics or equivalent P: Taken polytechnic foundation mathematics

Table 1: Data attributes in our dataset

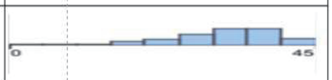
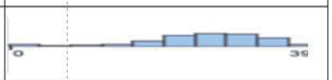
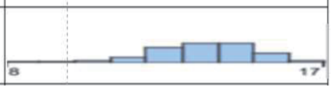
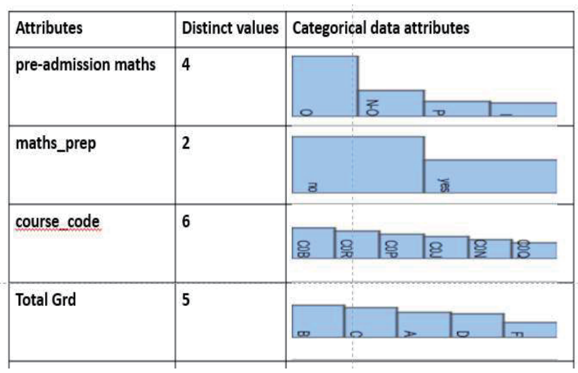
Attributes	Mean	Std	Histogram
M1	31.4	7.49	
M2	25.01	7.46	
MT	68.23	13.97	
Mean(Duration)	24.16	8.33	
Mean(Count)	5.137	1.17	
Mean(Content HR)	13.66	1.28	

Table 2: Histogram distribution of numeric discrete and continuous data attributes (Std= standard deviation)



Attributes	Distinct values	Categorical data attributes
pre-admission maths	4	
maths_prep	2	
course_code	6	
Total Grd	5	

Table 3: Categorical quantitative data attributes

Target Attribute:

Classification is one of the important data mining and analytics goals. In this paper, we will focus on the target variable, final Logic and Mathematics grades (i.e. MT of Table 1) of our students. The target attribute is a variable whose values are to be modeled and predicted by other attributes. The final grades (i.e. MT of Table 1) are modeled using three supervised approaches (Cortez, P and Silva, A., 2008):

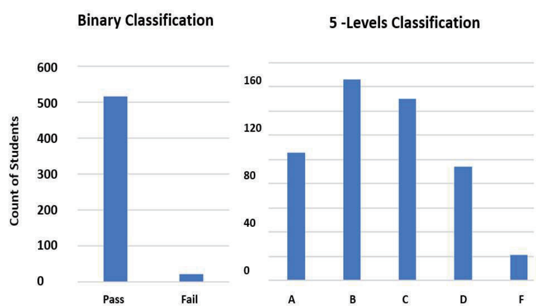
1. Binary classification – pass if MT ≥ 50, else fail;
2. 5-Level classification – based on the grade conversion system (Table 2);
3. Regression – the final score (numeric output between 0 and 100);

Category	Pass with different bandings to indicate performance levels				Fail
Marks (x)	≥ 80	70 ≤ x ≤ 79	60 ≤ x ≤ 69	50 ≤ x ≤ 59	≤ 50
Grades	A	B	C	D	F

Table 4: 5-level Classification

Distribution of Target Attribute:

To have a better sense of the underlying distribution of the final Logic and Mathematics grades, we create histograms. Based on the histogram's shape we draw some insights into the distribution of our numeric target attribute which is the students' final grades in the course. Based on Figure 1, students usually score grades A, B or C for this course. The early intervention warning is targetted at the outliers, students who fail, MT < 50 and students with MT < 55. We wish to improve the learning for these specific groups of students and engage them with targeted teaching strategies in our recommendations.



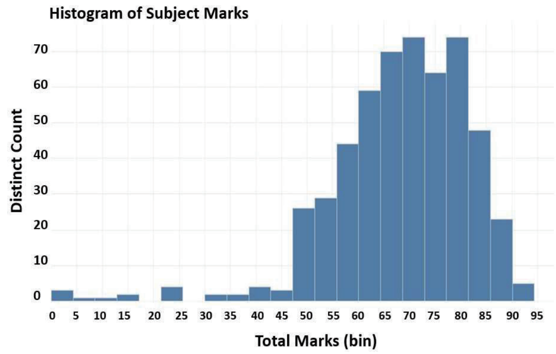


Figure 1: Histograms for the output variables (binary, 5-level classification and regression)

Findings

The e-learning environment provides an extremely rich source of data as user activities are held in the database waiting to be mined for research work (F. Bouchet, J. M. Harley, et. al., 2013). Notable research has been done in reference to e-learning (S. Sagiroglu. 2013, C. Romero. 2013). We will investigate if higher access counts, longer duration access or more content access on the online learning system leads to better performance in our students (M. Zajac. 2009, C.M. Chen, 2007). Besides measuring academic performance, behavioural patterns of learners and discovery of user online patterns can be studied using analytics (M. Kock and A. Paramythis, 2010).

Online learning patterns in a time-series domain:

Using Tableau software, we adopt qualitative methods to analyse the log data (S. K. MacGregor, 1999) and frequency counts of actions of year one students taking Logic and Mathematics subject. We mined the activity logs of individual students at successive equally spaced intervals across 18 weeks, obtaining 572 x 18 weeks of time series data points. Next, we apply the straightforward technique of plotting a line chart on a time-domain for irregularities and trend analysis. The data is drilled into the grade bandings for behavioural patterns analysis of specific groups of students. The Tableau visualization (Figure 2) traces what learners do in ways accurately although not perfect their online actions within the learning management system.

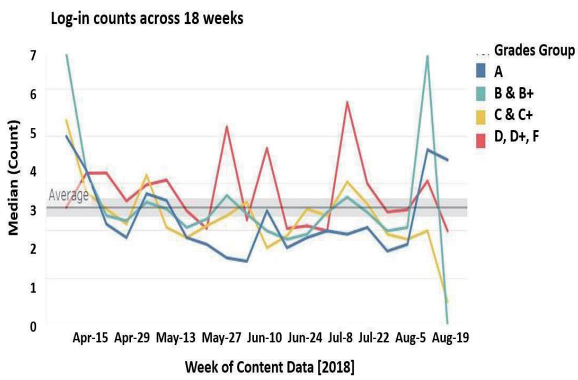


Figure 2: Access counts of online content (18 weeks)

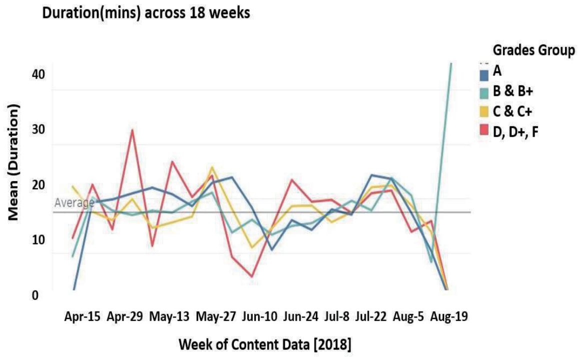


Figure 3: Duration access of online content (18 weeks)

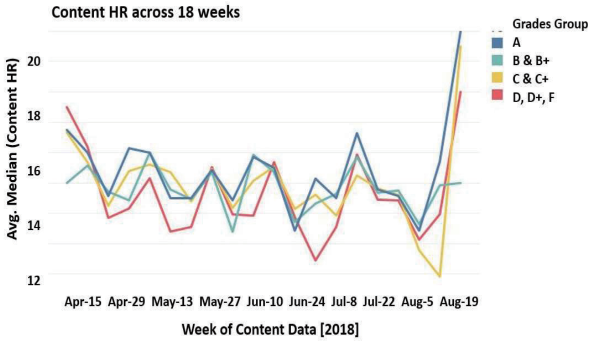


Figure 4: Online content HR access (18 weeks)

Based on the time-series domain analysis in Figures 2- 4, we noticed certain online behavioural patterns:

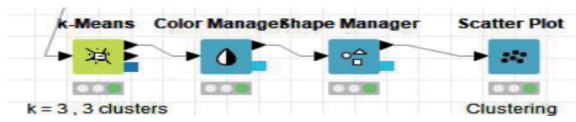
- On the average, students spend 20 minutes weekly on online learning.
- Grades D & F students predominate the irregularities of the online learning patterns. There exist erratic and random peaks of long duration (i.e. 35 mins) and counts (i.e. 6 counts) and troughs of extremely low duration (i.e. 5 mins).
- Assessments and assignment deadlines trigger a sudden surge of high volume of online activities around May 27 - June 10, 23 July and 6 Aug in an otherwise little online activities environment for students with Grades D & F.
- The online behavioural patterns of students with Grades B & C are closely similar.
- The strategies employed by top scoring or highly motivated students includes carrying out a more focused study activity (Caprotti.O, 2017). This explains a consistently higher than average online duration was observed from April 15 to June 24 followed by decreasing online learning activities of Grade A students.

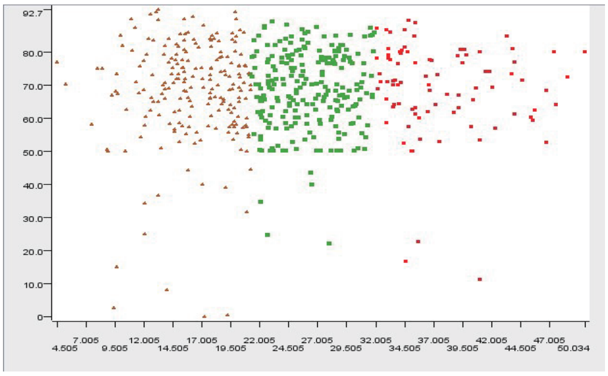
Unsupervised Clustering on online learning behaviour:

Clustering is a type of unsupervised learning that allows a user to make groups of data in order to find the frequent patterns from the data. In such classification, only subset of the online learning attributes is used in the k-means clustering. We pre-defined k = 3 for 3 clusters (low, average and high online activities) using k centroids in KNIME software. Each cluster is represented by a symbol using the Shape manager node in KNIME software for visualization purposes. After clustering, a comparison of final numeric scores with the online data attribute is shown on the scatter plots.

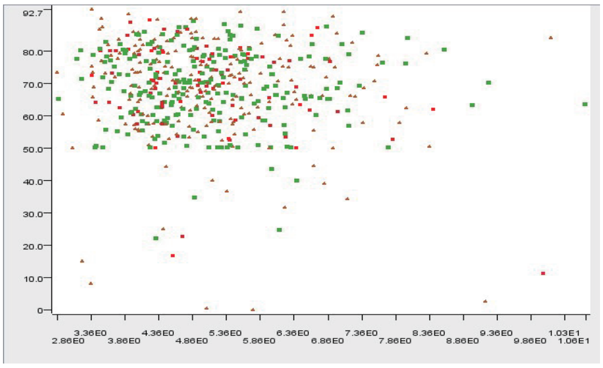
From the cluster and scatter plot (Figures 5), we deduce:

- Poor and no correlation of mean online duration and mean access counts with final scores (MT) for all clusters.
- Moderate correlation of content HR with final scores (MT) for all clusters

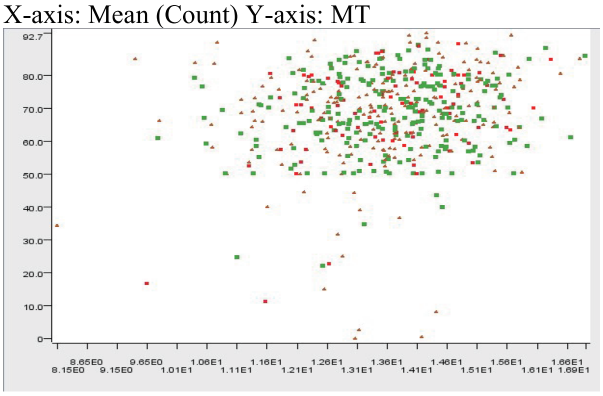




X-axis: Mean Duration Y-axis: MT



X-axis: Mean (Count) Y-axis: MT



X-axis: Mean (Content-HR) Y-axis: MT

Figure 5: Scatter Plot of mean duration, mean count and content HR against total marks with k-means (k = 3) clustering

Boxplot analysis for variations:

The technique of box plot is used here to scrutinize variations. The advantages of box plot include displaying variation in samples without any assumptions of underlying statistical distribution. We consider learner characteristics that have been identified as important sources of variation: Pre-admission maths qualifications, normalized entry aggregate scores, diploma courses, tutorial groups and online learning variables. We will compare box plots across tutorial groups, pre admission maths qualifications, online learning (mean & count) against the final numeric grades of students.

Boxplot analysis on tutorial groups and diploma courses:

Boxplot diagnosis can pinpoint the below-average performance classes after each summative assessment. As interquartiles and outliers are indicated clearly, weaker classes can be identified immediately after written test in week 8. Using statistical inferences, accurate and immediate early intervention can be executed by the respective tutors of the weaker classes.

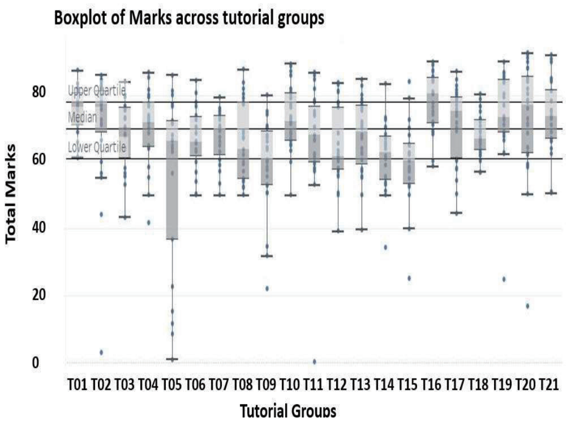


Figure 6: Boxplots of final marks (median=70.0, upper quartile =78.0, lower quartile=60.95) of tutorial groups

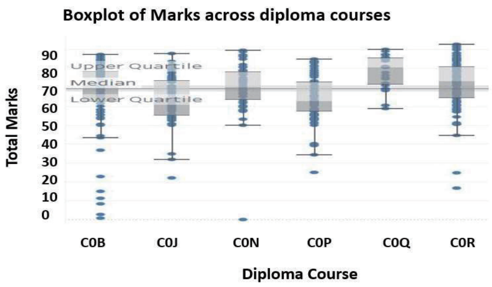


Figure 7: Boxplots of final marks across diploma courses

We noticed from Figure 6:

- All except 5 students of T14 & T15 score below median score = 70.0 (Figure 7). 50% of students of T03, T05, T06, T07 & T18 score below the median score = 70.0
- Outliers who score below 40.0 mostly come from T05, T09. The outliers (M_T < 40) are represented by dots can be identified early by their tutors.
- 50% of students of T01, T04 & T16 are in the median and upper quartile = 78.0 band, indicating students have attained their desired learning outcomes.

From Figure 7:

- Comparing the diploma courses, 50% of students from C0J and C0P performed below the median score = 70.0
- Tutors who are teaching diploma courses of C0J and C0P may note that students would require more scaffolding to bridge their learning gaps.

Boxplot analysis on pre-admission maths qualifications:

We find that students with different pre-admission maths qualifications have slight variations in their academic performance for logic and mathematics.

- 50% of students with international maths qualification and without O Levels mathematics qualification score fall below the median band = 70.00 (Figure 8)

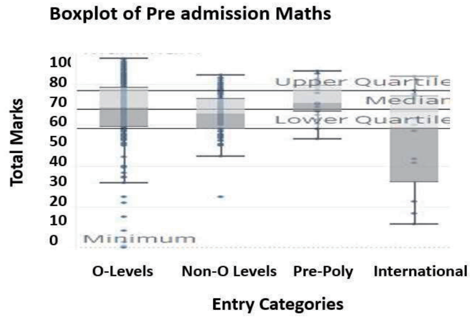


Figure 8: Boxplots of final marks across different pre-admission maths groups

Boxplot analysis on student's online learning:

There is no correlation implying spending less average time on online learning leads to weaker performance, refer to (Figure 5) and tutorial groups T19, T20 & T21 (Figure 8). However, we can use boxplot analysis to understand the engagement levels of learning management system across the 21 tutorial groups and if students utilize online materials as a studying tool.

- Students from T06, T10 & T18 spend higher durations for online learning.
- Students from T04 - T07& T19-T21 spent shorter duration time for online learning.

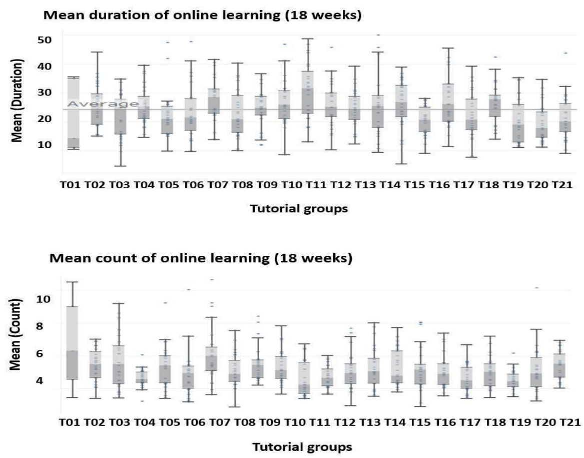


Figure 9: Boxplots of online duration and access counts across all tutorial groups

Correlation Matrix Analysis:

In the broadest sense correlation is any statistical association, the degree to which a pair of variables are linearly related. Correlations are useful because they can indicate a predictive relationship that can be exploited in practice. Since we have multiple variables at the same time, we compute a correlation matrix to investigate the dependence between all the data attributes. The result is a table containing the correlation coefficients between each data attribute and the others (Figure 10).

From the correlation matrix, weak correlation relationships exist between final total marks with mean content HR (+0.1893), mean online duration (+0.0278) and normalized marks (- 0.1969). Strong correlation pairs are M1(+0.751), M2(+0.871), M3 (+0.641) and M4(+0.612) with the final total marks.

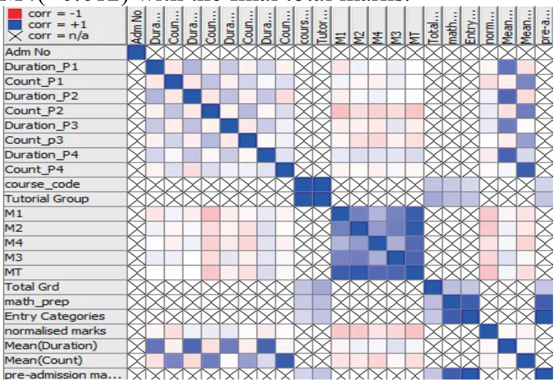


Figure 10: Correlation matrix of the data attributes or predictors

Decision Tree classification of grades prediction:

Classification is a technique used for categorical prediction based on previously learned classes from a training dataset. In this study, multiple classification techniques is used in the data mining process for predicting students' final grades. The idea of a decision tree is to split the original data set into two or more subsets at each algorithm step, so as to better isolate the desired classes to solve binary or multinomial classification problems (Breiman et al. 1984).

The following settings are used in the decision tree: 85% training set, 15% testing set, gain ratio split, MDL pruning method to handle overfitting of data (Han and Kamber, 2006) and split point average.

Three input configurations were tested for the decision tree model:

• A-with all variables from Table 1 except M_3, M_4 and MT (the output);

• B-similar to A but without M_2 (week 10 -18 period grade); and

• C-similar to A but without M_1(week 1 -8 period grade);

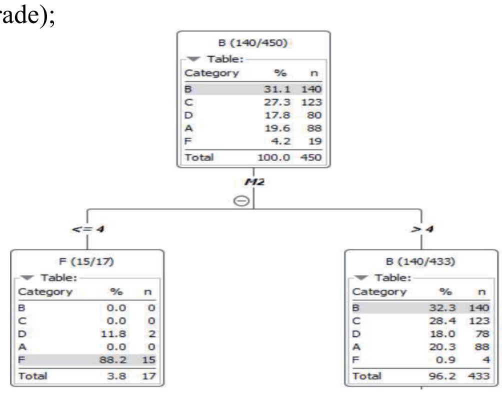


Figure 11: Decision Tree model (Multi-classification)

The classification rules extracted from the (multi-classification) tree:

1. If M2 < = 4, then class 'F (12/14)';
2. If M2 < = 28.3 and M1 < = 27.5 then class "D" (60/94);
3. If M2 < = 28.3 and and M1 < 40 then class "C" (117/272);
4. If M2 > 28.3 and and M1 > 33, then class "A" (85/152)

The accuracy for multi-classification using the decision tree model for input configuration A is 77.5%.

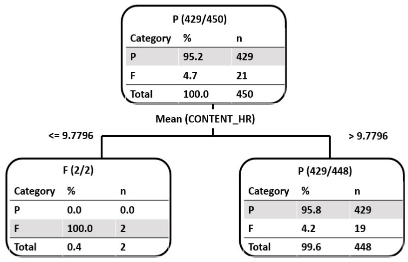


Figure 12: Decision Tree model (Binary classification)

	Correctly Classified (Accuracy)	Wrongly Classified (Error)	Cohen's kappa
Binary	76 (95.0%)	4 (5.0%)	0
Multi-classification	62 (77.5%)	18 (22.5%)	0.7

Figure 13: Accuracy of Decision Tree

Recommendations

Identification of at-risk students:

From the decision tree classification rules, students whose written test <= 27.5, assignment <= 28.3 and exhibit erratic online behavioural patterns are identified as at-risk students. From our multi-classification model, tutors can recognize the profiles of at-risk students for increased scaffolding, supervised learning and other learning strategies. This will help tutors to engage the identified at-risk learners at the beginning of the course.

Assessments as checkpoints:

Each summative assessment may serve as a checkpoint. Together with boxplot analysis, tutors teaching the identified weak classes can increase scaffolding, supervised learning, formative assessments and other teaching strategies to engage their learners. Individual students scores from week 8'd written test will indicate their likelihood of falling into the passing or failing group. Weaker classes require more monitoring of their learning and tutors can increase classroom intervention for learners to attain their learning goals.

Online learning behaviour as checkpoints:

From the analysis, students who had extremely low online activities but high activity levels prior to the submission deadlines are likely attain grades band D or F. Hence, early pre-emptive warning signals to online learning can be triggered from week 0 onwards. Tutors can access the learning analytics engagement viewer to monitor the weekly duration and access count of their students who fall below 50% of average online activities in the cohort.

Conclusions

In this paper, we implement data analytics techniques using educational data to help us learn student behaviour and student performance. Depending on selected input parameters, it is possible to integrate date mining techniques into the e-learning environment and data from online systems. We review the role of data mining techniques for predictive purposes so teachers can identify at-risk students early in the course. The patterns found in our data insights enable tutors to put into place early pedagogical interventions for at-risk students throughout the course to improve the students' success in the classrooms.

Acknowledgements

Temasek Polytechnic has provided the datasets of students in this study.

References

Breiman, L. (2001). Random Forests. *Machine Learning*, 45, no. 1, 5–32.

Breiman, L., Friedman, J., Ohlsen, R., & Ston, C. (1984). *Classification and Regression Trees*. Wadsworth, Monterey, CA.

Beck, J.E., Chang, K.-m., Mostow, J., & Corbett, A.T. (2008). Introducing the Bayesian evaluation and assessment methodology. *Proceedings of Intelligent Tutoring Systems*, ITS 2008, 383–394.

C. M. Chen., Y.Y. Chen., & C. Y. Liu. (2007). Learning performance assessment approach using Web-based learning portfolios for e-learning systems, *IEEE Trans. Syst*., Man, C, Appl. Rev., vol 37, no. 6, 1349- 1359.

C. Romero., & S. Ventura. (2010). Educational Data Mining: A Review of the State of the Art*, IEEE Transactions on Systems Man, and Cybernetics* – Part C: Applications and Reviews, Vol. 40, no. 6.

C. Romero., M. I. Lopez., J-M. Luna., & S. Ventura. (2013). Predicting students' final performance from participation in on-line discussion forums, *Compt. Edu*., vol. 68, 458-472.

Cortez, P., & Silva, A. (2008). Using data mining to predict secondary school student performance, in *Proceedings of 5th Future Business Technology Conference*, pp 5-12, Porto, Portugal, EUROSIS, ISBN 978-9077381-39-7

Dekker, G., Pechenizkiy, M., & Vleeshouwers, J. (2009). Predicting students drop out: A case study. *Proceedings of the 2nd International Conference on Educational Data Mining*, EDM'09, 41-50.

F. Bouchet., J. M. Harley., G. J. Trevors., & R. Azevedo (2013). Clustering and profiling students according to their interactions with an intelligent tutoring system fostering self-regulated learning., *J. Edu. Data Mining*, vol, 5, no. 1 .104-106

Han, J., Kamber, M. (2006). *Data Mining: Concepts and Techniques*, Second Edition, Morgan Kaufmann Publishers.

Hastie T., Tibshirani R., & Friedman J., (2001). *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*. Springer-Verlag, NY, USA.

Klosegen, W., & Zytkow, J. (2002). *Handbook of data mining and knowledge discovery*, Oxford University Press, New York.

Luan, J. (2002). Data Mining and Its Applications in Higher Education in A. Serban and J. Luan (eds.) *Knowledge Management: Building a Competitive Advantage for Higher Education*. *New Directions for Institutional Research*, No. 113. San Francisco, CA: Jossey Bass.

J. E. Beck., & B. P . Woolf. (2000). High-level student modling with machine learning, in Proc. 5th Int. Conf. *Intell. Tutoring System*, 2000, 583 -593.

Minaei-Bidgoli B., Kashy D., Kortemeyer G., & Punch W. (2003). Predicting student performance: an application of data mining methods with an educational web-based system. In Proc. Of *IEEE Frontier in Education*. Colorado, USA, 13-18

M. Kock., A. Paramythis,.(2010) Towards adaptive learning support on the basis of behavioural patterns in learning activity sequences, 2nd Int. Conf. intel. *Netw. Collaborative Syst*. (INCO), 100 -107.

M. Zajac, (2009) Using learning styles to personalize online learning, Campus-Wide Inf. Syst., vol 26, no. 3, 256-265.

Zhou, M. (2010). Data Mining and Student e-learning Profiles, IECEE 2010 The international conference on E-Business and E-government

Siemens, George., & Baker, Ryan. (2012). Learning analytics and educational data mining: Towards communication and collaboration. ACM International Conference Proceeding Series. 10.1145/2330601.2330661.

S. K. MacGregor. (1999). "Hypermedia navigation Profiles: Cognitive characteristics and information processing strategies" J. Educ. Computing. Res. New York, vol 20, 189-206.

The Importance of Building Collaborative Partnerships with Inbound and Outbound Partners

OKADA Akira

National Institute of Technology (KOSEN), Oyama College / Department of General Education, Oyama, Japan

akira.ok@oyama-ct.ac.jp

Abstract

The purpose of this talk is to present the importance of the collaborations with overseas institutions as well as domestic community partners for "Sustainable Society".

In order to create the sustainable society in the world, it is necessary to foster highly proficient human resources with a wide perspective, a creative talent and an international understanding. Then, how do we foster such human resources? In fact, every faculty in the world recognizes that they must make their students become active engineers or persons as a leader in the future, and it is certain that every university or institute, including National Institute of Technology, has some unique exchange programs which inspire students to join. Nevertheless, it is urgently required to make more and more students acquire such abilities and send them out into the world. This is because we are in the era in which we can never ignore the global issues such as global environment, global warming, equal rights in education and so on that might get more critical than ever and we need to come up with the solutions before these issues become serious.

In addition to the nurture of students through our effort, it is essential to consider how we get our students motivated to social contributions for the problem-solving.

Throughout this talk, some approaches in which our college is deeply engaged in the nurture of our students will be stated as follows; 1. Introduction of our projects with overseas institutions and community partners, 2. Proposal of the importance and the merit of inbound and outbound contribution activities, 3. Risk management system for students. While holding an exchange program successfully, we inevitably face a large number of tasks on the programs or the management system for students.

Solving various problems in the programs, we need to consider the exchange programs from now on which will lead to sustainable society.

This talk will definitely contribute to the concern of student-motivation for the collaborations with overseas institutions and the local community partners.

Keywords: *exchange program, sustainable society, collaboration, risk management, solving problems*

Introduction

No Japanese institutions exist without holding an English classes; English is the obligatory subject, generally from junior high or higher grades of elementary schools. Japanese government has decided that English classes in earlier levels of elementary schools should start as the new educational guidelines, which will come into force in 2020. This is partly because English is getting more and more important not only in Japanese society but also in global societies. The other possible reason is that it is urgently required to foster human resources with higher English proficiency and good communication skills. Such human resources must be nurtured at as earlier a stage as possible. Why are the new educational guidelines or the nurture of such peoples urgently required by Japanese government? The reason is that we need to establish "Sustainable Society". According to Lester (1981), it is defined as "one that is able to satisfy its needs without diminishing the chance of future generations" and it can be made to come true through the contributions to global societies. However, it must be tough for most of the students in our college to contribute to global societies without good understanding of the importance of contributions to the surroundings close to them or "Regional Society." As a first step, we must make them understand the importance of local contributions along with the importance of higher English abilities and communication skills.

At the same time, we, as teachers or supporters for our students, need to consider "Risk Management." We have been required lately to take good care of what our students do without being involved in any accidents, especially in foreign countries. This is because some unexpected accidents might happen everywhere in the world. It is necessary to take Risk Management Plan into consideration for our students.

Nevertheless, it is inevitable to make our students have a good opportunity for the improvement of English abilities and communication skills, for their active attitude or fresh ideas will lead to the contributions to the global wellbeing.

The following sections will show our projects with inbound and outbound partners, followed by risk management system.

1. Necessity to Foster Global Engineers with Good Talents for Solving Global Issues

We have known that our planet is full of global issues; the examples are Climate Change, Pollution, Violence, Security and Well Being, Lack of Education, and so on. Chloe Turner, a columnist for various kinds of world problems, describes the global issues in the internet magazine "The Borgen Project" issued in January 18th, 2018 as follows;

> "With so many current global issues that require immediate attention, it is easy to get discouraged. However, the amount of progress that organizations have made in combating these problems is admirable, and the world will continue to improve in the years to come. By staying active in current events, and standing up for the health and safety of all humans, everyone is able to make a difference in changing the fate of our world."

We can do something to change our world. For us, it is one of our obligatory works to make our students contribute to the world problems and world societies in order to solve the global problems. It is true that our work is to teach some specific skills and give knowledge to our students. However, it is also important to make them acquire wider views and international understandings through the regular classes as well as some exchange programs done with our inbound and outbound partners.

The actual programs which are held in our college with our partners will be stated in the following sections.

2. Introduction of Our Projects with Overseas Institutions and Community Partners

As globalization progresses year by year, it is becoming important to foster human resources who have the excellent ability for communication skills and good English abilities. According to the report in 2015 from National Institute of Technology (NIT), totally 2,409 students and 1,449 faculties went abroad with a view to studying English, attending international conferences and other purposes respectively. These figures are becoming much higher than before because NIT has gone into partnership with overseas institutions over past many years. In spite of that, it is unfortunately true that the students in every national college of technology have been said that their English abilities are poor at communicating with international students even though they have great skills for manufacturing new things. Taking such a situation into consideration, we must make our students communicate with international students or visitors from overseas positively through various English programs as a practical training in each college. In order to do so, each college needs to think of establishing the English training programs such as exchange programs with foreign institutions, internship abroad, English café and so on by themselves.

Our college do not have unique English training programs compared to those of other colleges. However, we have developed new exchange programs with overseas institutions under the basic educational policy of our college. We accept not only long-stay international students but short-stay international students as well from sister schools mainly in Asian countries. In addition, more and more students in our college seem to turn their attention to international conferences or interesting events like International Symposium on Technology for Sustainability (ISTS). The followings are some examples of the English-related events that are held in our colleges through the year.

2.1. Overseas English Learning Programs

It is generally said that the word of 'Globalization' has been frequently used since 1980s, when ordinary people could go abroad with more reasonable price than ever before. Along with such a trend, every educational institution began to consider English training programs for younger generations. NIT also considered special programs to foster human resources with good English abilities. Our English learning program in foreign countries started about twenty years ago and has sent over 100 students to foreign countries so far. The countries to which our college has sent our students are Australia, the United Kingdom and the US. Ten or more students participate in this program every year, attending private English language school with a two-week homestay. Through the homestay, they can have an unexpected good or sometimes undesirable experience to share their own lifestyles with host family. There are two good points which other programs do not have in this program.

The first one is that students can take English classes with international students from various countries according to their English proficiency. The level of English proficiency of every student in the class is almost the same, so that they can feel relaxed for the study without getting nervous. Furthermore, they can know every custom in different countries, which can lead to the acquisition of wider perspective. They will think of going abroad to meet their friends and realize the importance of English communication.

The second one is that they can visit world famous companies after classes. When this program is held in the US, our students have an opportunity to go to Boing Factory in Seattle, join Silicon Valley tour, famous university tours (UC Berkeley, Stanford University), and so on. As for university tours, they can drop in some laboratories which have much more expensive experimental devices than they can see in our college.

The above introductions are the good points, but there are some bad points to improve from now on. The number of students who participate in this program has been decreasing partly because we have now other interesting English training programs in which they can get credits with better scholarship. In fact, the students cannot get any credits in this program with less scholarship. Another factor may be hidden for the improvements. Even though there are undesirable points in this program, we need to keep making efforts to change the undesirable points into better ones.

2.2. Exchange Programs with Overseas Institutions

Our college has concluded agreements with several overseas institutions these past years and constantly carried out the student exchanges with them. Among them, it is seven years since we formed a partnership with Hong Kong Institute of Vocational Education (IVE). We accept IVE students in every May, the number of the students is about fifteen, and stay at our dormitory for ten days. Our students and IVE students exchange their opinions and get to know each other through various programs. The total number of our students who participated in the whole program is about 600 every year, which is higher than we expected.

At the same time, we send about fifteen students to Hong Kong in every August and stay at IVE dormitory for ten days. If our students successfully finish all the programs in IVE, they will be give two credits as an internship with scholarship. It is also obligatory for them to deliver a speech on their experience in IVE after they come back to Japan.

Our college has two other institutions with which we started new exchange programs. One is Institut Universitaire de Technologie (IUT) in France and the other is Universidad de Guanajuato in Mexico.

For IUT, we accept two or more students for three months from April to June. When they arrive at our college and the program starts, they will become a member of different laboratories. In each lab, they need to decide a theme which they can finish during their stay and deliver a speech on their final results in front of faculties. Meanwhile, we send a few students to IUT for one month from February to March. Also, we have started to send our students there from September to October as a two-month study program. Each of our students may go to different campus and take instructions from teachers for their research. During their stay, they must get successful grades from IUT teachers. When they come back to Japan, they must give a speech on their experience and research results. If the results are successfully passed, they will be given two credits as an internship with scholarship.

For Universidad de Guanajuato, we started this program three years ago, and sent two or three students every year through the collaboration with other national colleges (Ibaraki, Fukushima, Nagaoka and Tsuruoka). Different from the program in IUT, this program is short-stay (ten-day) program, so that the main purpose of this program is the student exchange. Our students can have an experience for studying Spanish, demonstrating Japanese cultures, visiting companies and so on. We also accept more than ten Mexican students every year. Last year, they stayed at our dormitory for five days, which led to the better student-exchange than ever.

Other exchange programs will be started in the near future in our college. Some unexpected problems may occur during the program, but it is necessary to keep doing the programs for the nurture of good human resources with a wider perspective and an international way of thinking.

2.3. Projects with Community Partners

The importance of the contribution to the local community has been pointed out for a long time. In spite of the fact that our college is one of the national technical colleges, we have made less effort for the contribution to the globalization of our community. In order to improve this situation, we have just started some joint events with our community partners. Instead of doing something new, we have decided to have our college students or short- or long-stay international students participate in the present events like an international festival, Japanese Speech Contest held by local community. One of our community partners accept our international students and give them free-guided tour as a volunteering activity. Our students can know the history of the town and some unique events there through the tours. Also, they can experience Japanese traditional cultures such as Japanese Tea Ceremony in our college. A teacher of the ceremony came to us for showing the traditional way of drinking Japanese tea a few times a year, especially the period while the short-stay students are staying at our college.

In addition to these activities, we have started, as I said, to send our students to the English school in a sister city which is affiliated with the local partner as an English training program since last year.

We consider the partnerships with the local communities to be so important for the local globalization and the nurture of our students that we must keep these activities with the surrounding communities.

3. Proposal of the Importance and Merit of Local Contribution Activities

As I stated earlier, it is important to contribute to local societies. Every local government must have its unique events where local students and international students from overseas sister cities can get to know each other and exchange their opinions about the differences of, for example, way of life, habits and so on. For the students who do not have any experiences to go abroad, the events are good opportunities and they can enjoy themselves without feeling much pressure. Moreover, the students' participation in the events leads to the contribution to the revitalization of the local societies. The institution of higher education like universities or technical colleges is, as it were, a wisdom-centered facility and their 'wisdom' must be returned to local societies for its revitalization through the efforts of faculties as well as college students. If the revitalization of local societies goes well, the number of foreign visitors as well as Japanese ones will increase and more local products will be distributed inside and outside the country. After all, younger generations with good English abilities and high communication skills play an important role in the globalization of local societies.

4. Risk Management System for Students

So far, the importance of the contribution not only to local societies but also global societies has been described in earlier sections. In addition, it has been pointed out that it is urgently required to foster human resources with good English abilities and high communication skills. Such human resources can be nurtured through intercommunication with international visitors or going abroad by themselves. However, we need to take some risks for our students to grow and develop their global understandings. In order to make all the programs go well, it is necessary to consider as many potential problems as possible beforehand and successful management before starting the programs as in the statement of Japanese government which emphasizes the importance of risk management. According to the description of Institute of Risk Management, "risk management involves understanding, analyzing and addressing risk to make sure organizations achieve their objectives."

What is it that we should do as the risk management? Our college conducts the followings as the risk management. First, we take out emergency assistance service or Overseas Student Safety Management Assistance (OSSMA). Second, we register the service managed by Ministry of Foreign Affairs of Japan, which is called "Tabi-Reji" or mail service about the information on foreign affairs. Third, we make an emergency contact network. Recently, many insurance companies hold a seminar on risk management for companies in which the employees will go to overseas branches. The escort teachers for students going abroad together as well as other faculties in every college should take seminar for the risk management. Otherwise, we can do nothing if an emergency happens.

We cannot take away all the risks for our achievement of our goals, so that it is necessary to take every measure as the risk management for our students and for the exchange programs.

5. Conclusion

The purpose of this paper is to show our programs with overseas institutions and inbound partners for the nurture of human resources with good English abilities and high communication skills along with introducing my viewpoint on the importance of risk management. The following points are shown as a conclusion.

(1) In order to foster human resources who can communicate with foreign visitors with good English abilities, it is inevitable to make younger generations have an opportunity to make use of English as a practical training through domestic and foreign institutions.

(2) The contribution to local and global societies should lead to Sustainable Society in the future.

(3) Much attention must be paid to risk management in order to make our programs go successfully.

Sustainable society can be made to come true if we take good care of exchange programs or English training programs in which new generations will participate. Unless they go beyond their own current abilities for English and communication, the real sustainable society will go far away. It is necessary to make every effort to foster human resources who can communicate with others from overseas.

Acknowledgements

I would like to thank the members of International Exchange Promotion Office in National Institute of Technology, Oyama College for their supports on this paper.

References

Okada, A. (2016). English Study Motivation Cultivated by Exchange Programs. *Proceedings of National Institute of Technology, Oyama College, 49, 5-8.*

Okada, A. (2016). Report of Exchange Programs Conducted in National Institute of Technology, Oyama College. *Journal of The Council of College English Teachers, 36, 107-114.*

Home Page of National Institute of Technology
http://www.kosen-k.go.jp/joho_kokusai.html

Home Page of The Borgen Project
https://borgenproject.org/top-10-current-global-issues/

Institute of Risk Management
https://www.theirm.org/the-risk-profession/risk-management.aspx

Sustainability Degrees
http://www.sustainabilitydegrees.com/what-is-sustainability/sustainable-society/

A project-based learning approach in developing students' cross-discipline engineering skills

T.W. NG[*,a], K.P. WONG[a], S.Y. CHAN[a], T.H. MAK[a], W.H. WONG[a] and Y. GUAN[b]

[a] Department of Engineering, Institute of Vocational Education (Chai Wan), 30, Shing Tai Road, Chai Wan, Hong Kong
[b] Shenzhen Bauhinia Valley Technology Co. Ltd, Shenzhen – Hong Kong Youth innovation Entrepreneurship Base, Nanshan iPark, Shenzhen City, China

*eetwng@vtc.edu.hk

Abstract

In this paper, a project-based approach that nurtures students' interest in engineering skills is presented. In addition to the ordinary guidance in written or spoken format, experiential activities like hands on works are imposed to further consolidate learning content through the project work. The project itself adopted a brand new development board running an Operating System (OS) with Graphical User Interface (GUI).

The primary objectives of the project are: 1) to raise students' problem solving and cross-discipline engineering skills include but not limit to programming, circuit analysis, electric motor control and relevant Integrated Circuit (IC) selection. 2) to develop an engineering application using latest development board. 3) to handle an engineering problem on liquid dispensing.

A proposed Liquid Dispensing or Vending Machine with a touch screen is adopted to show the product list. Users simply interact with the machine by touching the screen. Product categories, prices and quantities are amended either at local or remote mode. Meanwhile transaction data and usage history records are stored locally in on board memory and the development board has the capability to share these information to other devices via Internet.

Students are asked to develop their own integrated software and hardware projects as they would start their coding work on a normal Personal Computer (PC) in preliminary development stage and migrate the system to a portable mini-computer. The outcomes of selected students' work would be presented and their methodologies would be discussed. Finally a conclusion will be given to evaluate the effectiveness of the project based learning and some recommendations will be made as a project accomplishment.

The project has the capability to further be developed to meet certain industrial requirements and is expected to solve an engineering problem from students' creativity.

Keywords: *Project-based learning, Cross-discipline Engineering skills learning, Liquid dispensing machine*

Introduction

Under the Basic Education Curriculum Guide, the Education Bureau of The Government of the Hong Kong Special Administrative Region has put project learning as one of the Four Key Tasks in secondary education curriculum (2002). In this paper, a project-based learning (PBL) approach has been adopted to tertiary education which aims to raise students' interests in problem solving skills by introducing an engineering challenge requested from industry.

Exploration from students' view

Differ from traditional problem solving in terms of writing; the students' answer is no longer consisted of descriptive paragraphs which may only include procedures and numerical explained with calculations steps. Instead, students' works are presented in form of presentation. A specification was drafted which listed the objectives of an industrial project and its functions to be accomplished. Students are given rooms and chances to explore the feasibility of their own proposed solution.

Project Objectives

The project aims to design a vending machine with the following functions:

1. Dispensing four categories of liquid with various combinations.
2. Suits to various container with opening area larger than 1cm^2 with height less than 20cm.
3. Graphical User Interface with touch control.
4. Electronic payment
5. Inventory/Sales record for analysis

Definitions and Terms

Vending machine: A machine which provides liquid dispensing service via users/operators commands. The machine should follow procedures defined to interact with users/operators.

User: any person uses the service provided by the vending machine by giving commands via human touches.

System Design

The system is divided into three major parts namely 1) Graphical User Interface (GUI), 2) Central Control Unit and 3) Dispensing Unit. Fig.1 shows the system schematic which gives the overview of the Liquid Dispensing Machine. The functions of the three core parts are described as follows:

The Graphical User Interface aims to provide an interaction between the user/operator and the machine. Either users/operators can initiate their commands by touches and receive graphical or textual feedback from the machine to complete the purchase.

The Central Control Unit acts as a connection between the GUI and Dispensing Unit. Moreover it processes the commands given from users/operators and determines the actions involved as feedback.

The Dispensing Unit receives commands from Central Control Unit and actuates the dispensing process by activating the pumps. The filling process is controlled by Flow control sensors and switches to prevent over/under-dispensing. Another function of the Dispensing Unit is reporting the storage of the dispensing liquid by counting the amount of the outflow volume.

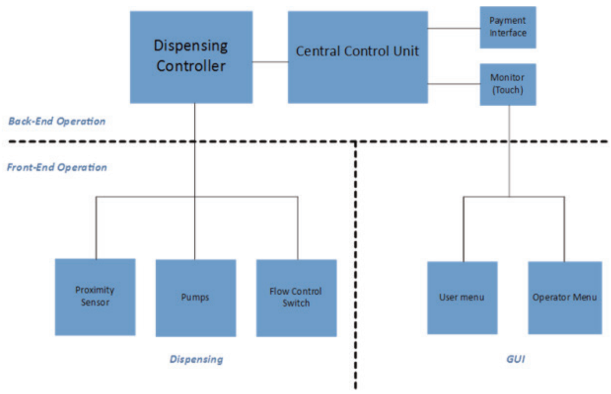


Fig. 1 System Design of the Vending Machine

Two flow charts were drafted by the project team which help them in developing the GUI are shown in Fig.2a and Fig.2b. A user starts the purchase by selecting the sizes and categories of the liquid accordingly with his touch. The user should put the container into the dispenser and select the payment method. Once the transaction is completed, the liquid dispensing unit would operate and pump the liquid out. User should take the container with fillings out of the feeder when the process finished.

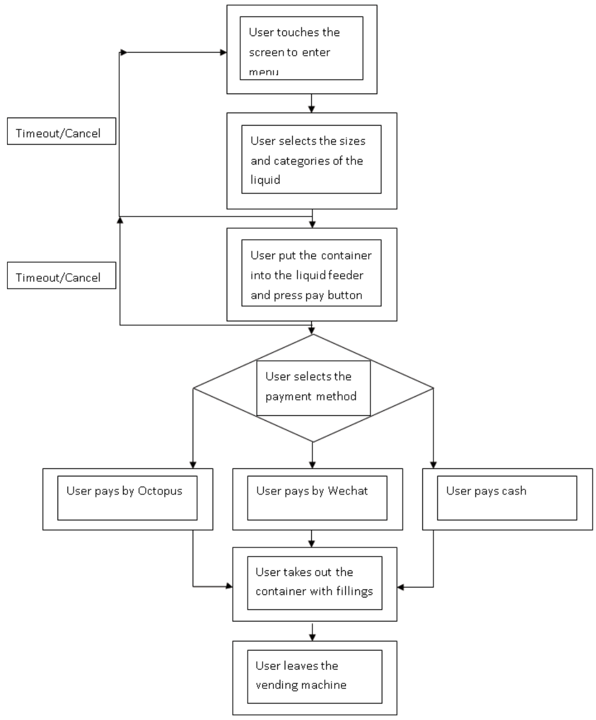


Fig. 2a Operator Flow Chart

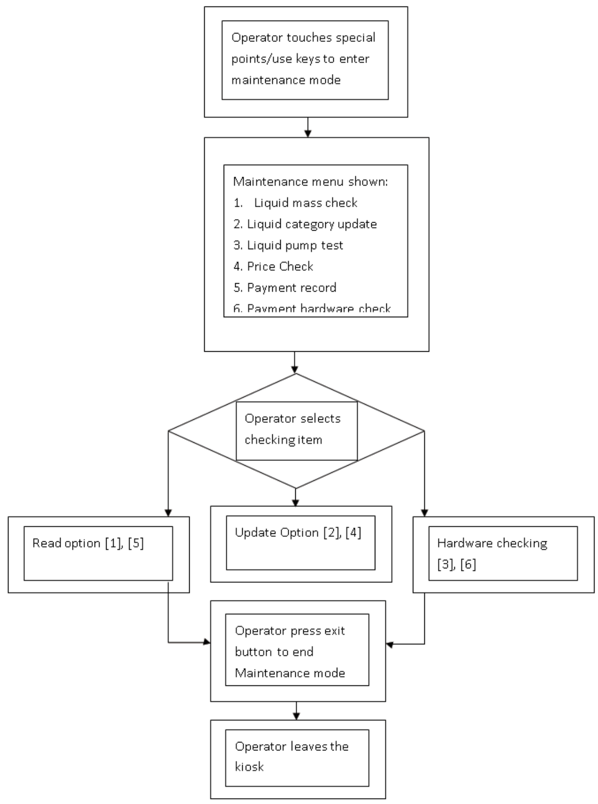


Fig. 2b Operator Flow Chart

A special method is introduced to the project team to interchange the user/operator mode. Firstly, a transparent button is created and located at the upper corners. To enter the operator menu, the corner button should be pressed twice consecutively. Differ from the user menu, the operator menu provides more functions like amending items and unit prices, checking inventory, verifying payment record and other hardware tests.

Stage 1 Implementation – GUI

The GUI design requires student to fabricate an input interface with human touches. The interface should include but not limited to retrieving commands, providing graphical responses, sending commands to controller which generates driving signals for motors and generating reports for analysis. It should be able to handle simple exceptions like particular liquid is sold out, pumps is not in functions, container is not well-connected to the outlet, etc.

Further to the functions mentioned in the flow chart, the GUI designed should be presented in a friendly manner with large font sizes and buttons should be adopted. The menu should also avoid too much information displayed on a single page in order to let the user get familiarized with the operations easily. Colour and location of the buttons follow the following rules:

- The choices offer to user should be place at bottom or lower right corner of the screen.
- To proceed to a new page, core information from previous page should be kept in the new page.
- Homing mechanism should be implemented and be triggered either by users' commands or operation time out.

The GUI menu is illustrated as screen shot and shown in Fig. 3. To enter the operator menu, a transparent button located on the top right hand corner on the user main menu should be pressed. The button provided a simple emulation of a key is inserted to the vending machine for maintenance.

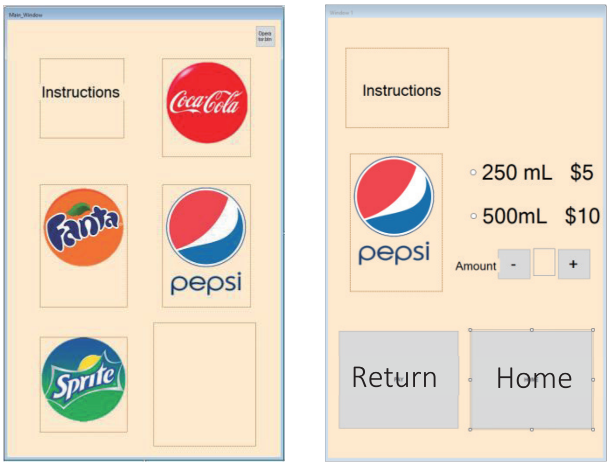


Fig.3. Screen Captures of the User Main Menu and Sub-Menu

Stage 2 Implementation – Motor Drives and Control Circuit

The motor drives and control circuit formed the core function Dispensing Unit. The driving signal from the control circuit board is not strong enough to drive motor pumps directly. In view of this, a signal amplifier is fabricated using a Darlington transistor (1989) to provide on/off control to four motor pumps individually. In addition, a proximity sensor and a flow control switch were implemented to the control mechanism in order to initiate and terminate the dispensing process. Fig. 3 depicts the motor drivers circuits which to be connected to the control circuit. The control circuit had to achieve the following functions: 1) handle 4 individual pumps start and stop. 2) sense the proximity and the flow rate of liquid and 3) interface with the Central Control Unit. Arduino Uno had been adopted as the hardware control unit due to its easiness of development and its high degree of flexibility and extendibility which allows further feature development of the project.

Stage 3 Implementation - Central Control Unit

The control logic of the CCU is created under the same development platform as the GUI to reduce the effort and raise the efficiency of the project team. The control logic 1) handles all the users'/operators' commands; 2) perform action control to the motor drive via Arduino in accordance with the designed flow; 3) receive sensor signal feedback from the flow sensor from Arduino I/O; 4) collect and prepare relevant information for the GUI display. Such selection of the development platform adopted the built interface between the CCU and the graphic display. However, it limited the choices of selected hardware due to compatibility.

A database is built to record the sales and inventory. The transaction should be logged with type of payment, transaction number, item sold, unit price and quantity. Fig. 4 showed the operator menu and the sales log in maintenance mode.

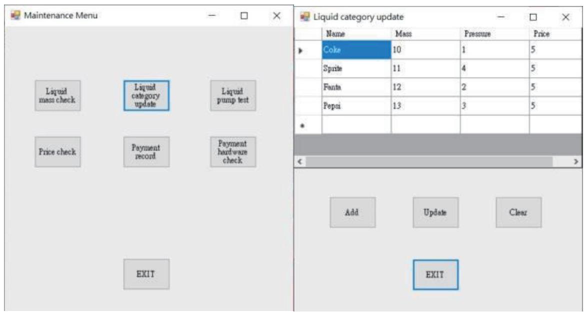


Fig. 4 Screen Captures of the Operator Menu

System Integration

An integrated solution which provides all GUI, Central Control and Motor Control is proposed. LattePanda (2017) is a complete minicomputer integrated with Arduino running full version Windows OS pre-installed as operation system. In the meantime, LattePanda is also designed with an Arduino compatible co-processor, which enables it can be used to perform control and process the sensor signal. Such minicomputer lowered the burden on the touch screen driver development and provided an integrated platform for visual studio solution.

Results and Discussion

The front end and the back end of the prototype are illustrated as Fig. 5 and Fig. 6. The metal frame is built into layers to separate the liquid and the electronics. The dimension of the frame is subject to change upon the volume of the liquid container. The motor control circuit adopted hard wire connections instead of printed circuit board for easier components replacement and tuning. The Control board itself is a minicomputer which connected to the touch monitor via universal serial bus to reduce the effort in trouble shooting of touch monitor's driver compatibility problem.

Fig.5 Frontend of the Vending Machine Prototype

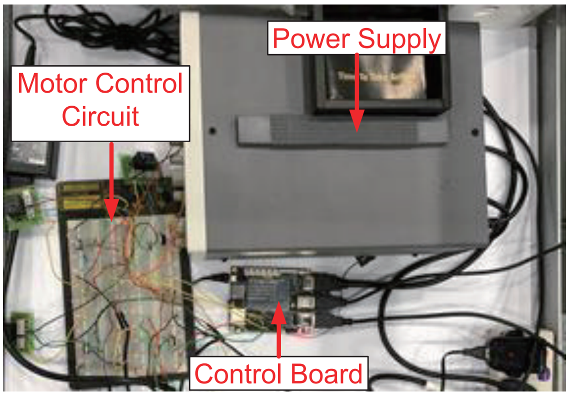


Fig.6 Backend of the Vending Machine Prototype

A number of skills had been developed during the project works. Students were given chances to explore solutions from various areas like Mathematics, mechanical, electrical and electronics work, computer programming and interfacing, Graphic designs. The project itself provided opportunities to students perform engineering and workmanship like wiring, soldering, metal cutting, drilling, instrumentation and measurement. Students' feedbacks were collected from their logs and reports and concluded as follows:

1. Mechanical Design: the project team explored how to determine a suitable pump for dispensing liquid at various viscosities. The project team also discovered pump-head determines the dispensing speed.

2. Electrical Circuit Design: the project team built the first version of the motor drive circuit with a single Bi-polar Junction Transistor (BJT) but the pump did not work according to the driving signal. They discovered that the driving current is not enough and a Darlington transistor would solve the problem.

3. GUI Design: the project team referenced to other vending machines with GUI that were in service in various commercial buildings, schools and government premises. They found the structure of the menu depends on human reading preferences and icon locations and colours should be carefully selected to provide a user-friendly interface.

4. Computer Programming: the project team studied with four development platform and determined one of them as the most appropriate to achieve the tasks. Selection criteria include but not limited to cost, feature extension, interface connectivity and difficulty in manipulating skills, etc. Result of student's analysis are concluded and tabulated in Table. 1.

Development Tools	**LabView**	**Arduino**	**Visual Studio**	**Android**
Developing Time	Short	Short	Medium	Very Long
Level of difficulty	Low	Low	Medium	Very High
Cost	High	Low	Medium	Medium
Interface Capability	High	Low	High	Medium

Table 1: Summary of Development Platform

Conclusions

Four out of five project objectives had been accomplished except the electronic payment. The reason is the online payment platform only accepts a company/organization registry as an authorized user of the payment platform. A lot of administrative work would be involved and the project team agree to skip the online payment development at present stage and this would be the project team's future challenge.

In recent years, industry-based project which aims to provide working environment exposure to the tertiary institute students for a better familiarization in the field had brought into practise to enhance students' learning experience (2016). In Hong Kong, tertiary institute full time students indeed can gain relevant industry professional experience and knowledge however in return only a minority of them had the chance to handle a complete project due to limitation of the working period. With the new curriculum partly embeded vocational education as senior secondary education introduced in 2009, secondary students nowadays obtained an early chance to attempt the Applied Learning courses which included engineering topics (2015). The vending machine project itself provided a chance for students to explore feasible solutions for a thorough engineering problem which students may able to learn multi-discipline engineering skills through the tasks.

Acknowledgements

The author would express his gratitude to the engineering students whom participated in the project. Special thanks are given to staff of the Department of Engineering, Institution of Vocational Education (Chai Wan) for their kind and in time help upon the completion of the project.

References

Horowitz, Paul; Winfield Hill (1989). *The Art of Electronics*. Cambridge University Press. ISBN 0-521-37095-7.

Kari CHIU. (2015). *Review of development of vocational education in Hong Kong.* Research Office, Legislative Council Secretariat.

Maker Faire (2017). LattePanda at Maker Faire Bay Area 2017. Retrieved from *http://www.lattepanda.com/blog-tag/questions*.

Rajibussalim, Raji, Sahama, Tony, & Pillay, Hitendra (2016), *Enhancing the learning experiences through Industry-Based Learning from Indonesian university perspective.* In EDULEARN16 8th Annual International Conference on Education and New Learning Technologies. Barcelona.

The Hong Kong SAR Government Education Bureau, Basic Education Curriculum Guide (2002). Retrieved from *https://www.edb.gov.hk/attachment/en/curriculum-development/4-key-tasks/moral-civic/BECG%203a%20MCE_Eng.pdf*

Fostering Global Leaders through the "International Seminar on Technology for Sustainability"

C. Okuma[*,a], M. Shimakawa[b] and Y. Shimada[a]

[a] Global Leadership Development Center,
National Institute of Technology (KOSEN), Kumamoto College, Japan
[b] Department of Human-Oriented Information Systems Engineering,
National Institute of Technology (KOSEN), Kumamoto College, Japan

*chiharu@kumamoto-nct.ac.jp

Abstract

The National Institute of Technology (KOSEN) is working toward improving the technical competency of students and fostering global leaders through the "International Seminar on Technology for Sustainability (ISTS)". ISTS is an international program co-organized by KOSEN, Nagaoka University of Technology (NUT), Toyohashi University of Technology (TUT) in Japan and KOSEN's overseas partner institutions. The aim of ISTS is to contribute to fostering students' global communication skills, English communication skills, teamwork skills in diverse groups, international mindset, etc. Participating students worked on solving problems and making prototypes for practical problems given by companies. In addition, the student organizing members aimed to reach higher levels on skills such as managing, planning, and hosting of ISTS. Results of student self-assessment reveal a strong impact of ISTS in fostering global leaders who can work globally in the future.

The first ISTS was held in 2011, and since has been held annually, leading to the eighth ISTS in 2018. NIT (KOSEN), Kumamoto College first supported NIT (KOSEN), Ibaraki College and Oyama College in hosting ISTS2016 held at the Universitas Gadjah Mada in Indonesia. We then independently hosted ISTS2017 held in Turku University of Applied Sciences (TUAS), Finland and ISTS2018 held in King Mongkut's Institution of Technology Ladkrabang (KMITL), Thailand.

This paper introduces the workshops we held at ISTS2018 in collaboration with KMITL. The workshops were designed, focusing on feasibility, building on KOSEN's rich experience in hands-on projects. The workshops applied the hackathons approach, requiring KOSEN students and students from overseas institutions to work in teams on problems given by Thailand companies. The task involved finding problems, proposing and implementing ideas, and evaluating their outcomes.

ISTS2018 turned out to be a big event with more than 150 participants. In order to prepare NIT (KOSEN), Kumamoto College and KMITL students to manage the big-scale international event, we supplied training sessions at the "Japan Seminar on Technology for Sustainability (JSTS)" focusing on developing necessary skills such as facilitation skills, planning skills and execution skills. This paper reveals the educational impact of ISTS in fostering global leaders, based on the pre-post self-assessment.

Keywords: *partnership of KOSEN, global competency, leadership, practical engineering, feasibility, problem-solving, making prototypes, sustainability*

Introduction

In 2011, the first ISTS was held in Thailand. Many of students from NIT (KOSEN) and universities students in Asia attended the ISTS2011 and presented their research. That's why the ISTS stood for "International Symposium on Technology for Sustainability". A couple of years later, we changed the aim of ISTS and renamed it "International Seminar on Technology for Sustainability" in order to foster "global leaders" through a workshop. During ISTS, students had to participate in workshop and discuss common problems set in advance and work on finding solutions of the problems. In 2017, the workshop of ISTS2017 was designed, focusing on feasibility, building on KOSEN's rich experience in hands-on projects because we had to develop more effective workshop for students.

NIT (KOSEN), Kumamoto College was in charge of a host of ISTS2017 and 2018. ISTS2017 was co-hosted by TUAS and Kumamoto College in Finland in August 2017. And a sister program of ISTS, named "Japan Seminar of Technology for Sustainability (JSTS)", was held in Kumamoto in May 2017. We set a workshop focusing on making prototype like "MONOZUKURI" for solving practical problems provided by local companies to improve the English communication skills of KOSEN students and to develop organizing committee students' abilities such as facilitation skills, planning skills and execution skills to organize ISTS2017. We co-hosted ISTS2018 with King Mongkut's Institute of

Technology Ladkrabang (KMITL) in Thailand in October 2018.

In this paper, we introduce and discuss the educational effects of ISTS2018 in fostering global leaders, based on the pre-post self-assessment.

JSTS/ISTS Objectives

The aims of JSTS/ISTS are to contribute to fostering global leaders. The participants of these seminars are advanced or graduate students of KOSEN and partner institutions of KOSEN. JSTS2018 and ISTS2018 were designed as hackathon-style workshops that worked on manufacturing for practical problems focusing on feasibility. Participants enhanced global communication abilities in an international diversity environment through integrated activities including finding problems, idea creation, prototyping and presentation. Overall, students were expected to grow themselves as a global engineer and to gain the international perspective and various skills shown below.

- logical thinking
- problem solving ability
- execution ability
- critical thinking ability
- collaborative ability
- adaptive ability
- challenging mind
- presentation ability
- communication ability
- creativity
- positiveness
- empathy
- tolerance
- cross-cultural understanding ability

Outline of JSTS2018

JSTS2018 was a closed seminar for students who were in charge of organizing committee of ISTS2018 because aim of this seminar was to train facilitation skills and communication skills of the students. In total, 49 students from Thailand and Japan including university students from NUT and TUT participated in JSTS2018.

At the opening ceremony, we had a keynote speech on SDGs which are 17 Sustainable Development Goals adapted as the 2030 Agenda for Sustainable Developments (achievement criteria) at a historic United Nations summit in September 2015. The aim of keynote was to raise the awareness of the participating students who were going to be facilitators in the workshop of ISTS. At beginning of the seminar, we designed a facilitation seminar conducted by two instructors invited from Republic Polytechnic, Singapore in order to foster various skills including planning, management, facilitation and leadership in international events. Participants learned useful methods for icebreaking, team building and how to proceed with discussions and how to respond to stagnation of discussions while practicing in two workshops. As for the workshop topic were provided by two local companies in Kumamoto. The students were divided into small groups of 5 to 6 members, and tackled problem finding and discussion for problem solving, and students presented their solution to the company. These workshops were aimed to develop their experience and to foster the facilitation skills acquired in the facilitation training, so all participants experienced the role of facilitator because each of the participants were supposed to be a facilitator at IST2018. Furthermore, we had university students from NUT and TUT as mentors who supported the facilitators and gave advice to the facilitators. In fact, JSTS2018 was also aimed to train university students as mentors.

Table 1 shows entire flow of JSTS2018. We also had some activities like reflection meeting and excursion. Students considered to make a schedule and logistic plans of JSTS2018.

Table 1 Schedule & Activities of JSTS2018

Day	Events
1	Company visit, Opening ceremony, Keynote speech (SDGs), Ice braking
2	Facilitation training seminar, Team building
3	Facilitation training seminar, Practicing training (workshop 1)
4	Discussion & pitching about WS1 Practicing training (workshop 2)
5	Practicing training (workshop 2)
6	Reflection meeting, Closing ceremony, Excursion

Outline of ISTS2018

ISTS 2018 was hosted by KMITL and 150 students from Singapore, Hong Kong, Indonesia, Japan and Thailand participated in. It was held as Princess Cup of Thailand so that it became a big event. NIT (KOSEN), Kumamoto college worked with KMITL to make success in ISTS2018, and finally 187 students participated in

(a) Opening Ceremony (b) Training Seminar (c) Facilitation Training

Figure 1 Activities on JSTS2018

ISTS2018. Table 2 shows details of student's home institution. Students were dived into groups with diverse member in nationalities, expertise, etc., and tackled problems provided by five local companies in Thailand. Hackathon-style was adopted to workshops of ISTS2018, too.

Date: 7th-13th, October 2018, 7days
Venue: Bangkok and Pattaya, Thailand
Host: King Mongkut's Institute of Technology Ladkrabang (KMITL)
Participants: 187 students (shown in Table 2)

Table 2 The Number of Participants

Member	Institution		Total
Ordinary Participants	NIT(KOSEN), Japan	51	150
	KMITL, Thailand	45	
	Thammasat University, Thailand	6	
	Five Polytechnics, Singapore	14	
	UGM, Indonesia	7	
	IVE, Hong Kong	27	
Student Organizing Committee	NIT(KOSEN), Kumamoto	12	37
	NIT(KOSEN), Fukushima	4	
	KMITL	16	
	Nagaoka Univiersity of Technology	3	
	Toyohashi Univiersity of Technology	2	

Table 3 shows the topics of the workshop. All topics of ISTS2018 were mainly related to IT, but there were some students who were not so familiar with IT. In spite of the situation, students were doing well to make an idea proposal adopting their strengths and to discuss their own ideas based on their expertise with team mates. After introducing information of the topic, students discussed the problem situation and worked on problem solving and tried to find solution. Then students pitched their ideas to the company in the intermediate pitching session and tried to make their ideas better by following the feedback from the companies. At ISTS2018, students were requested to make prototype of their idea as outcomes of their work. Therefore, during the ISTS2018, the companies helped students in providing technical information, advice and provision of equipment.

In the final presentation, students presented their achievement to the representatives from organizers and sponsor companies and higher rated students won awards the Princess Cup, the company or organizer awards. In addition, we carried out a popular vote on the Facebook page of ISTS2018 based on the uploaded short promotion movies by students in order to share their ideas with others. It was a good way for students to know and to touch other ideas from different point of view.

The schedule of ISTS 2018 is shown in Table 4. We provided exchange events to deepen communicate with each other and to touch Thai culture.

Table 4 Schedule & Activities of ISTS2018

Day	Events
1	Opening ceremony, Ice braking
2	Problem cases introduction, Research, Discussion for solution, Designing prototype
3	Designing prototype / Training technical skills
4	Interim presentation & feedbacks, Excursion
5	Designing prototype / Mentoring session, Cultural night event
6	Developing prototype / Presentation/movie
7	Final pitching, Closing ceremony

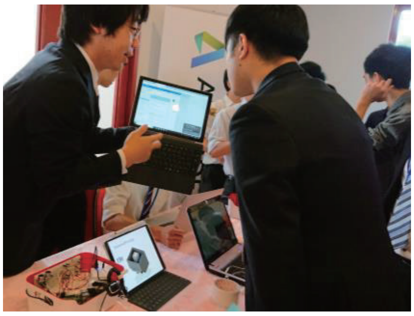
Table 3 The Topics and Challenges of ISTS2018

Topics and Sponsors	Outline of Challenges and Relating Technology
Environmental Data Visualizer [Sponsor] Amazon Web Service	Design a solution that is able to read key word search in a web browser and from the search results, output to an Interactive Data Dashboard [Technology] AWS, Alexa voice service, Big data, AR, VR&3D with Amazon Sumerian, etc.
AI empowered chatbot to improve daily lives [Sponsor] Autodesk	Develop a smart home gadget that is AI empowered to make our daily better [Technology] chatbot, AI, website, application development, 3D modeling using Fusion 360
Technology to improve user experience [Sponsor] Lomprayah	Idea creation for service proposal targeting tourism [Technology] chatbot, AR, big data analysis
Innovations to improve lending process [Sponsor] Krungthai bank	Create ideas for automation / simplification of bank lending process [Technology] website, application development
Drone for warehouse management [Sponsor] PTT Digital	Design and implement a warehouse management solution to check, locate product and verify the number of stocks in the warehouse. [Technology] drone, application development

(a) Workshop 1

(b) Workshop 2

(c) Excursion



(d) Prototype Exhibition

(e) Awarding 1

(f) Awarding 2

Figure 2 Activities of ISTS2018

Discussion

In this chapter, I discuss the results of pre and post self-assessment surveys of ISTS2018 and focus in educational effects of ISTS in fostering global leaders.

Self-assessment:

Target: 51 KOSEN students,

Assessment: 29 items, as shown in Table 5.

Growth of Ordinary Participants through ISTS

The self-assessment is consisted of 29 items relating the six *basic skills* which are expected to improve, (A) self-leading skills, (B) leadership and influence skills, (C) sense of ethics, (D) problem solving ability, (E) futuristic, and (F) English skills, and also including the (G) *curiosity and desire for knowledge.* Students made self-assessment on a scale of 1 to 5 for each item before and after participation in ISTS2018. Figure 3 shows the difference of pre and post evaluation of the six basic

Table 5 Self-assessment Items

No.	Assessment Items: Basic Skills	
1	(A) Self-leading skills	Activator
2		Positivity
3		Self-control
4	(B) Leadership and Influence skills	Leadership
5		Communication
6		Tolerance
7		Flexibility
8		Ownership
9		Organization
10	(C) Sense of Ethics	Acceptance of diversity
11		Adaptability
12		Self-understanding
13		Self-expression
14	(D) Problem Solving skills	Problem finding
15		Logical thinking
16		Ideation

No.	Assessment Items: Basic Skills	
17	(E) Futuristic	Positive thinking
18		Challenging spirit
19	(F) English skills	English (Beginner level) 1
20		English (Beginner level) 2
21		English (Intermediate level) 1
22		English (Intermediate level) 2
23		English (Advanced level) 1
24		English (Advanced level) 2

No.	Assessment Items: Motivation & Interest	
25	(G) Curiosity and Desire for Knowledge	Motivation (Major field)
26		Motivation (Language)
27		Interest & Knowledge (Thailand)
28		Interest & Knowledge (Japan)
29		Interest & Knowledge (International relation)

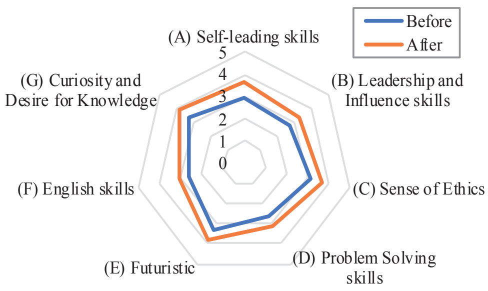


Figure 3 The Difference of the Pre and Post Evaluation in six Basic skills(A-F) and Curiosity and Desire for Knowledge(G) -The average of all participants

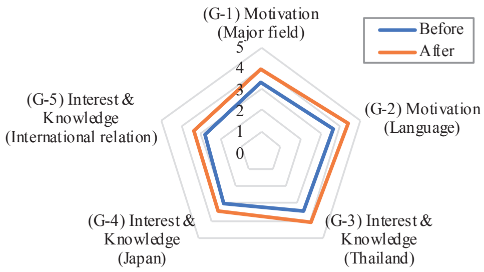


Figure 4 The Changes in Curiosity and Desire for Knowledge(G) -The average of all participants

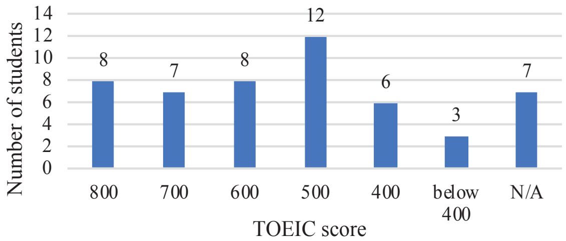


Figure 5 English level of 51 KOSEN participants

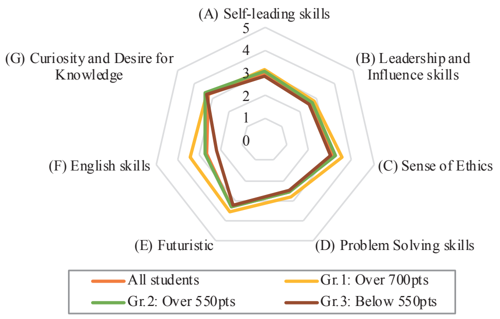


Figure 6 Self-assessment for skills - before ISTS

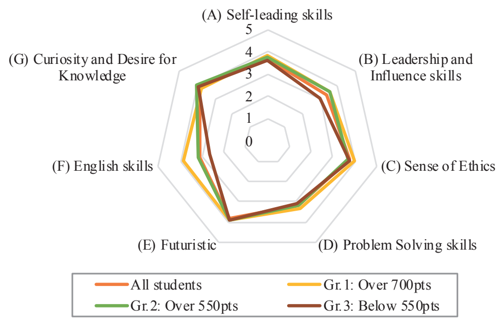


Figure 7 Self-assessment for Basic skills - after ISTS

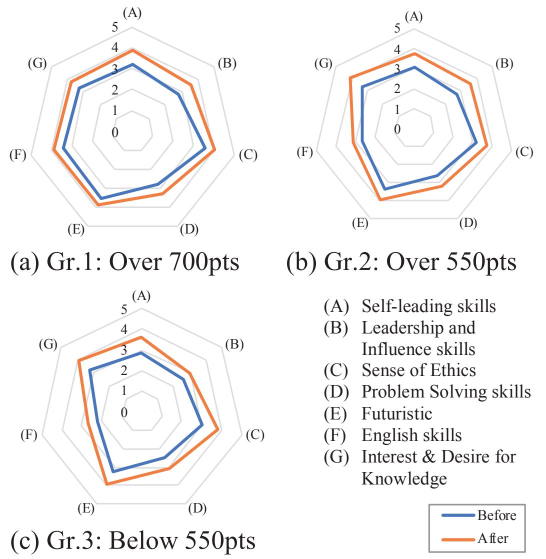


Figure 8 Changes of Basic skills

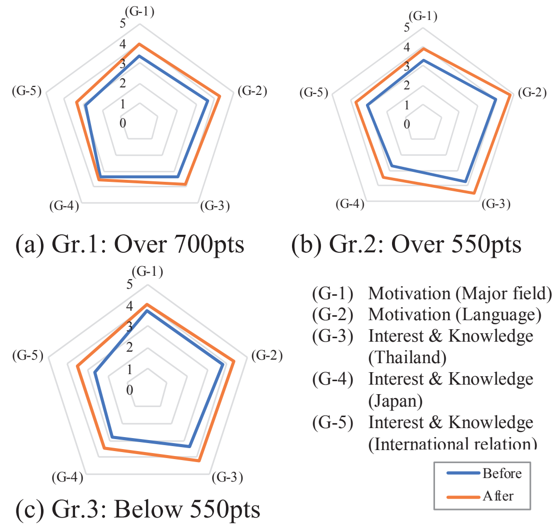


Figure 9 Changes in Curiosity and Desire for Knowledge(G)

skills, and Figure 4 shows the changes in curiosity and desire for knowledge. As shown in Figure 3 and 4, students thought that they could improve their skills in terms of all the six skills.

Next, I investigate relationship between English proficiency and students' self-assessment results. The distribution of students' TOEIC scores is shown in Figure 5. According to the self-report by students, the highest score is 900, the lowest one is 340, and the average is 627.61. For next discussion, I divide the students into three groups based on score of TOEIC, Gr.1: over 700 points (34%), Gr.2: over 550 points (36%) and Gr.3: below 550 points (30%).

Figure 6 and 7 show radar graphs showing self-assessment result of all Japanese students. According to the figures, it is obvious that Gr.1 rated highest in all terms because the students are more confident in speaking, listening, writing and reading in English than the other groups. Therefore, they may be satisfied with their performance at ISTS2018.

Let's take a closer look into at Figure 8 and 9 which show results of self-assessment of each group. As shown in these figures, all of groups' answer have a similar tendency that post ISTS2018 rating was higher than pre ISTS2018 in all terms, however, attention is paid to the following three points in particular. First, according to the difference among the groups in terms of (G-1), English skills might be needed for discussion of technical matters because there is no significant difference between post ISTS2018 rating and pre ISTS rating. Second, ISTS2018 may not have been able to improve students' English skills drastically because Gr.1 students didn't feel they could improve their English. Third, ISTS2018 had positive effects on the students because all groups students felt that they could improve various skills to a certain degree.

Growth of JSOC through Management of JSTS/ISTS

Both of JSTS and ISTS are student-centered events. Kumamoto College built Japan Students Organizing Committee (JSOC) in advance to host JSTS. JSOC consisted of 20 - 30 students and they managed everything necessary to JSTS. They visited companies to explain theme of JSTS and asked the companies to collaborate with us. Then, JSOC visited partner institution to discuss in details of JSTS and ISTS.

Meanwhile, Thai Student Organizing Committee (TSOC) was organized in KMITL to host ISTS. These two students organization worked together as International Students Organizing Committee (ISOC) to host JSTS and ISTS. JSOC and TSOC members made great efforts in preparation, planning and managing of JSTS/ISTS and brushed up many kinds of skills, e.g. international skills, communication skills, negotiation skills, management skills, team work skills.

(a) Press Conference (b) Preparation Meeting

(c) Facilitation on WS (d) ISOC Members

Figure 10 International Students Organizing Committee, ISOC2018

Conclusions

At JSTS/ISTS 2017 and 2018, the workshops were designed focusing on feasibility and building on KOSEN's rich experience in hands-on projects. The workshops adopted the hackathons approach. In the workshops, participants were expected to work in team on practical problems and develop into manufacturing. ISTS2018 co-organized with KMITL in Thailand was approved as the Princess Cup of Thailand, and it became big and international diversity event gathering over 150 participants from not only Thailand but also Hong Kong, Singapore, Indonesia, and Japan. It was a valuable opportunity for participants to work in international group. As show in chart of self-assessment, almost of all Japanese participants improved skills such as problem finding ability, problem solving ability, discussion, team work and so on through manufacturing workshop. In addition, JSOC and TSOC members did a great deal of work to plan and manage big international events and lead the workshop as a facilitator. Furthermore, ISOC enhanced the global vision, coordination ability, and communication skills to a quite high-level applicable in international team. KOSEN has to foster students who can work as global leaders and global engineers in the world, not only KOSEN students but also partner institutions' student. JSTS/ISTS is the event that strongly boosts to grow students. Kumamoto College took over the baton of JSTS/ISTS to the next host institutions Fukushima College and Thammasat University. The next workshop on JSTS/ISTS2019 will be held an event focusing on SDGs. JSTS/ISTS are expected to develop as seminars to foster global engineers who can focus on global sustainability.

Acknowledgements

NIT (KOSEN), Kumamoto College is grateful to many companies in Japan and abroad who cooperated in JSTS/ISTS2017 and 2018. We also thank Turku University of Applied Sciences (TUAS), King Mongkut's Institute of Technology Ladkrabang (KMITL), Nagaoka University of Technology (NUT) and Toyohashi University of Technology (TUT) who were co-organizers of JSTS/ISTS. We express appreciation to headquarter of KOSEN, too.

References

ISTS2018 movie (2018). Produced by ISOC2018. https://youtu.be/EJtF84qhjFI

ISTS2018 website (2018). Managed by ISOC2018. http://ists2018.kmitl.ac.th/

JSTS2018 movie (2018). Produced by JSOC2018. https://youtu.be/iB_cwTvimEY

JSTS2018 website (2018). Managed by JSOC2018. http://jsts2018.kumamoto-nct.ac.jp/

HIGH STAKE E-ASSESSMENT IN ENGINEERING

Tay Jin Wei[*,a]

[a] Ngee Ann Polytechnic / School of Engineering, Singapore

* TAY_jin_wei@np.edu.sg

Abstract

The use of E-assessment in higher education has become more prevalent in the recent years as studies on the implementation of E-assessment has demonstrated positive outcomes (Stödberg, 2012). E-assessment is not just about replacing paper based theory tests as it is able to provide insights about assessment to the lecturers with more efficiency and effectiveness. One key feature of E-assessment is the timeliness in which information/data is provided to the lecturers to enable them to make informed decisions on future learning and assessment strategies, timely feedback and remediation to positively influence student learning outcomes.

At Ngee Ann Polytechnic, in the School of Engineering, E-assessment is implemented in the 'Windows Servers' module for students in the Diploma in Network Systems & Security (NSS). In this module, students learn hands-on configuration and management of Windows Servers, create virtual machines both in their laptops and in the NSS private cloud infrastructure using virtualization technology. The E-assessment is adopted as it is more effective in developing the assessment tasks by ensuring the quality of assessment experience, it is also more efficient in terms of managing assessment process, providing assessment data that would provide feedback to students on learning and performance, and information for staff to track students and module performance.

This paper will share the considerations that were made prior to the implementation of E-assessment, the implementation process, the outcomes of the experience by students and staff and also the future plans.

Keywords: *E-assessment, E-examination, theory test, practical test, instant feedback*

Background

Students' expectations are changing the type of education experiences that are being designed which now includes the move towards the use of embedded technology and digitization in learning and assessment.

The 'Windows Servers' module is a core module in the Diploma in Network Systems & Security (NSS) course, in the School of Engineering, Ngee Ann Polytechnic. In this module, students learn the foundational knowledge and practical skills in operating and managing the Windows Servers. These are essential skills that graduates need to have when they work in the industry as system administrator managing server technologies where the ability to troubleshoot and fix technical issues are key know-how that graduates need to have. To ensure that students in this module have sufficient opportunity to develop both content knowledge and practical skills, the module is designed to include different learning modes including classroom lectures, practical hands-on sessions, and mini-projects.

While the current assessment basket which consists of paper and pen theory test (20%), practical test (40%) and a mini-project (20%) was able to assess students' content knowledge and practical skills sufficiently, there are new modes of assessment that would provide more information about students' learning performance in a more timely, effective and efficient manner.

Challenges in using Paper & Pen Assessment Tests

The assessment format was the traditional form of pen and paper assessment for theory tests to evaluate the hands-on skills. While these assessment types are quite common for engineering modules, it was not effective in terms of timely feedback, and was also difficult administer and manage. Some challenges include:

(1) Feedback for learning

Students have commented that feedback from the theory test was too long as the tests needed to be graded manually, collated and checked before the scripts are returned to them. Although the process of grading the assessment may not take long, it is the administrative processes such as keying in test scores, script checking etc. that has caused the delay. Students are unable to receive timely feedback on their learning which may hinder their progress in learning. Some students may even progress with wrong understanding of the concepts until they are corrected when the feedback for assessment is returned to them.

(2) Limitations in scheduling tests

The paper and pen test is more resource intensive in terms of manpower, time scheduling, and venue management. It requires lecturers as invigilators and all 3 classes of students to have a Theory test at a common time slot, which poses challenges in scheduling the test. The insistence on having all three classes take the test at the same time is to ensure fairness to all students as all the students have to take the same paper.

(3) Inefficient assessment process

The logistics that is required to prepare a pen and paper assessment is tedious. It takes days to check and print the script, keep the scripts in a safe place and to ensure that the scripts are distributed to the correct classes. The post-test administration including marking, script checking and documenting marks do take up considerable amount of time and effort to ensure that marks are recorded accurately. The time spent could be better used to prepare the curriculum and to coach weak students in their learning.

Rationale for implementing E-Assessment

Faced with these challenges, the teaching team from NSS decided to pilot the use of E-assessment using Examsoft (www.examsoft.com) for the theory test. They decided to review the possibility of using E-assessment to overcome the challenges in assessing learning in the 'Windows Servers' module.

(1) Immediate feedback for learning

Students get instant feedback of their results immediately after the Theory Test. A score is shown immediately after students submit and upload the answers to the system. The timeliness of the feedback from the system allows for students to progress at a faster pace as there is no lag time between assessment and grading/feedback. Data on students' performance can also allow for early intervention with the weaker students as they would be able to get timely help from lecturers or seek help from their peers earlier.

(2) Development of Question Bank

E-Assessment allows lecturers in the teaching team to develop questions and store them in the question bank where lecturers can review the questions' validity and clarity, and modify them any time before the E-assessment takes place. Questions can be mapped to categories based on Bloom's taxonomy, specific subject topics, question types or difficulty levels. This categorisation of questions allows the lecturer to have a quick overview of the test in terms of the balance of difficulty in the questions, areas of assessment and its alignment to the learning objectives.

Another key benefit of the question bank is the ability to generate different test sets using questions with the same set of categories in terms of topics and level of difficulty. This means that students from different classes do not need to take the test at the same time as the system will generate different test sets for each class, allowing for different classes to take their test within their scheduled classes

(3) Data analytics to improve learning & performance

E-assessment allows lecturers to leverage on the data collated during the assessment to improve student learning and performance. By assigning a category to each question, lecturers can generate analytics reports for each assessment. The report focuses on item analysis, question statistics and ranking of students in each class, thus providing the lecturer an overview of students' performance in the assessment and the quality of the test items. Lecturers will be able to use the data to identify the topics that students are weak in and provide more support for learning or re-design the lesson with more emphasis on the difficult topics. By knowing the students' strengths and weaknesses, lecturers can provide appropriate feedback to students and provide timely intervention to students who may be falling behind. The Item Analysis reports will also be useful to lecturers as they will be able to analyse the test items and to improve the quality of assessment.

This analysis of students' performance data would not be obtained as quickly when using the paper and pen tests in the past, as lecturers would need to do manual input of test scores before they are able to see the same result that the E-assessment tools is able to provide almost immediately after the tests are scored.

(4) Efficiency in assessment preparation

E-assessment is an efficient method to assess students as lecturers spend less time in the logistics arrangements and pre-assessment preparation. Lecturers also have a longer period of time to prepare their questions as they do not need to send them for printing and preparing the test papers. Moderation of papers can also be done online as different lecturers can review the questions at the same time and any changes can be made quickly. Diagrams can be saved in the database and lecturers do not have to worry about misalignment or unclear pictures when the diagrams are printed out in hard copy paper-based tests, thus increasing the reliability of the assessment. E-assessment also has an auto-marking feature which helps to reduce marking error and improve accuracy in grading. The time saved on marking and script-checking can be spent on teaching the students and guiding the weaker ones to achieve the learning objectives as their peers more efficiently.

(5) Alignment to industry practices

E-assessment prepares students for the computerized certification examinations in the real world. E-assessment mimics the real life certifications that students may attempt during the course of study at the

Polytechnic or after they graduate. Most of the software certification examinations such as Microsoft's Microsoft Technology Associate (MTA) and CISCO's CISCO Certified Entry Networking Technician (CCENT) uses multiple choice questions format to test the students' understanding and application abilities. Over the past few years, increasing use of new technologies have led to the increased use of multiple choice questions as a method of assessment in higher education courses (David, 2007). E-assessment provides students with the opportunity to accustom themselves to this type of assessment which differs from the traditional assessments methods that most of them are used to.

Implementation of E-Assessment

E-Assessment was implemented using the Examsoft tool (www.examsoft.com). This tool grades the assessment automatically and is able to generate reports based on the assessment almost immediately for review and evalution of students' performance and the quality of the assessment as mentioned above.

The implementation of E-Assessment using Examsoft Tool is explained below:

(1) Building a question bank

Lecturers login to the polytechnic Examsoft account and the specific course that the school has setup to build the assessment. There are different question types available, Multiple Choice, True/False, Essay, Matching or Hot Spot. Lecturers can chose to use graphics or videos in their questions. Questions can be saved as draft and reviewed by other lecturers who can act as a moderator to the assessment for the level of difficulty and relevance.

(2) Building an asssement

The assessment or test is built after the questions are prepared. This involves indentifying the questions and their identified catagories/topics that would be included in this test and the scores for each question as shown in Figure 1. Lecturers can also have the option of sharing the scores with the students immediately on exit, which provides students with an immediate "feedback" on how well they did.

Using the Security options available in Examsoft, lecturers can ensure that the test is administered in a secure, lock-down environment as students would not be able to access any other applications except the Examsoft application. Lecturers are also able to randomize the questions and answer choices as well as setting the time limit. This restricts the opportunities for students to copy from one another. A blueprint of the assessment (as shown in Figure 2) will be created based on the categories of questions selection. This allows the lecturers to check at a glance the topics that are tested in the assessment to ensure coverage and consistency across the different sets of test papers.

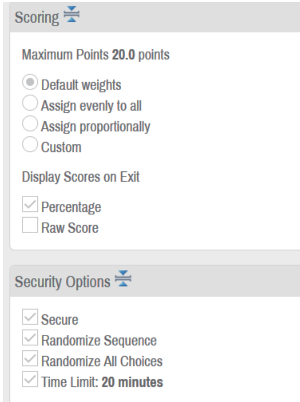


Figure 1: Options available for selection

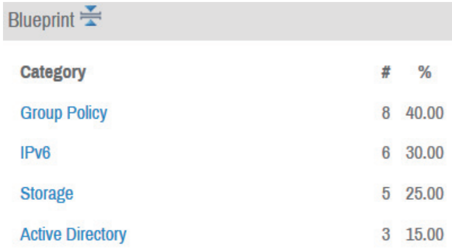


Figure 2: Blueprint of the assessment

(3) Posting an assessment

Once the assessment is created, students can download the test within the stipulated 'Start' and 'End' time (see Figure 3). The Upload Deadline date and time indicated when a student must upload their test. Once the deadline passes, they will not be able to upload their answers for the test unless the time and date are modified by the lecturer.

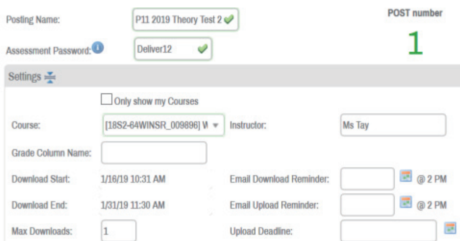


Figure 3: Posting an assessment

(4) Taking the E-assessment

In order to take the E-assessment, students must also ensure that their laptops are ready with the appropriate software - Examplify - to download the questions and to upload the anwers for assessment. Once successfully logged into Examplify tool, students can download the Theory Test (Figure 4). However, students will not be able to start until the day of the exam when the password is given by the lecturer.

On the launch of the Examplify tool, the students' laptops are disabled from access to external accessories like bluetooth keyboards, headsets, thumb drives and also other programs or documents. This minimises the necessity to check for hidden notes or check for cheating activities by students. The password will be given out by the lecturers for students to input, as shown in Figure 5. Upon completion, students need to submit the assessment by uploading their answers to the system and alert the lecturer that his/her test has been submitted and uploaded successfully.

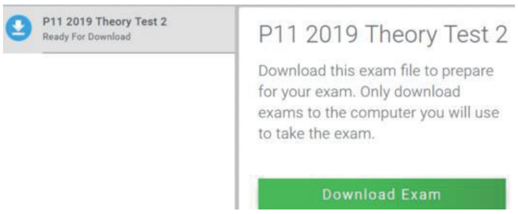


Figure 4: Theory Test ready for download

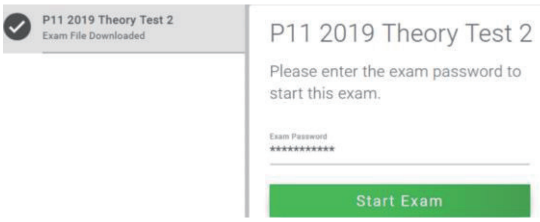


Figure 5: Student is ready to start Theory Test

Value & Impact of E-assessment

E-assessment empowers students with immediate knowledge of their strengths and weaknesses in the topic and enables them to identify areas which they need to spend time to revise and review as they progress to other topics in the module. With robust reporting and analytics that yield valuable data, E-assessment provides actionable insights into improving assessments and students' performance.

a. Data on quality of assessment

One set of data that Examsoft provides for the lecturer is about the overall quality of the assessment. Figure 6 shows the assessment performance with an average score of 65%. The KR-20, or Kuder-Richardson score, measures overall test reliability and ranges from 0 to +1. A high value shows the assessment is reliable because its questions do a good job consistently discriminating among high and low performing students. A 0.62 value is satisfactory in discriminating among students who mastered the subject matter and those who did not. It helps lecturers to set the assessment with rigour to ensure students achieve relevant competencies.

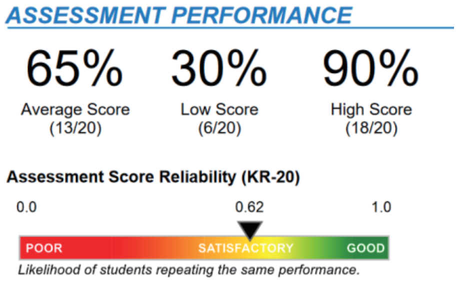


Figure 6: Assessment performance of Theory Test

b. Data on weak students

As mentioned in the earlier paragraphs, another set of data that is important for the lecturers are data on weak students and more significantly, the timeliness with which the data is obtained after the test. In Figure 7, the 3 at-risk students in the class from the lower 27% performing students are shown. This helps the lecturers to start remediation efforts on the low performing students almost immediately.

AT RISK STUDENTS

StudentID	Last Name	First Name	% Correct
s1018XXX1	.	Student1	30%
s1018XXX2	.	Student2	50%
s1018XXX3	.	Student3	55%

Figure 7: List of at-risk students

c. Identifying difficult topics

An Item Analysis report can be generated for each assessment. The value marked in the square box indicates the number of students who got the correct answer. Lecturers can see which questions are more difficult, on a scale of 0 to 1. A difficulty level of 0.88 means the question is easy, a difficulty level of 0.25 means it is difficult, while a value of 0.53 means the question is of moderate level. Lecturers can review the categories and revise the topics that are generally more challenging for the students.

Figure 8 also shows the Point Biserial value which indicates whether getting the question correct correlates positively or negatively with performing well on the test as a whole. It measures the reliability of each answer choice presented to students. The point biserial value ranges from -1.0 to +1.0. A correct answer choice's distractor point biserial correlation should be close to +1.0. It indicates the answer choice is more reliable as it discriminates the students who mastered the test material and those who did not. In contrast, a wrong answer choice should have a distractor point biserial correlation of close to -1.0. A +0.64 point biserial value on the correct answer means that students who performed well on the test as a whole got the question correct. A -0.04 point biserial value does not show much correlation as most students got the question correct. If this is a foundation level question, most students are expected to get the question correct.

Question #	Correct Responses			Disc. Index	Point Biserial	Correct Answer	Respo			
	Diff(p)	Upper	Lower				A	B	C	D
1	0.38	75.00%	40.00%	0.35	0.20	A	*6	1	4	5
-	-	-	-	-	-	% Selected	37.50	6.25	25.00	31.25
-	-	-	-	-		Point Biserial (rpb)	0.20	-0.23	0.25	-0.33
Categories: CATEGORIES\SOE\Active Directory, CATEGORIES\SOE\Storage										
2	0.88	75.00%	80.00%	-0.05	-0.04	B	0	*14	0	1
-	-	-	-	-	-	% Selected	0.00	87.50	0.00	6.25
-	-	-	-	-		Point Biserial (rpb)	0.00	-0.04	0.00	0.45
Categories: CATEGORIES\SOE\Storage										
3	0.63	100.00%	20.00%	0.80	0.64	A	*10	3	1	1
-	-	-	-	-	-	% Selected	62.50	18.75	6.25	6.25
-	-	-	-	-		Point Biserial (rpb)	0.64	-0.06	-0.23	-0.56
Categories: CATEGORIES\SOE\IPv6										
4	0.44	25.00%	0.00%	0.25	0.25	B	1	*7	1	6
-	-	-	-	-	-	% Selected	6.25	43.75	6.25	37.50
-	-	-	-	-		Point Biserial (rpb)	-0.14	0.25	-0.23	0.12
Categories: CATEGORIES\SOE\Active Directory, CATEGORIES\SOE\IPv6										
5	0.25	75.00%	0.00%	0.75	0.62	A	*4	1	8	3
-	-	-	-	-	-	% Selected	25.00	6.25	50.00	18.75
-	-	-	-	-		Point Biserial (rpb)	0.62	-0.39	0.06	-0.52
Categories: CATEGORIES\SOE\Group Policy										

Figure 8: Item Analysis report for lecturers

In Figure 8, the Upper and Lower values indicate the percentage of the top and bottom 27% of the students who got the question correct. The Discrimination Index is a point biserial correlation coefficient ranging from -1 to 1. A negative value of -0.05 suggests that the high performing students have got the particular question wrong. This may be useful for lecturers to determine if there are distractors in the question that drew the high performing students from the correct answer. A strong and positive correlation of +0.80 suggests that students who get the question correct also have a relatively high score on the theory test.

Figure 9 shows that students can review their own learning with their Strengths & Opportunities report to see where they went wrong in the test and to benchmark their performance against their classmates. This performance data, through mapping of questions to categories, helps students improve self-directed learning efforts so they can manage study time efficiently and focus more on areas that need immediate improvement.

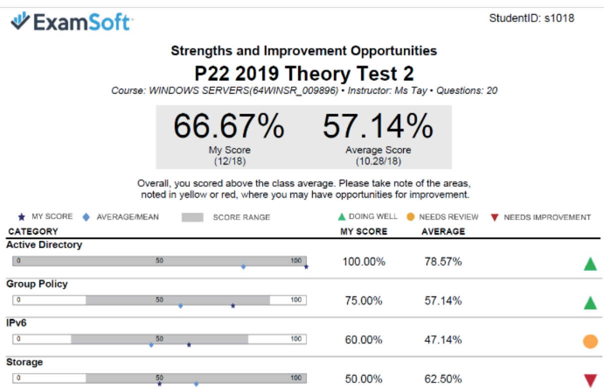


Figure 9: Strengths and Opportunities for individual student

Students and Staff Experience

A survey was conducted at the end of E-assessment to find out about students' experience with taking their assessment online. Feedback from survey indicated that majority of the students agreed that the E-assessment tool was easy to use in terms of user interface and navigation. Majority of the students also agreed that the instant feedback they recieved from E-assessment was useful to allow them to understand their mistake and to progress in their learning.

By improving student performance through meaningful feedback, delivering engaging and timely results, E-assessment provides lecturers with more time to teach and guide students efficiently to identify learning gaps early in the semester. As students are graded immediately upon completion, each checkpoint is an assurance of the students' competencies. Lecturers can address learning weakness on the spot and use personalized feedback to help identify focus topics to motivate students to be self-sufficient. This is echoed in the research by Naomi (2015) that increasing student engagement improves students learning and contributes to the overall student experience. The module lecturer commented that he was able to provide timely feedback to most students. The subsequent lessons allowed him to encourage the weaker students with personalized quality and constructive feedback as the content learnt is still fresh in students' minds.

Conclusion

The introduction of E-assessment in Theory Test has allowed for a more effective and efficient method of assessing students' learning and improving the rigour of the assessment.

E-assessment has made it easier to identify gaps for learning through the data that is collected from both students performance and item analysis. Instant and personalized feedback on students' learning motivates them to work harder as they know their weak areas and where to focus their learning. For the lecturers, it is not just the reduction in marking load that is advantageous. It helps to free up time that can then be used to support students' learning. The Item Analysis ensures that the assessment is reliable and there is rigour in the quality of the assessment.

Moving forward, different forms of test items can also be included in the E-assessment so that different skillsets can be assessed, for example, assessing students' ability to draw their topology in response to a scenario-based question and upload to the portal for grading which was not possible in the previous E-assessment experience. The experience with E-assessment is only the start of a different way to evalute students that would provide more information on students learning rather than just grades.

References

David Nicol (2007) E-assessment by design: using multiple-choice tests to good effect, Journal of Further and Higher Education, 31:1, 53-64, DOI: 10.1080/03098770601167922

Naomi Holmes (2015) Student perceptions of their learning and engagement in response to the use of a continuous e-assessment in an undergraduate module, Assessment & Evaluation in Higher Education, 40:1, 1-14, DOI: 10.1080/02602938.2014.881978

Stödberg, U. (2012). A research review of e-assessment. Assessment & Evaluation in Higher Education, 37(5), 591–604.[Taylor & Francis Online]

The Application of Practical Activities in Science and Engineering to Kosen English Curriculum

Yokota Miyo[a*], and William Tharion[b],

[a]National Institute of Technology (KOSEN), Hachinohe College, Japan
[b] Tharion Research Consulting, USA

*Yokota-g@hachinohe-kosen.ac.jp

Abstract

Hachinohe-Kosen students' attitudes toward English and the practicality of using English as a part of active learning methods were examined. The 4th year students (n = 152) enrolled in English Enshu class, and learned Science and Engineering (SE) concepts in English. They also created a SE project prototype and made group presentations in English. Two surveys were administered at the beginning and end of the English course. Initially, half of the students provided their interest in English and the majority of students indicated that they were not good at English. In the post-course survey, the students evaluated that the approach taken in the English course had helped them more actively engage in the use of the English language.

Keywords: *ESL education, practical learning, Science and Engineering, active learning, students' attitudes toward English*

Introduction

English is the global language used in many research and business institutions, journals, and conferences throughout the world. In recent years the Japanese Ministry of Education, Science and Technology (MEXT) recommended that schools and teachers utilize "active learning" methods in English as Second Language (ESL) education for improving students' language skills[1]. "Active learning" includes self-exploring the learning process and developing skills in association with discovering, identifying, cultivating, and solving problems (MEXT 2015; Ito, 2016). However, the guidance for teachers and educators to implement "active learning" methods into English classes lacks specifications, and as a result, its interpretation varies among school professionals, educators, and teachers (Asanuma 2015, Jones and Palmer 2017, Kamegai and Croker 2017). In addition, the majority of the content in high school textbooks registered by MEXT tends to be designed for liberal arts students, which may not fully engage the interest of National Institute of Technology (NIT) Kosen College students who specialize in studying science and engineering (Ito 2016; Morizumi 2016; Ooura 2016).

Despite the efforts for improving English, according to the 2018 Education First English Proficiency Index, Japan was ranked 49th out of 88 countries and classified as one of the low English proficient countries (EF EPI, 2018). Given these realities, practical activities using scientific materials were introduced into English classes as a part of active learning approaches and students' responses to the English teaching style are presented. Here the practical activities refer to preparation and simulations for actual work settings in science and engineering fields that Kosen students are likely to experience after they graduate from NIT-college. The approach requires reading scientific texts in English, finding and solving problems, building hypotheses, identifying what needs to be done, all completed using the English language. This approach is likely to lead non-native English speaking students in Kosen to actively learn the language by stimulating positive emotions towards English and cognitive engagement of the mind.

Materials and Methods

A total of 152 fourth-year students (52 women (34.2%) and 100 men (65.8%)) at Hachinohe-Kosen were enrolled in an English class (English Enshu I). Table 1 is the distribution of number of students by academic major. There were three students of foreign nationalities (2%), while the rest were native Japanese.

During the 16-week course an instructor taught English primarily using a basic Science and Engineering (SE) textbook (Okumura et al., 2016). The students learned SE materials in English by understanding main principles, SE terminologies and their definitions. The students were additionally asked to provide two English presentations that could likely be used in realistic work and research settings. Figure 1 is an example of active learning procedure (Unit 1 from SE textbook, Okumura et al., 2016).

Table 1. Number and percent of students by academic major.

Major	***n***	**Percent**
Chemistry	39	25.7
Mechanical Engineering	38	25.0
Architecture/Civil	39	25.7
Electrical Engineering	36	23.6
Total	152	100.0

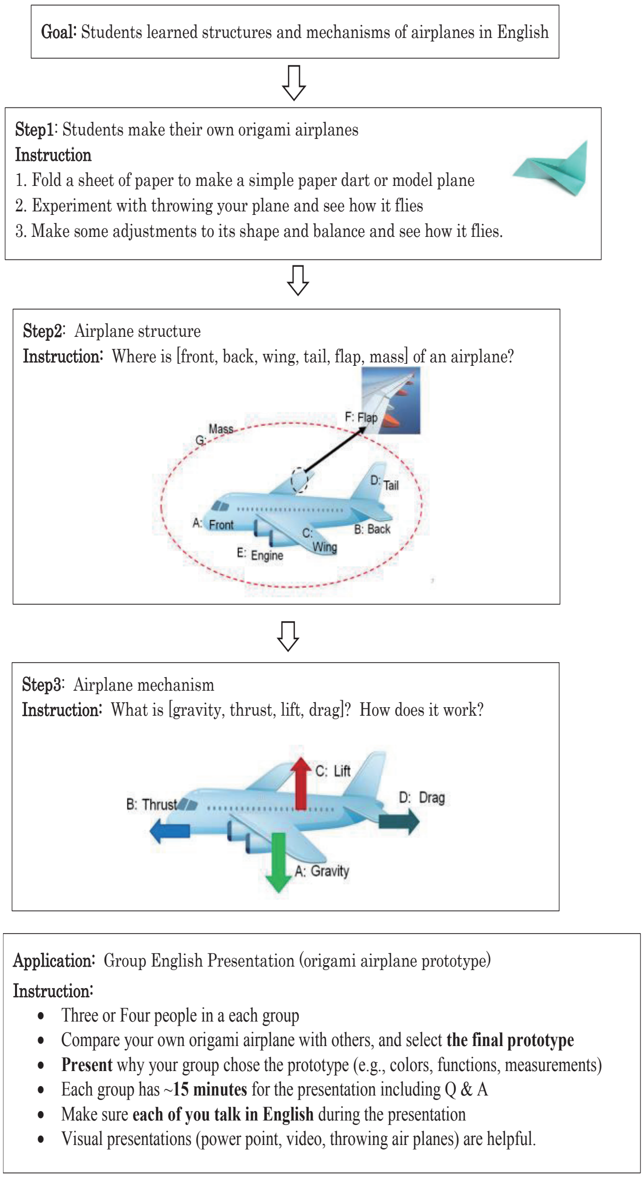


Figure 1. An example of English class using an active-learning approach

At the beginning and end of the course, students took the survey questions including preference and interest in English (both before and after the class), effectiveness and usefulness of the class (surveyed after the class), and future perspectives toward English.

Results are presented as frequencies of response and differences in these frequencies over time were determined with chi-square tests, with the level of significance at $p \leq 0.05$.

Results

A) Likeness or Dis-likeness of English

In the initial survey, 44.7% had a positive view of English, i.e., they liked English a little or very much. In contrast, 31.9% of students had a negative view of English, i.e., they did not like English a little or very much.

Figure 2 summarizes top five reasons of students' attitudes towards English prior to taking the English Enshu I. It should be noted, that similar open-ended responses provided by students have been paraphrased into one common response that summarizes the common overall concept being expressed by these students. The most common positive comments about English referred to an interest in English to understand various English media students desired to comprehend and engage in. For example, interest in music, movies, books and television were most often cited (24 comments).

Liking English

- I like foreign (English speaking) music, movies, books, television, and You Tube (*n* = 24)
- English is fun/enjoyable or I like English (*n* = 20)
- Allows me to understand, speak and interact with English-speaking cultures (*n* = 10)
- Broaden my experience (world) and can communicate with different people through travelling, study abroad etc. (*n* = 11)
- I am good at English (*n* = 7) due to good grades, English-speaking environment etc.

Disliking English:

- Cannot understand, do, speak or use English or English grammar (*n* = 26)
- I am not good in English (*n* = 15)
- I liked English during middle school, but I don't like the Kosen English due to cramming methods, very difficult to understand, my low confidence in English (*n* = 6)
- Not interesting although not boring (*n* = 3)
- I don't like English teachers (n = 2)
- To me, English classes are not necessary/ or no benefit (*n* = 2)

Figure 2. Top five reasons of students' liking or disliking English

The second most frequently stated reason surrounded an interest in speaking, listening, and reading English because students liked it, found it fun, or were just generally interested in English (20 comments). Some students commented that they liked or were interested in English despite the fact that they reported that they were not in particular proficient in English.

In addition, the students who liked English were likely to answer in the initial survey that they were interested in learning SE materials in English (p=0.003). Negative comments consisted of various reasons including difficulty learning in English, English teaching methods, academic concerns, the amount of English curriculum hours, financial reasons, and personal necessities. The top two reasons that students stated for not liking English were that English is hard to learn (26 comments) and they were not good at English (15 comments). Of particular note, for negative comments was that some students liked English when they were taught English at a younger age, but then when exposed to the Kosen method of emphasizing English vocabulary they no longer liked English (6 comments).

Table 2 shows the comparisons of their preference in English prior to and after taking English Enshu I. A significant change in views of English took place after teaching science and engineering in English (English Enshu I): students who held a negative view of English decreased to 13.4% (a change of 18.5%) and those with a positive view increased to 56.7% (a change of 12% (χ^2 = 77.84 ,df = 16, p <0.0001).

Table 2. Comparison of how much students like or dislike use of English before vs. after the English course

	How much do you like English: After classes*					
How much do you like English: Prior to classes*	1	2	3	4	5	Total
1	3 (2.1)	1 (0.7)	2 (1.4)	2 (1.4)	0 (0.0)	8 (5.7)
2	2 (1,4)	10 (7.1)	16 (11.3)	9 (6.4)	0 (0.0)	37 (26.2)
3	0 (0.0)	1 (0.7)	13 (9.2)	15 (10.6)	4 (2.8)	33 (23.4)
4	0 (0.0)	2 (1.4)	10 (7.1)	31 (22.0)	6 (4.3)	49 (34.8)
5	0 (0.0)	0 (0.0)	1 (0.7)	7 (5.0)	6 (4.3)	14 (9.9)
Total	5 (3.5)	14 (9.9)	42 (29.8)	64 (45.4)	16 (11.3)	141 (100)**

Note: *1: I dislike English very much, 2: I dislike English a little, 3: Neutral, 4; I like English a little, 5: I like English very much. **There were 152 participants that took part in the survey but 11 participants did not answer this question after taking classes.

B) Self-Assessed Proficiency and Improvement in English

In the initial survey when students were asked to self-assess whether they thought they were good at English, 57.4% of students self-assessed themselves as being not good or really not good at English. Only 8.8% of students gave a positive self-assessment of being good or really good at English. After taking classes in English, 93 students (66.4%) believed that their English improved, 46 students (32.9%) felt their proficiency in English did not improve, one student said both "yes" and "no" regarding improvement in English (0.7%). Twelve students did not respond to this question. When students were asked after taking classes in English, 134 (95.0%) students believed that learning English will be useful to them in the future, while only 7 (5.0%) students answered that learning English would not be useful. Eleven students did not respond to this question.

Discussion

The number of Hachinohe-Kosen students who showed some preference and interest in learning English surpassed the number of those who disliked and showed a lack of interest in English. The students with a positive perspective were generally more interested in foreign cultures and English related media. The students, who expressed difficulty with the English language and having problems with an English curriculum, tended to respond unfavorably toward English. The students who liked to learn SE in English did not feel any difficulties in learning their specialized materials when studying in English. These results explain the link in like/dislike of English using this teaching style. It might be inferred that students that are having problems with English, tend to carry over to their understanding of the SE material, and thus they will assess learning English negatively. Conversely, if they do not have problems learning English, doing it while engaged in SE classes probably makes use of English more engaging and pertinent to students' overall learning experience.

In the open notes, many students indicated that English would be useful in their career and deepen their knowledge base by improving their abilities to read technical papers and to better understand technologies from different countries. However, many students acknowledged they were not good at English and their English skills were poor. Such opinions and thoughts toward English agree with the findings at other NIT colleges (Majima et al., 2018, Mizuno, 2016)

It is noted that many students were initially agitated to learn English in the current active learning method. Japanese students are familiar with "passive learning" style in which they listen to/follow English teachers' instructions. Japanese students don't tend to raise questions during classes because they are afraid of breaking the silence and don't like to stand out from other students. In response to this situation, the teacher in the class described in this study created an environment in which students were encouraged to use English, learn from their mistakes, greet people as a starting opportunity to carry further conversation, and convey the opinions during presentations. As a result, students gradually opened up and used English during their course work. At the conclusion of the course, more students expressed their interest toward English and their consciousness of not being good at English diminished. Regarding, whether students' attitudes and thoughts toward English are positive or negative, their responses such as "the importance of using English" "gaining confidence by challenging to learn in English," and "difficulty learning in English and need more improvement" are directly associated with the consequences of "proactive" learning. In other words, questions, planning, analytics, and accomplishment using active learning methods are the actions required for actual work settings (Ito, 2016).

The students felt that the approach was new to them but found merit in this teaching style. In spite of this positive finding, active learning may not be the best option for all students to learn the English language. It is likely students with particular personalities and characteristics, or students having learning disabilities may not benefit from this active learning method. Additional research examining these mitigating factors is needed. Moreover, follow-up research needs to be conducted to ensure the long-term effects of this active learning method on students' abilities to learn in English as a part of their academic curriculum can be maintained.

Acknowledgements

We would like to thank the students of Hachinohe-Kosen who participated in this study.

References

Asanuma, S (2015). Japanese Teachers' Struggle for Active Learning. *International Consortium for Universities of Education in East Asia.* Nagoya: International Center.

EF EPI (2018). *EF EPI English Proficiency Index.* Toronto: Education First.

Ito, O et al., (2016). *New One World.* Tokyo: Kyoiku Shuppan.

Jones, B.A. & Palmer, R. (2017). Active Learning in Japanese University EFL Classes: Clarifying the Construct. *Hirao School of Management Review,* 7, 107-125.

Kamegai, M. & Croker, R. (2017). Defining active learning: From the perspective of Japanese high school teachers of English 朝日大学一般教育紀要 (*Asahi University general education bulletin*), 42, 65-79.

Majima, A. et al. (2018). Our History of Making ICT Learning Materials, Using Extra-Linguistic Information: A Model of a Kosen Joint Project. *The Council of College English Teachers.* 37, 125-133.

Ministry of Education, Culture, Sports, Science and Technology (MEXT) (2015). *MEXT Meeting on Education Rebuilding report.* Retrieved from http://www.mext.go.jp/b_menu/shingi/chousa/shotou/102/houkoku/attach/1352464.htm.

Mizuno, C. (2016). The Efficacy of Extensive Reading for the Improvement of Students' Native Attitudes Toward English Learning at National Institute of Technology, Kagawa College. *Kansai Eigo Kyoiku Gakkai Kikou*. 39, 57-67.

Morizumi, M., et al (2016). *My Way: English Communication I.* Tokyo: Sanseido

Ooura, A., et al., (2016). *Cosmos: English Communication I.* Tokyo: Sanyuusha

Okumura N et al., (2017). *Exploring SciTech English.* Tokyo: Kairyudo

SCENARIO-BASED LEARNING IN BIOINFORMATICS: THE USE OF INFECTIOUS DISEASE OUTBREAK

K.S. Lee[*,a]

[a] Ngee Ann Polytechnic/School of Life Sciences & Chemical Technology, Singapore

*lks9@np.edu.sg

Abstract

Bioinformatics is an interdisciplinary study that combines biosciences, statistics and the application of computational tools for analysis of biological data. As life sciences curriculum generally focuses on skills training to work on bench, students often find bioinformatics a difficult subject to cope with since it requires enhanced skills in mathematics, computing and advanced statistical analysis. Many life sciences students are unable to appreciate the application of bioinformatics particularly for understanding and problem solving in biology. To enhance students' appreciation for bioinformatics, a scenario-based approach using a disease outbreak simulation was created to enable them to apply their knowledge and analytical skills in bioinformatics.

In this simulation of infectious disease outbreak, students work in groups to represent laboratories at various locations in a hypothetical country. Each group will obtain DNA sequence data of viruses derived from outbreaks that occur at their locations at specific time points over a period of 10 days. Students are expected to analyse their data in order to characterize the virus. To create the sense of urgency, they are to report and to share their analysis with other groups in neighbouring laboratories on an online platform within 24 hours after receiving the data. As part of the simulation, a delay of analysis and reporting will lead to the spread of disease to neighbouring locations. This results in more cases and data to be analysed by neighbouring laboratories. Apart from enabling students to apply their skills in bioinformatics, this simulation requires students to collaborate, communicate and practice good time management.

Students' feedback on the learning and appreciation of the subject were positive overall, highlighting the effectiveness and potential of simulating real world applications to enable students to apply their knowledge and skills other areas in life sciences. In this paper, the design and implementation of the case scenario simulation as well as student feedback and performance outcomes are discussed.

Keywords: *Bioinformatics, case-scenario, disease outbreak, simulation, problem solving, collaboration*

Introduction

In recent years, advances in molecular technologies such as high throughput genome sequencing has resulted in the rapid growth of biological data (Kodama, Shumway, & Leinonen, 2012). As such, bioinformatics is becoming an increasingly important discipline in biology and life sciences (Ranganathan, 2005; Schneider et al., 2010). Bioinformatics is an interdisciplinary field that requires a combination of expertise in areas ranging from biology to chemistry, statistics, mathematics and computer science. The ultimate goal of bioinformatics is to enable scientists to manage, mine and analyse biological data for deeper understanding of systems biology and to solve complex problems dealing with evolutionary pathways such as transmission of diseases. Given the multidisciplinary nature of bioinformatics particularly with the requirement for computer programming, it is often viewed by life sciences students as a challenging subject. Traditionally, computing related subject such as bioinformatics is rarely taken by life science students as most computing related subjects are designed for computer science and engineering courses (Qin, 2009).

The Molecular Biology & Bioinformatics module is currently taught in the second year of life sciences diplomas at Ngee Ann Polytechnic (NP), a post-secondary educational institution in Singapore. As computer programming is not part of the life sciences curriculum, the bioinformatics module was designed with the aim to train students with hands-on skills in using bioinformatics applications such as data storage, retrieval and analysis of biological information, rather than on the development of new bioinformatics tools. In particular, students are exposed to bioinformatics resources and databases that stored sequence-based biological information and students are trained to use software such as MEGA (Kumar, Stecher, Li, Knyaz, & Tamura, 2018) for nucleotide and amino acid sequence analysis and phylogenetic reconstruction.

Problem-based Learning used to teach bioinformatics have been previously described (Maurice HT Ling, 2017; Nunes, Barbosa de Almeida Júnior, Pessoa Pinto de Menezes, & Malafaia, 2015). Many successful cases of the use of problem-based learning in bioinformatics have been reported (Emery & Morgan, 2017), however many of the examples were based on solving questions on fundamental sciences for a given dataset, which may not truly reflect the real world problem that would make the experience authentic. For example, student may be given a DNA sequence data and tasked to determine the possible functions of the peptide coded by the DNA sequence. To enhance students' appreciation for bioinformatics, there is a need to provide students the avenue to apply their knowledge and analytical skills in solving real world problems that better reflect the need for such technical skillset at the workplace. One such example is the use of bioinformatics tools in public health sector in order to gain better understanding of disease transmissions and risk assessment of the disease involved.

This paper describes the design and implementation of a scenario-based learning activity in bioinformatics for life science students. The scenario-based activity involved simulation of a real world problem (dengue virus outbreak in this scenario) for students to apply their knowledge and analytical skills using bioinformatics tools with the intent to enhance students' appreciation for bioinformatics as well as to achieve a better learning experience and outcomes.

Materials and Methods

Preliminary activity and setup

A scenario on outbreak of dengue viruses was used for students to analyse and interpret the data using the bioinformatics skills and knowledge that they have learned. Prior to the activity, students were given a journal article to read and to gain some understanding about the diversity and spread of dengue viruses in term serotypes, genotypes and strains that were circulating globally (Lee et al., 2012). Through reading this article, students are expected to understand the association between the different genotypes or strains of dengue viruses and their epidemic potential as well as the importance of early detection for effective control of outbreak. As the journal article provides information about nucleotide sequences of various virus genotypes and strains that circulated globally, it served as the starting point for students to perform datamining in Genbank database (www.ncbi.nlm.nih.gov) for their analysis in the scenario-based activity.

The duration of the scenario-based activity was approximately 10 days. Students worked in pair as a group and each group represents a public health laboratory at a specified location in a hypothetical country. Each group/pair of students is expected to receive a set of virus sequence data on certain days between 3-6pm, which signify that new cases have been reported at their location. Upon receiving the new dataset, students performed the analysis and reported their findings and interpretation. A Google Sheet was also set up to enable all students to view the status update of viruses in other localities.

Design and implementation of scenario-based activity

Disease outbreak scenario

In this scenario, each group (2 students) played the role of an analyst in a public health laboratory in a hypothetical country that is endemic for dengue viruses. As a simulation, 3 most common dengue virus serotypes (DENV-1, 2 and 3) are concurrently circulating in this hypothetical country. Within each serotype, there were multiple genotypes and strains of viruses which could potentially emerge at any locations throughout the scenario-based activity. As an endemic country for dengue, it is also vulnerable to other viruses that are transmitted by Aedes mosquitoes. In the setting up of the scenario-based activity, all groups were allowed to choose their groups' preferred locations within the map (Figure 1).

Figure 1: Map of a hypothetical country with 16 students in 8 groups/locations (A – G). Groups were spread out in 8 distinct locations that are connected by highways, which served as an important mode for dengue virus transmission via human movements.

In this simulation, students were to anticipate dengue outbreaks to occur at their locations. Whenever cases of dengue were reported, students received notifications of dengue outbreaks with information about the dengue serotypes causing the outbreak at their locations. Along with the notifications, students also received a dataset of sequences of the virus that caused the outbreak and were expected to carry out analysis, risk assessment of the emerging virus and reporting. Throughout the 10-day activity, different groups will receive different datasets that consist of different dengue serotypes and virus strains at different time intervals (Table 1).

Analysis of virus sequence data

With the given dataset, students will need to perform DNA sequence assembly and multiple sequence alignment with reference dataset followed by the construction of phylogenetic tree to determine the genotypes and strains of dengue viruses that caused the outbreak at their locations. Based on the phylogenetic analysis, students were tasked to determine the risk of the virus that has emerged and to provide updates about the dengue virus to the "headquarter" (lecturer) and community of analysts (other groups in the class) via a shared Google Sheet.

Table 1: Simulated sequence of events throughout the 10-day scenario-based activity.

Day	Simulated sequence of event
0	All locations received datasets for analysis - Locations A, B and E (DENV-1) - Locations C and D (DENV-2) - Locations F, G and H (DENV-3)
1	Reporting and feedback on reports
2	More dengue cases (existing strains) reported at locations A, D, E and G
3	More dengue cases (existing strains) reported at locations B, C, F and H
4	New dengue serotype/genotype/strain reported at locations A, D, E and G
5	New dengue serotype/genotype/strain reported at locations B, C, F and H
6	Reporting and feedback on reports
7	Rest day
8	All locations received importation of new dengue virus serotype/genotype/strain or new virus species
9	Reporting
10	Feedback on reports and evaluation

Reporting

Students were expected to write a report consisting of a phylogenetic tree of dengue viruses with the new dataset, comments and interpretation of the circulating virus which caused the outbreaks and risk assessment based on their analysis. In particular, students were expected to highlight the association between the virus reported at their locations and possible clinical outcomes as well as its potential to spread based on the knowledge gained through the reading of previous publication on the epidemiology of dengue viruses. Students were given 24 hours to perform the analysis and report their findings.

In order to simulate closely to the real life scenario, any delay in reporting or incorrect findings or misinterpretation of analysis will result in the spread of the virus to neighbouring locations on the following day. In the event when no reporting was done after 36 hours, dengue virus will continue to spread and result in double amount of data received by neighbouring locations (Figure 2).

Assessment of learning outcomes

This scenario-based activity formed part of the practical components of the Molecular Biology & Bioinformatics module. Assessment comprised a total of 4 reports (40 marks) over 10 days for each group which are to be submitted within 24 hours upon receiving the dataset. Marks were given based on the content of the report and accuracy of findings, as well as updates on Google Sheet (12 marks) and email reports (8 marks) to lecturer within 24 hours after receiving the dataset.

Post-activity feedback

Feedback from students through open-ended questions were gathered at the end of the 10-day activity. Survey questions to find out about students' experience in the scenario-based activity include how the activity has helped them to be more aware of the importance of bioinformatics and how the activity helped to increase their confidence in data analytics using bioinformatics tools.

Figure 2: Example of delay in reporting or misinterpretation of analysis at location G results in the spread of dengue virus to neighbouring locations E, F and H.

Results

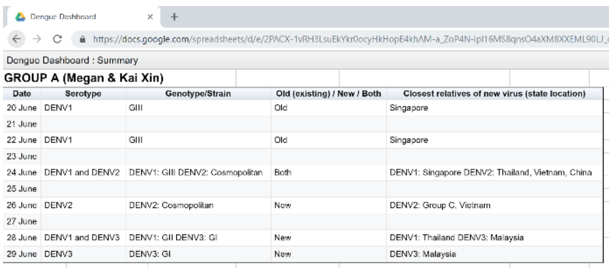
Sixteen students who took the Molecular Biology & Bioinformatics module participated in this scenario-based learning activity. Two weeks prior to the exercise, students were taught in weekly lesson how to perform datamining in Genbank database, DNA sequence assembly, multiple sequence alignment and followed by phylogenetic analysis using MEGA software (Kumar et al., 2018). Students were also taught how to read and interpret the phylogenetic tree for a given dataset. Example of student's report is shown in Figure 3.

Evidence based on students' reports submitted throughout the activity clearly showed the ability of students to carry out the required analysis using bioinformatics tools such as multiple sequence alignment and phylogenetic tools to determine the dengue virus genotypes or strains. Students also presented their skills in reporting on Google Sheet that was created for the purpose of this scenario-based learning activity (Figure 4).

In general, students demonstrated the ability and skills to generate the required analysis and provide interpretation of their findings. While not all students presented the same level of depth in terms of their interpretation of findings and risk assessment, the reports submitted throughout the activity clearly showed that all students were able to perform multiple sequence alignment and construction of phylogenetic tree using the MEGA software.

Group/Name	B/Lauren and Lareina
Title	Analysis of DENV-3 based on new data received
Date	28 June 2016
Phylogenetic Analysis	
Findings	• New virus dataset showed that a genotype II of DENV-3 is now circulating in our location. • This new virus of Genotype II is closely related to the virus previous reported in Vietnam in 2014. • The earlier DENV-3 (Genotype I) has evolved as shown by extended branches since it was last detected in our location.
Risk Assessment	• New virus of Genotype II detected was previously reported to be associated with severe dengue infections • No known reported risk of evolved virus within Genotype I

Figure 3: Example of students' report containing the analysis, findings and risk assessment.


Dengue Dashboard
https://docs.google.com/spreadsheets/d/e/2PACX-1vRH3LsuEkYkr0ocyHkHopE4khAM-a_ZoP4N-ipl16MS8qnsO4aXM8XXEML90LJ_
Dengue Dashboard : Summary
GROUP A (Megan & Kai Xin)

Date	Serotype	Genotype/Strain	Old (existing) / New / Both	Closest relatives of new virus (state location)
20 June	DENV1	GIII	Old	Singapore
21 June				
22 June	DENV1	GIII	Old	Singapore
23 June				
24 June	DENV1 and DENV2	DENV1: GIII DENV2: Cosmopolitan	Both	DENV1: Singapore DENV2: Thailand, Vietnam, China
25 June				
26 June	DENV2	DENV2: Cosmopolitan	New	DENV2: Group C. Vietnam
27 June				
28 June	DENV1 and DENV3	DENV1: GII DENV3: GI	New	DENV1: Thailand DENV3: Malaysia
29 June	DENV3	DENV3: GI	New	DENV3: Malaysia

Figure 4: Dengue dashboard in Google Sheet with updated information of students' findings.

Student's experience and feedback

Students' experience in the scenario-based learning activity was generally positive. A majority of students reported that the activity was helpful in creating better awareness on the importance of bioinformatics skills in solving real world problem. Twelve out of 14 students who provided their feedback indicated a score of 4-Agree or 5-Strongly Agree. Twelve students also indicated that the activity has helped to improve their confidence in performing data analysis using bioinformatics tools. However, a majority (10 out of 14 respondents) felt that the workload of the activity was inappropriate and the duration given for conducting the analysis and generating the reports (24 hours) was insufficient.

To assess the impact of the scenario-based learning on students' appreciation of bioinformatics, feedback through open-ended questions were obtained. In order to find out what students consciously perceived as useful in this activity, they were asked the question, "What aspects of this scenario-based learning were most useful?" In general, most students were positive about the exercise in terms of how the activity helped them to understand the importance of mastering the skills in bioinformatics. Two such examples are listed below which highlight the positive outcome of the scenario-based learning activity.

"The dengue outbreak analysis using phylogenetic enlightened us on the importance of bioinformatics in real life events and research. It changed our perspective about research and has opened our eyes to other career options other than vet clinic practice."

"The dengue scenario exercise was very interesting and it gave us a platform to apply what we learned in theory. We were taught how to explore the software to construct phylogenetic tree. This skills gave us an edge over our A-Level friends as they only get to learn from the textbook."

In addition, students commented on the usefulness and benefits of using scenario-based activity as part of the learning of bioinformatics. Some of these comments are highlighted below:

- *Interesting activity that forced us to work collaboratively and manage our time better.*
- *Real world application of bioinformatics*
- *Teaches us something different as compared to the other modules in a sense that it has a lot of computer or technology work involved especially during the bioinformatics part.*
- *An exciting activity that keep the whole class stressful. The repeated analysis helped me to be very familiar with the use of MEGA program for sequence analysis.*
- *The dengue scenario activity forced us to communicate and collaborate with other groups to get things done.*
- *Learning bioinformatics is more meaningful with hands-on application of the MEGA software in a real world scenario*
- *Real life application of bioinformatics.*

Discussion

In scenario-based learning, students actively learn and applying their domain knowledge, skills and critical thinking as well as problem solving skills to realistic stories or triggers, usually in a safe but real world context. Here we described the design and implementation of a scenario-based learning activity for bioinformatics in the context of an infectious disease outbreaks. We demonstrated that a scenario-based approach can be successfully implemented within the scope of a module that covers the application of essential bioinformatics tools for sequence based analysis. The requirement for students to apply their knowledge and skills through hands-on activities in learning bioinformatics render it suitable to employ scenario-based learning in teaching bioinformatics. Indicators from students' feedback in a post-activity survey highlighted that this approach was effective in strengthening the understanding of the application of bioinformatics tools for solving real world problems. Apart from hands-on application of knowledge and skills in bioinformatics, the nature of this scenario-based activity also encouraged students to communicate and to work collaboratively among different groups that represent neighbouring locations. Given the limited duration for analysis and reporting of findings, this activity also trained students to exercise good time management skills.

Challenges in Implementation

A literature search on the use of scenario-based approach in teaching bioinformatics did not yield anything specific result. Based on the experience in implementing the scenario-based learning for bioinformatics in the context of infectious disease outbreaks, several aspects in the design of the scenario should be considered to overcome its limitations. As several serotypes and strains of dengue viruses are used for different groups or locations, such activity is only feasible for small classes since the sending of sequence datasets to students are done manually by email.

Such scenario-based learning activity also requires very intensive monitoring of students' reports and findings. This includes daily updates in Google Sheet to check for accuracy of analysis and interpretation of findings, followed by feedback to students throughout the period of the activity. It is therefore important to consider the complexity of the scenario and the combination of different variables used.

Other challenges which are purely operational in nature include the timing of implementation of the scenario-based learning. Implementation of such activity during the period when students have many other module assignments to complete may result in students being unable to cope with their workload. The delay submission of reports will result in a more complex situation in the activity.

Conclusion and future work

A scenario-based activity using simulated dengue virus outbreaks was designed and implemented to enhance students' appreciation for bioinformatics. Evidence based on students' reports and indications from students' post-activity feedback clearly showed that the use of scenario-based hands-on activity was effective in enhancing students' appreciation on the subject. Students were able to apply and sharpen their analytical skills using bioinformatics tools for problem solving. The implementation of this scenario-based activity for bioinformatics will be expanded to cover other areas or problems such as non-communicable diseases and questions related to systems biology. However, considerations on the complexity of scenario and duration of activity will be given for effective implementation and learning.

References

Emery, L. R., & Morgan, S. L. (2017). The application of project-based learning in bioinformatics training. *PLOS Computational Biology*, *13*(8), e1005620. https://doi.org/10.1371/journal.pcbi.1005620

Kodama, Y., Shumway, M., & Leinonen, R. (2012). The sequence read archive: explosive growth of sequencing data. *Nucleic Acids Research*, *40*(D1), D54–D56. https://doi.org/10.1093/nar/gkr854

Kumar, S., Stecher, G., Li, M., Knyaz, C., & Tamura, K. (2018). MEGA X: Molecular Evolutionary Genetics Analysis across Computing Platforms. *Molecular Biology and Evolution*, *35*(6), 1547–1549. https://doi.org/10.1093/molbev/msy096

Lee, K.S., Lo, S., Tan, S. S.-Y., Chua, R., Tan, L.-K., Xu, H., & Ng, L.-C. (2012). Dengue virus surveillance in Singapore reveals high viral diversity through multiple introductions and in situ evolution. *Infection, Genetics and Evolution*, *12*(1), 77–85. https://doi.org/10.1016/j.meegid.2011.10.012

Maurice HT Ling. (2017). Problem-based learning (PBL), an important paradigm for bioinformatics education. *MOJ Proteomics & Bioinformatics*, *Volume 5*(Issue 4). https://doi.org/10.15406/mojpb.2017.05.00166

Nunes, R., Barbosa de Almeida Júnior, E., Pessoa Pinto de Menezes, I., & Malafaia, G. (2015). Learning nucleic acids solving by bioinformatics problems: Learning Nucleic Acids Solving by Bioinformatics Problems. *Biochemistry and Molecular Biology Education*, *43*(5), 377–383. https://doi.org/10.1002/bmb.20886

Qin, H. (2009). Teaching Computational Thinking Through Bioinformatics to Biology Students. *Proceedings of the 40th ACM Technical Symposium on Computer Science Education*, 188–191. https://doi.org/10.1145/1508865.1508932

Ranganathan, S. (2005). Bioinformatics Education—Perspectives and Challenges. *PLOS Computational Biology*, *1*(6), e52. https://doi.org/10.1371/journal.pcbi.0010052

Schneider, M. V., Watson, J., Attwood, T., Rother, K., Budd, A., McDowall, J., … Brooksbank, C. (2010). Bioinformatics training: a review of challenges, actions and support requirements. *Briefings in Bioinformatics*, *11*(6), 544–551. https://doi.org/10.1093/bib/bbq021

Effect of career education using the training ship and Consideration of teaching technology

S. Akiba[a,] M.Tada[a], N.Yuda[a], T. Murakami[a], T. Housyuyama[a], A. Futamura[a], T. Miyamoto[a], N. Matunaga[a], E. Mori[a], S. Yamashita[a], K. Nonoyama[a]

[a] National Institute of Technology (KOSEN), Yuge College, Maritime Technology Department, Japan

* E-Mail akiba@yuge.ac.jp

Abstract

After the training ship experience cruise for elementary school students, we conducted a questionnaire. The questionnaire evaluates how the students felt about ship's work, the trial events, and National Institute of Technology (KOSEN). In order to familiarize students with both the maritime technology department of KOSEN and maritime knowledge, a career education was conducted with the training ship and the trial events. The teaching technology for the trial event was discussed based on the result of the questionnaire. In the questionnaire of career education, students chose one answer from "Agree(1)," " Agree a little(0.5)," "Neither agree nor disagree(0)," " Disagree a little(- 0.5)," "Disagree(-1)." A high score point means that many students selected "Agree." For example, if everyone selects "Agree," the result is 100 points. For the question, "What do you feel about ship's work?" "Ship's work is fun work" and "It is hard work" got about 40points each. But, the question "Ship's work is worth doing" got about 60 points. According to the questionnaire, students thought ship's work was worth doing, rather than they think it was fun or hard. This result indicates that the training ship experience cruise is a very effective way of career education. In the questionnaire, a degree of recognition of KOSEN was also examined. Although 30% of the participants know KOSEN, 40% of them live near KOSEN. This result indicates that we need to promote a career education more for primary and secondary education. Students chose answers from "visiting lecture," "experience cruise," "rope work," "paper cups rocket," as interesting trial events. 85% of the students selected "experience cruise" as an interesting event and 70% of them selected "rope work" and "paper cups rocket," as an interesting event, while 30% of them selected "visiting lecture" as an interesting event. These results of the questionnaire are that the trial events using the training ship are suitable for career education and improvement of the recognition of KOSEN.

Keywords: *Career education, Teaching technology, Training ship, trial event*

Introduction

National Institute of Technology (KOSEN) educates the student who has necessary broad intelligence and systematic expertise by the curriculum that balances general education and specialized subject. The student develops applied skill and creativeness by ample practical work and graduation research. Many companies admit the education of KOSEN is valid, and the student who gets the necessary ability, get appropriate vocational.

The unemployment rate (The Japan Institute for Labour Policy and Training. (n.d.).) was higher from the late 1990s to the mid -2010s, and the rate of new employee turnover (Ministry of Health, Labour and Welfare. (2018, October, 23th)) and the rate of non-regular employment (Ezashi, H. & Miyashita, Y. (2015)) are still higher from the 1990s. These problems indicate that new employees and students who have a low aptitude of vocational can't get appropriate vocational (Ministry of Educations, Culture, Sports, Science and Technology. (n.d).). Therefore, to get suitable employment in the future, vocational education and career education are emphasized in primary and secondary education.

Vocational education is the essential developing knowledge, skills, ability, and attitude to get General or specific vocational. Vocational education is the acquiring basis ability and attitude to get General or specific vocational. Career education is promoting career development by acquiring basis ability, and attitude for each person's social and vocational independence and Career education includes Vocational education. Therefore, the education of KOSEN is Career education because the education of KOSEN develops the base of engineers.

The junior high school student population is decreasing by a declining birth rate. In addition, the majority of junior high school students and parents focus on advancing to university from high school by Education oriented trend and Teachers provide career guidance in line with the wishes of parents and students. Therefore, the majority of students do not choice KOSEN as a main wish course for the student.

In order to increase the number of applicants, KOSEN has been visiting lecture at junior high schools

小学生のみなさまへ

弓削商船高等専門学校

船を動かす仕事と高専についてのアンケート

わたしたちの食べ物や服などは，ほとんどが船にのって海をこえて運ばれてきています。
その船を動かす仕事をしている人たちのことを，船員といいます。
高等専門学校の商船学科では，船員になるための勉強をすることができます。
このアンケートでは，船を動かす仕事や，船や海のことを勉強する学校について，
みなさんがどのように思っているかを，お聞きします。

質問を読んで，あてはまる回答を，〇で囲ってください。
答えにくい質問，わからない質問については，答えを書かなくても大丈夫です。
あまり深く考えず，素直に答えてください。

1	**男子**ですか，**女子**ですか。	男子(174)	女子(190)

2	**学年**を教えてください。					
	小学 1年生()	小学 2年生	小学 3年生	小学 4年生 (119)	小学 5年生 (144)	小学 6年生 (101)

3	日頃から船に乗ったり、海や港、または，海や港に近い公園や施設を訪れるなど、**船や海に接する機会**が多いですか。(もっとも近いものを選んでください)				
	1週間に数回ある(34)	1か月に数回ある (60)	1年に数回ある (131)	2～3年に数回ある (102)	これまでに一回もない (32)

4	**船員になってみたい**と思いますか。				
	思う(43)	すこし思う(128)	どちらでもない(65)	あまり思わない(72)	思わない(56)
5	船を動かす仕事は，**面白い仕事**だろう，と思いますか。				
	思う(124)	すこし思う(129)	どちらでもない(49)	あまり思わない(40)	思わない(22)
6	船を動かす仕事は，**危険な仕事**だろう，と思いますか。				
	思う(146)	すこし思う(136)	どちらでもない(34)	あまり思わない(34)	思わない(34)
7	船を動かす仕事は，**きつい仕事**だろう，と思いますか。				
	思う(117)	すこし思う(138)	どちらでもない(46)	あまり思わない(46)	思わない(17)
8	船を動かす仕事は，**自慢できる仕事**だろう，と思いますか。				
	思う(127)	すこし思う(94)	どちらでもない(65)	あまり思わない(44)	思わない(34)
9	船を動かす仕事は，**誇りをもてる仕事**だろう，と思いますか。				
	思う(185)	すこし思う(95)	どちらでもない(59)	あまり思わない(15)	思わない(10)

裏に続きます。

Fig.1 Questionnaires Sheet (front)

and giving presentations on classes and research at events such as open schools, and vocational education and career education are emphasized in primary and secondary education of getting suitable employment.

In order to increase the number of applicants, KOSEN has doing visiting lecture at junior high schools and giving presentations on classes and research at events such as open schools. Also, vocational education and career education are emphasized in primary and secondary education to getting suitable employment, as mentioned above. Therefore, KOSEN and nearby elementary and junior high schools should cooperate in career education for each purpose.

However, it is difficult for KOSEN to repeat Career education at the same school because KOSEN has a lot of duties such as class and training, research. In other words, if students are only taking lecture, they have to do so many times in order to obtain educational effects. In trial events, there is often a limit to the number of students who can participate simultaneously, and the event will have to be repeated many times. Therefore, effective teaching techniques for "visiting lecture" and "trial events" that many students participate must are considered.

We conducted an "experience cruise" using a training ship and "visiting lecture" and "trial events." In addition, we conducted a questionnaire after the training ship experience cruise for elementary school students. The questionnaire evaluates how the students felt about "ship's work," "the trial events," and "National Institute of Technology (KOSEN)."

In this study, for career education and improvement of the recognition of KOSEN, the usefulness of training ships, and teaching technology of the trial event was discussed based on the result of the questionnaire.

Materials and Methods or pedagogy

At the Port of Tokushima Komatsushima 70th anniversary events (2018), YUGE College (KOSEN) conducted educational events of maritime knowledge in Tokushima Prefecture. An experience cruise using a training ship "YUGE MARU" and trial events were conducted for 8 primary schools (458 students) between 9/11 and 9/13. A visiting lecture was conducted for 6 schools (273 students) of 8 schools between 8/17 and 9/7.

After the experience cruise for students, we conducted a questionnaire. Returned questionnaires sheets were 419. 2 sheets were excluded by written content. The 365 sheets of 4th grader, 5th grader and 6th grader students who can consider career were selected. In order to compare by gender, 1sheet that was no gender was excluded. The Male-female ratio in the questionnaire is 48% male and 52% female.

The questionnaire sheet was shown in Fig.1 and Fig.2. From Fig.1 and Fig.2, numbers in ( ) in the figures are the total of answers. Question1 to Q3 was about the attributes of the student. Q1 was "Are you male or female?." Q2 was "What grade are you in?." Q3 was "How many times did you have boarding ship, or How many times did you have visiting sea or port or

10	今回のイベントや授業より前から、**「船の仕事」**があることを知っていましたか。				
	知っていた (296)	知らなかった (94)			
11	10で「知っていた。」と答えた人は、**どうして知りましたか**。書いてください。 (例：家族や人から聞いた。テレビで知った。本で調べた。など)				
12	今回のイベントや授業より前から，高専の商船学科のような**「船の学校」**があることを知っていましたか。				
	知っていた (78)	知らなかった (285)			
13	12で「知っていた。」と答えた人は、**どうして知りましたか**。書いてください。 (例：家族や人から聞いた。テレビで知った。本で調べた。など)				
14	今回のイベントや授業より前から，**「高専（高等専門学校）」**があることを知っていましたか。				
	知っていた (121)	知らなかった (247)			
15	14で「知っていた。」と答えた人は、**どうして知りましたか**。書いてください。 (例：人から聞いた。テレビで知った。本で調べた。など)				
16	今回、**楽しかったもの**に全部○を付けてください。				
	出前授業 (79) 弓削丸体験乗船 (307) ロープワーク (256) エンジンについての授業 (249)				
17	16で答えた**理由**を書いてください。				
18	今回のイベントや授業により、**船への興味が高まった**と思いますか。				
	思う (159)	すこし思う (137)	どちらでもない (29)	あまり思わない (19)	思わない (18)
19	今回のイベントや授業により、**船や海の知識が増えた**と思いますか。				
	思う (194)	すこし思う (124)	どちらでもない (21)	あまり思わない (10)	思わない (10)

ご協力ありがとうございました。

Fig.2 Questionnaires Sheet (back)

Coastal area?." In Q3, students chose one answer from "several times a week," "several times a month," "several times a year," "several times in few years," "Never visited or boarded before." This question means "familiarization of sea." Q4 to Q12 are about ship's work. Q13 to Q15 are about KOSEN and school for a ship. Q16 to Q19 are about the effect of this event.

In Q4 to Q9, Q18 and Q19, students chose one answer from "Agree (1)," "Agree a little (0.5)," "Neither agree nor disagree (0)," "Disagree a little (-0.5)," "Disagree (-1)." Numbers in ( ) in the answer are coefficients. The Strength of intentionality for the questionnaire (f(s)) was calculated by Eq. (1).

$$f_{(s)} = \frac{1 \times n_a + 0.5 \times n_b + 0 \times n_c + (-0.5) \times n_d + (-1) \times n_e}{N} \quad (1)$$

where

N: Total of students in the event

n_a: Total of "Agree"

n_b: Total of "Agree a little"

n_c: Total of "Neither agree nor disagree"

n_d: Total of "Disagree a little"

n_e: Total of "Disagree"

Results and Discussion

In the experience cruise using "YUGE MARU," the students who were divided into small groups looked around in the ship and on the deck. They observed Komatsushima Port from the sea at Flying Bridge. And they were lectured about ship's operating and the device for Navigation, at Wheel house. In addition, they were lectured about the engine and propeller system in the engine control room. The officer of company's ship lectured about ship and ship's work in the lecture room.

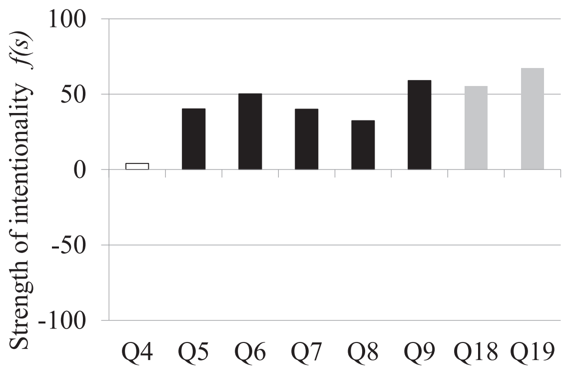


Fig.3 Strength of intentionality of answers

The Strength of intentionality for the questionnaire was shown in Fig.3. Questions4 was "Do you want to be a sailor (merchant mariner)?." Q5 was "Do you feel that ship's work is fun work?." Q6 was "Do you feel that ship's work is dangerous work?." Q7 was "Do you feel that ship's work is hard work?." Q8 was "Do you feel that ship's work is proud work?." Q9 was "Do you feel that ship's work is worth doing?." Q18 and Q19 were "Did you feel about the educational effect of the ship and the ocean in this event?." The bars in the graph are color-coded by the group. White indicates "How are students want to be a sailor?," and Black indicates "What are students feel about ship's work?,"

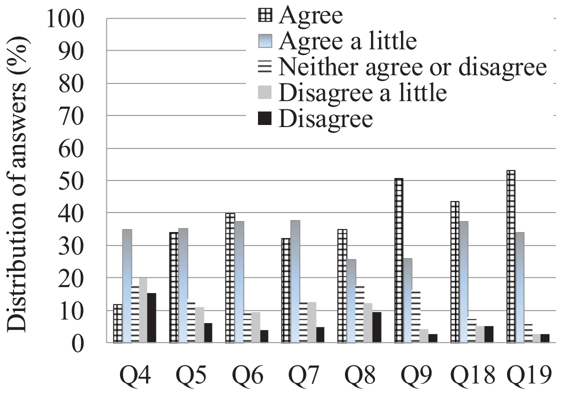


Fig.4 Distribution of answers

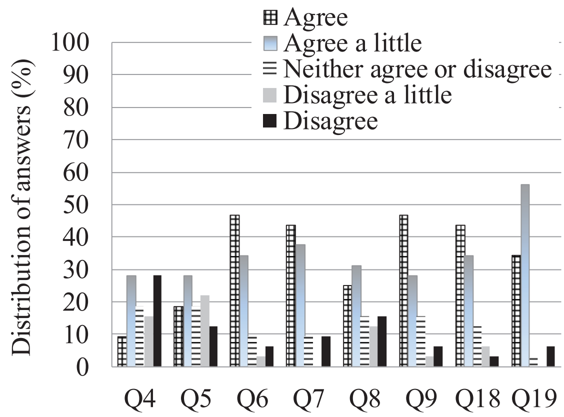


Fig.5 Distribution of answers
(Selected "Never visited or boarded before" in Q3)

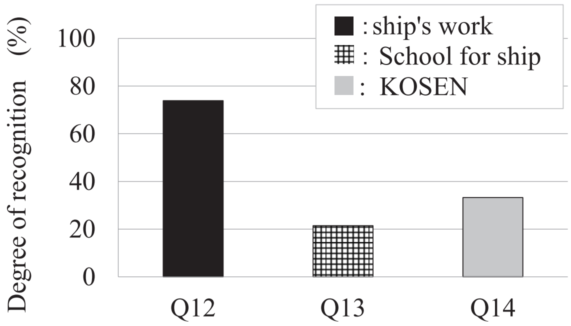


Fig.6 Degree of recognition

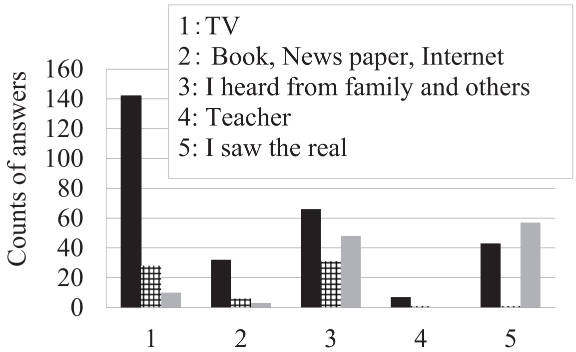


Fig.7 Counts of answers

and Grey indicates "How are students feel that Event using Training ship is effective for ship and ocean education?."

Q4 was 4.1points, Q5 was 40.2points, Q6 was 50.3points, Q7 was 40.1points, Q8 was 32.4points and Q9 was 59.1points. From Q4, it was found that few students wanted to be a sailor. From Q5 to Q9, students felt ship's work was worth doing, rather than they think it was fun or hard or dangerous. From Q18 and Q19, Students felt that the Educational effect of events was high. The distribution of answers was shown in Fig.4. From Fig.4, it was found that a lower Strength of intentionality for Q4 was because the answers were scattered all over. Also, it was found that a higher Strength of intentionality for Q9, Q18 and Q19 were because the answers of "Disagree" and "Disagree a little" were less than other answers. These results indicate that many students feel that the event using a ship was effective in career education. However, this result is indicative of the overall trend, and it is necessary to make sure that students who are not interested in ships have the same tendency.

The distribution of answers for students who selected "Never visited or boarded before" in Q3, was shown in Fig.5. We compared the relationship between the educational effect of the event using ship and the student who were lower familiarization of sea. Because students who were higher familiarization of sea want to be sailor, and many of them selected "Agree." The students who chose Disagree were 32 persons. The Male-female ratio in the questionnaire is 44% male and 56% female. From Fig.5, the Strength of intentionality for Q9, Q18 and Q19 were higher because many students who were lower familiarization of sea selected "Agree" or "Agree a little " as in Fig.4. Therefore, it is supposed that the students who chose "Never visited or boarded before" also feel the educational effect of the event using the training ship was high. Those results indicated that the training ship experience cruise is a very effective way of career education.

The degree of recognition for Q10, Q12 and Q14 was shown in Fig.6 and Counts of free descriptions words for Fig.6 were shown in Fig.7. Q10 was "Did you know the ship's work before these events?," Q12 was "Did you know the school for ship before those events?" and Q14 was "Did you know KOSEN before those events?." In Fig.7, free descriptions words were classified into group 1 to group 5, and the number of words was counted. Group 1 is "TV." For example, an example answer is to see the ship's work on TV. Group 2 is "Book, Newspaper and Internet." An example answer is to read a book or a newspaper about the ship's work. Group 3 is "I heard from family and others." An example answers are "I heard from a friend" and "Father is a sailor" or "Family business is a fishery." Group 4 is "Teacher." An example answers are "I heard from Teacher" and "I was lectured export and import." Finally, Group 5 is "I saw the real." An example answers are "I saw a sailor working in a ship" or "I saw a ship sailing in the sea" or "I had been on the ship." The color and pattern of the bars in Fig. 6 and 7 are the same for each question.

From Fig.6 and Fig.7, the degree of recognition for ship's work was very higher, but the degree of recognition for school for ship was low. Many students got knowledge about the ship's work from TV. Therefore, this result indicates that we must consider ways to improve the recognition of school for ship because many students get knowledge about the ship's business field but the degree of recognition for school for ship was low.

Besides that, students get knowledge about ship's work by group 2 and 3, 5 evenly, but few students get knowledge of ship's work from "Teacher (4)". The typical answer of 4 was "I was taught in the lecture of export and import in 5th grader". Import and export are the contents to the lecture in the 5th grader, and the 6th grader students were 101persons, but the answers which classified into group 4 were 7counts. This result indicated that career education might be not well integrated . Therefore, it is supposed we need to promote a career education more for primary and secondary education.

In addition, if it is possible to strengthen the cooperation between KOSEN and elementary schools and junior high school for career education, teachers may be better able to improve the understanding of KOSEN, ships and the ocean at the same time. It seems that the possibility that the teacher may encourage students to go on to KOSEN will be increased because the teachers who get to improve the understanding of KOSEN, will provide career education in the future.

The degree of recognition for KOSEN was 33.2 %(121), and 39.7% (48) of them live near KOSEN. Therefore, the actual degree of recognition for KOSEN is not high. Counts of answers of group 5 were 57persons, and many students get knowledge for KOSEN from student's families and other persons.

Summarizing the above results, we need to promote a career education more for primary and secondary education. In addition, we must consider ways to improve the recognition of KOSE that include the Department of maritime technology.

The favorability of events was shown in Fig. 8 and Fig.9. The visiting lecture was that students were lectured for ship and ship's work using projector at 6 schools (273) of 8 schools.

The rope work was that students practiced knot which clove hitch and bowline knot etc. were, and made an ornament with a rope. Paper cup rocket was the experiment that the paper cup is blown away by the air that has expanded rapidly by the heat was generated by the combustion of alcohol in the can, and it was a part of the lecture of a Diesel engine system. After explaining the configuration of engine parts, students were lectured for the compression ignition system. They learned by experimental compression ignition device about the compression ignition system. In addition, they confirmed the relationship between air' volume and heat using a flask and syringe, and they experienced the power of heat with a paper cup rocket. However, due to the size of the event room, it was not possible for all the students to experience the paper cup rocket.

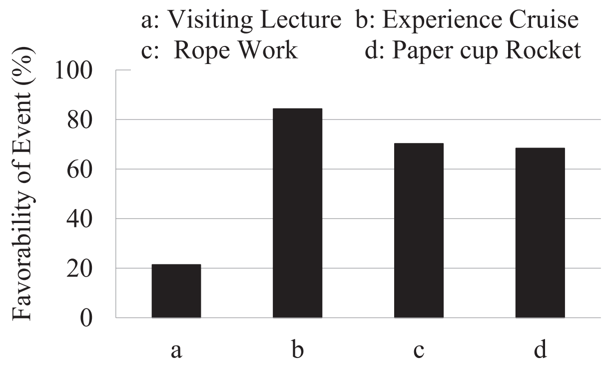


Fig.8 Favorability of Event

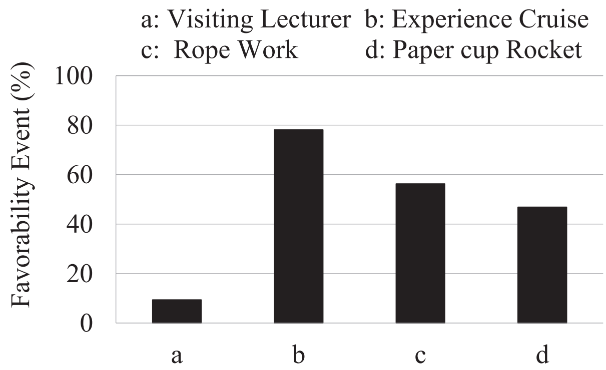


Fig.9 Favorability of Event
(Selected Never visited or boarded before in Q3)

Table1 Free descriptions of words

	Visiting Lecture	Experience Cruise	Rope Work	Paper Cup Rocket
Teaching	1.6	2.5	3.0	2.5
knowledge	4.4	21.2	28.0	14.6
Experience	1.9	14.0	9.1	9.6
Human	1.4	4.7	5.2	3.8
Interest	6.6	9.9	9.6	9.9
Ship	0.0	15.1	0.0	0.0

Fig.8 was favorability of all answers, and Fig.9 was Favorability of students who selected "Never visited or boarded before" in Q3. Figure 8 and Figure 9 show the same trend. The experience cruise was higher, and the visiting lecture was very lower, and rope work and paper cup rocket were slightly lower than experience cruise.

Free descriptions of words of Q17 were classified as visiting lecture, experience cruise, rope work, and paper cup rocket. However, free descriptions of words were often not written specifically. For example, "Knowledge of the ship has increased" or "Fun," or "Teacher taught me kindly," etc. In those cases, words were classified into all corresponding events by the answers of Q16 and the content of free description. The classification results of free descriptions words were shown in Table 1. From table1, "Human" means the impression of students of YUGE, staff and teachers. And "Ship" means seasickness, the sway of ship, etc.

From table.1, the students did not feel that experience has been obtained from the visiting lecture, but they felt that experience had been obtained from "experience cruise" and "rope work" and "paper cup rocket." Students tied ropes, and made decorations in rope work. And they observed that a paper cup was blown off along with a heavy sound by the power of heat. And students were stimulated by environments of a ship which were waves, winds and specialized devices, in the experience cruise. However, students were only stimulated by the story of the teacher and the projected image in the visiting lecture. Therefore, it is supposed that the favorability of trial events was higher than the visiting lecture.

From Fig.8 and Fig.9, Rope work and paper cup rocket were comparable for favorability, and from table1, students felt to get the same level of experience with rope work and paper cup rockets. In other words, the educational effect of rope work that was practical training format and the educational effect of paper cup rockets that was lecture format incorporating experiments were comparable. Therefore, it is supposed that the educational effect of the visiting lecture is improved by the impactful content such as sound, light and experiments, etc.

These results of the questionnaire are that the trial events and using the training ship are suitable for career education and improvement of the recognition of KOSEN.

Conclusions

The goal of this study was to develop an understanding that the usefulness of training ships, and teaching technology of the trial for career education, and improvement of the recognition of KOSEN. The results are summarized as follows.

1. In questions about ship's work and the effect of events, the many students have a positive answer, and few students have negative answers for the effect of events using a ship of career education. In addition, the distribution of all answers and distribution of answers of students who are lower intentionality for sailors have the same trend. Therefore, the training ship experience cruise is a very effective way of career education.
2. The degree of recognition for ship's work was very higher, but the degree of recognition for school for ship was low. Also, the degree of recognition for KOSEN was 33.2 %, and 39.7 % of them live near KOSEN. In addition, few students get knowledge about ship's work and KOSEN from "Teacher." Therefore, we need to promote a career education more for primary and secondary education. In addition, we must consider ways to improve the recognition of KOSE that include the Department of maritime technology.
3. The students did not feel that experience has been obtained from the visiting lecture, but they felt that experience had been obtained from "experience cruise" and "rope work" and "paper cup rocket." Therefore, the trial events and using the training ship are suitable for career education and improvement of the recognition of KOSEN.
4. Rope work and paper cup rocket were comparable for favorability, and students felt to get the same level of experience with rope work and paper cup rockets. In other words, the educational effect of rope work that was practical training format and the educational effect of paper cup rockets that was lecture format incorporating experiments were comparable. Therefore, it is supposed that the educational effect of the visiting lecture that was lower favorability of events, is improved by the impactful content such as sound, light and experiments, etc.

Acknowledgements

This event is part of "Shin Kaiji Jinzai Project" and "KOSEN4.0". This event was supported by Tokushima Prefectural Government, Tokushima Naikou Kaiun-kumiai, The Japan Shipowners' Association, Maritime Technology Department of KOSEN (Toyama College, Toba College, Hiroshima College, Oshima College).

References

Ezashi, H. & Miyashita, Y. (2015). *Toukei Today No.97* from https://www.stat.go.jp/info/today/097.html.

Ministry of Educations, Culture, Sports, Science and Technology. (n.d). *Appendix 4* form http://www.mext.go.jp/b_menu/shingi/chukyo/chukyo10/shiryo/attach/1280902.htm.

Ministry of Health, Labour and Welfare. (2018, October, 23th). *Press Release* from https://www.mhlw.go.jp/content/11652000/000510780.pdf.

The Japan Institute for Labour Policy and Training. (n.d.). *Fig.1 Unemployment rate, Effective job offer ratio* from https://www.jil.go.jp/kokunai/statistics/timeseries/html/g0301.html.

THE IMPACT OF DISTRIBUTED PRACTICE ON STUDENTS' ACADEMIC ACHIEVEMENTS IN DATABASE SYSTEMS MODULE

Irene Tan WC, Diana Wang and Ng Tek Ming

Republic Polytechnic/School of Infocomm, Singapore

tan_wah_chin@rp.edu.sg, diana_wang@rp.edu.sg, ng_tek_ming@rp.edu.sg

Abstract

Distributed practice is a learning approach which starts with an initial learning phase, followed by a subsequent review (or practice) phase that is spaced out over time to activate and deepen prior learning. This is due to a phenomenon called the *spacing effect* that can lead to long-term learning and retention (Kang, 2016). For more than half a century, benefits of distributed practice have been demonstrated in a wide range of disciplines. However, there are still limited studies conducted using distributed practice in the Information Technology discipline. This pilot study examines the impact of distributed practice in a Database Systems module which is offered to full-time year 1 students from the School of Infocomm in Republic Polytechnic. For our study, we created an experimental group (577 students) and a control group (63 students) to compare their summative assessment scores, so that the impact of distributed practice on the academic achievements of our students in the Database Systems module can be investigated. We have also administered a survey and conducted Focus Group Discussions with the experimental group to understand their experiences with distributed practice. Our findings showed no significant difference on students' academic achievements in the mid-semester assessment and the end-semester exam for the experimental group. However, the experimental group was found to have performed statistically better in continuous assessment quizzes. The better performance could be due to having the so-called optimal lag between the initial learning and the review during the next lesson, with the continuous assessment quizzes conducted at the end of each learning package. Optimal lag was also explored by Cepeda et al. (2009) where it was suggested that learning retention was highest when the lag was about 10% to 20% of the tested retention interval. Our study also includes examining the perception of lecturers and students on distributed practice, finding key aspects of distributed practice that help learning and those that hinder learning and identifying other modules that may benefit from implementing distributed practice as a learning approach.

Keywords: Distributed practice, Spacing effect, Long-term learning and retention, Optimal lag

Introduction

Distributed practice is a learning approach which starts with an initial learning phase, followed by a subsequent review (or practice) phase that is spaced out over time to activate and deepen prior learning. Research has shown that the review phase which is spaced out from the initial learning can lead to a more effective learning than a review that takes place immediately after the initial learning, with the total study time kept the same in both cases. This is due to a phenomenon called the *spacing effect* that can lead to long-term learning and retention (Kang, 2016). Among numerous theories to explain the *spacing effect*, the Encoding Variability theory explains that while learning, information is recorded in memory and connected to other pieces of information in a web-like structure. The more connections a piece of information has, the more likely it will be retrieved whenever required. When a piece of information is learned in different ways or at different times, it is likely to have more connecting pathways (Smith, Glenberg, Bjork, 1978; Smith and Rothkopf, 1984; Smith, 1982). Learning performance improves when encoding conditions are variable (Glenberg, 1979; Melton, 1970; Greene, 1989). In this view, distributed practice places learners into varying contexts during review, thus prompting variable encoding and more retrieval routes for long-term memory retention (Thalheimer, 2006).

The benefits of distributed practice have been demonstrated in a wide range of disciplines, including history (Carpenter et al., 2009), music (e.g., Simmons, 2011), and surgery (e.g., Moulton et al., 2006). However, there are limited studies conducted on the use of distributed practice in the Information Technology (IT) discipline. Our aim is to first study the impact of distributed practice in a Database Systems module before considering to extend distributed practice to more IT modules. The Database Systems module is offered to full-time year 1 students from the School of Infocomm in Republic Polytechnic.

Materials and Methods or Pedagogy

We created an experimental group and a control group to compare their Summative Assessment (SA) scores for the purpose of investigating the impact of distributed practice on the academic achievements of our students in the Database Systems module. We have also administered a survey and conducted Focus Group Discussions (FGD) with the experimental group to understand their perception of distributed practice, and to identify key aspects of distributed practice that help learning, as well as those that hinder learning.

Our implementation comprised of 26 Database Systems classes (577 students) that form the experimental group. A typical 4.5-hour lesson, previously conducted in a single day was 'distributed' or split to two days of 2.25-hour lessons each within the week, with a one-day lag between the two lessons (e.g., lesson on every Monday and Wednesday). Each lesson included a review of previous lesson(s). Another 3 Database Systems classes (63 students) formed the control group. These three classes were conducted in 4.5 hours within the same day still i.e. not distributed.

The lessons in the Database Systems module were grouped into six learning packages for the semester of 13 weeks. Each lesson package generally spanned across two weeks, where a gradable continuous assessment quiz was conducted during the last lesson of each package. To help students to re-inforce what they had learned after each lesson, non-gradable online practice questions were made available after each lesson to both the experimental and control groups of students. The total weekly contact hours in the module was kept the same for both groups. The lesson materials, end-of-lesson online practice questions, and continuous assessment quizzes were also kept the same for both groups.

The SA scores were collected from the 6 sets of continuous assessment quizzes, a mid-semester assessment and an end-semester exam for the module. Based on the Shapiro-Wilk normality test, it was found that not all samples from the experimental group and the control group followed a Gaussian distribution. Therefore, the non-parametric Wilcoxon test was used for comparing the mean of the respective SA scores from both groups at 0.05 level of significance. The null hypothesis of both groups having similar SA mean was tested against the alternative hypothesis of the experimental group having a better SA mean than the control group.

For the purpose of this study, a survey was created and administered online in mid-semester (Week 7) to the experimental group. The survey received a response rate of 91% (525 responses). Data was collected from the eight survey items on the 5-point Likert Scale which ranged from 1 (strongly disagree) to 5 (strongly agree), and two open-ended questions. Using SPSS, the suitability of data for Exploratory Factor Analysis (EFA) was assessed on the eight Likert Scale items. With the Keiser-Meyer-Olkin (KMO) measure of sampling adequacy at 0.900, there was sufficient correlation between pairs of items to proceed with EFA. Bartlett's test of Sphericity was found to be significant, rejecting the null hypothesis that all items were uncorrelated, hence lending considerable support to the factorability of the correlation matrix. The Principal Axis Factoring (PAF) was used on the eight items to examine the shared variance. PAF was chosen because it avoided the inflated estimates of variance. Based on an eigenvalue cut-off at 0.7 for a more exploratory analysis (Jolliffe, 1972), PAF revealed the presence of two components with eigenvalues at 5.056, and 0.796. The two components explained a total of 64.232% of the variance. To aid in the interpretation of these components, the Promax Oblique Rotation Method was chosen as we anticipated that factors may be correlated. As observed from Table 1, both components showed a number of strong loadings on each component. We named the two components as "*affective learning*" and "*attention span*". *Affective learning* relates to students' interests, attitudes, and motivations that are essential components of a 21st century university education (Gano-Phillips, n.d.). Specifically, it is concerned with how students feel while learning, and how learning experiences are internalized to guide students' attitudes, opinions, and behavior (Miller, 2005). With these, learning occurs more frequently and more extensively (Tooman, n.d.).

To measure internal reliability, the Cronbach Alpha (0.876 for *affective learning* and 0.866 for *attention span)* indicated a very high consistency of measures. Each exceeded the rule of thumb acceptance range of 0.5 to 0.7. All these provided clear evidence that both *affective learning* and *attention span* should be retained for further discussion in the results section.

Table 1: Loading on each component identified through Promax

Pattern Matrix[a]

	Factor	
	1	2
Q2	.884	
Q3	.843	
Q8	.677	
Q7	.585	
Q6	.525	
Q4		.857
Q5		.857
Q1		.560

Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Exploratory Text Clustering Analysis was conducted using Orange, a text analytics tool, on the two open-ended survey questions:

- Which aspect(s) of distributed practice helped your learning?
- Which aspect(s) of distributed practice hindered your learning?

Based on hierarchical clustering, a Dendrogram was used to decide on the number of clusters for the text data. The outcome is discussed in the next section.

After the mid-semester assessment, FGD were conducted with 17 students and seven lecturers from the experimental group. The 17 students were further divided into three FGD sessions based on their Database Systems module's mid-semester assessment scores, forming the following FGD sessions:

- Session #1: six students with scores >= 70%;
- Session #2: seven students with scores >= 55% but < 70%;
- Session #3: four students with scores < 55%;
- Session #4: seven lecturers.

Data collected from the FGD was transcribed and analysed to identify emerging themes for discussion in the next section.

Results and Discussion

Based on the Wilcoxon test at 0.05 level of significance, our findings showed no significant difference in students' academic achievements in the mid-semester assessment and end-semester exam scores. The alternative hypotheses of the experimental group having a better mean than the control group for both the mid-semester assessment and the end-semester exam were rejected based on p-values of 0.961 and 0.687, respectively.

However, students from the experimental group performed statistically better in continuous assessment quizzes than students from the control group. This was concluded based on acceptance of the alternative hypothesis of the experimental group having a better mean than the control group in the continuous assessment quizzes, based on p-value of 0.017. The better performance in the quizzes from the experimental group could be due to having the so-called optimal lag between the initial learning and the review during the next lesson. Optimal lag was also explored in Cepeda et al. (2009) where it was suggested that learning retention was highest when the lag between the initial learning and the review was about 10% to 20% of the tested retention interval (time between the last review and the test). For the experimental group, the one-day lag between the first two lessons of the learning package within the week was aligned with the optimal lag guideline from Cepeda et al. (2009). For example, having the first lesson on Monday, followed by the second review-cum-lesson on Wednesday. The 10% to 20% optimal lag was calculated based on having the continuous assessment quiz on the following Wednesday.

The eight Likert Scale items from the survey were analysed in Table 2 according to *affective learning* and *attention span*, as identified by PAF. Items Q2, Q3, Q6, Q7 and Q8 from the survey were analysed together under *affective learning*. Item Q2 ("I can remember Database Systems concepts and syntax learned better with distributed practice") scored the highest mean score of 3.86 out of 5, where 70% of the respondents chose options *agreeing* or *strongly agreeing*. Under *affective learning*, the majority of the survey respondents expressed that they:

- could remember database concepts and syntax better, and could apply them faster to solve problems;
- believe they could do better in the exams with the distributed practice approach;
- feel more motivated to attempt online practice questions repeatedly outside of lessons;
- had more time to prepare for continuous assessment quizzes.

These insights pointed favorably to suggestions that distributed practice could help students to enhance their *affective learning*.

Table 2: Ranking of Items influencing how students felt taking the Database Systems module via the distributed practice approach

Factors	Items	Mean (out of 5)
Affective Learning	Q2 – I can remember Database Systems concepts and syntax learned better with distributed practice	3.86
	Q3 – I can apply Database Systems concepts and syntax learned to solve problems faster	3.81
	Q8 – I can do better in the exams with the distributed practice approach	3.71
	Q6 – I have more time to prepare for the continuous assessment quiz at the end of each learning package	3.70
	Q7 – I feel more motivated to attempt the online practice questions repeatedly outside of lesson time	3.67
Attention Span	Q1 – Better to split 4.5 hours whole day learning into two days per week (2.25 hours per lesson)	3.90
	Q4 – Shorter lesson duration (2.25 hours) makes me more focused in class	3.90
	Q5 – Shorter lesson duration (2.25 hours) makes me feel less tired to learn	3.85

Items Q1, Q4 and Q5 from the survey were analyzed together under *attention span*. Both items Q1 ("Better to split 4.5 hours whole day learning into two days per week") and Q4 ("Shorter lesson duration makes me more focused in class") scored the highest mean score of 3.90 out of 5 as shown in Table 2, where 72% and 71% of the respective respondents chose options *agreeing* or *strongly agreeing*. Under *attention span*, majority of the survey respondents expressed they:

- felt more focused during lessons;
- were less tired to learn;
- were supportive of the split of the 4.5-hour whole day learning of the Database Systems module across two days per week.

These insights pointed favorably to suggestions that distributed practice could help students to improve their *attention span* during lessons.

The Dendrogram generated from the hierarchical clustering of text data from the first open-ended question in the survey, at a height ratio of 60%, revealed that:

- the shortened lesson duration to 2.25 hour made it easier for students to stay focused;
- the reduced content per lesson made it easier for students to understand the concepts taught;
- the twice weekly lessons helped students to have more in-class practices and remember the previous lesson(s) better.

At a height ratio of 63%, the Dendrogram generated from the second open-ended question in the survey revealed that the following has been reduced due to having a shorter lesson duration:

- time for students to seek clarifications with lecturers;
- time for students to conduct research from own learning resources;
- time for class/team learning activities.

There was also feedback that some lessons were significantly heavier in content than others. This resulted in students and lecturers being rushed to complete the lessons. Better logistical planning and implementations may help to reduce these.

From the FGD conducted, 71% (12 out of 17) of the students in the FGD felt that distributed practice was useful to help them learn better in the Database Systems module. The students from the FGD session with mid-semester assessment scores between 55% and 70% were divided in their support for distributed practice. Those who did not support distributed practice generally felt that the pace of lessons was too fast. They did not have time to catch up as there was no official break within the module lesson. They also did not have time to check with friends when they were lost during the lesson. In contrast, 100% of the student participants from the other two student FGD sessions supported distributed practice for the module. On the other hand, 72% (five out of seven) of the lecturers in the FGD felt that distributed practice was useful in helping students learn better in the module, one felt otherwise while one lecturer stayed on neutral ground. In addition, students and lecturers who were supportive of distributed practice felt that it should be continued for the Database Systems module, and it could also be considered for other technical modules which require regular practice, such as programming or mathematics modules. Other than the above, the feedback received during the FGD has similar findings as those established from the survey.

Though this is our first attempt to introduce distributed practice as a learning approach in an IT module, we have gained the following valuable insights:

- Better performance in continuous assessment quizzes from the experimental group;
- Positive perception of distributed practice from the majority of the students and lecturers from the experimental group;
- Understanding of key aspects of distributed practice that help learning, as well as those that hinder learning.

Conclusions

Our study has shown that students under distributed practice have performed better in continuous assessment quizzes and they have also expressed positive learning experiences. For a more conclusive impact of distributed practice on our Database Systems module, we are extending our study to two more runs of the module. For the next run, we would like to examine how distributed practice can improve the mid-semester assessment and end-semester exam performance which was not achieved in the current study. This could involve further examining the *spacing effect* between lessons and other logistical aspects. If distributed practice is found to be effective, it could be considered for other modules that require regular or constant practice such as programming or mathematics. It could also be beneficial to modules that are heavy in content. The distributed practice approach could help to break-down the heavy content into bite-sized chunks, to be covered in shorter but more frequent lessons.

References

Carpenter, S. K., Pashler, H., & Cepeda, N. J. (2009). Using tests to enhance 8th grade students' retention of U.S. history facts. Applied Cognitive Psychology, 23, 760–771.

Cepeda, N. J., Coburn, N., Rohrer, D., Wixted, J. T., Mozer, M. C., Pashler, H. (2009). Optimizing distributed practice: Theoretical analysis and practical implications. Experimental Psychology, 56(4), 236-246.

Gano-Phillips, S. (n.d.). Affective Learning in General Education. Retrieved from http://www5.cuhk.edu.hk/oge/oge_media/rcge/docs/journal/issue_06/01_susanganophilips.pdf.

Glenberg, A. M. (1979). Component-levels theory of the effects of spacing and repetitions on recall and recognition. Memory & Cognition, 7, 95-112.

Greene, R. L. (1989). Spacing effects in memory: Evidence for a two-process account. Journal of Experimental Psychology: Learning, Memory, and Cognition, 15, 371-377.

Jolliffe, I. T. (1972). Discarding variables in a principal component analysis. I. Artificial data. Appl. Statist., 21, 160-173.

Kang, S. (2016). Spaced Repetition Promotes Efficient and Effective Learning: Policy Implications for Instruction Policy Insights from the Behavioral and Brain Sciences 2016, Vol. 3(1) 12–19.

Melton, A. W. (1970). The situation with respect to the spacing of repetitions and memory. Journal of Verbal Learning and Verbal Behavior, 9, 596-606.

Miller, M. (2005). Teaching and learning in affective domain. In M. Orey (Ed.), Emerging perspectives on learning, teaching, and technology. Retrieved from http://projects.coe.uga.edu/epltt/.

Moulton, C.-A., Dubrowski, A. E., MacRae, H., Graham, B., Grober, E., & Reznick, R. (2006). Teaching surgical skills: What kind of practice makes perfect? Annals of Surgery, 244, 400–409.

Simmons, A. L. (2011). Distributed practice and procedural memory consolidation in musicians' skill learning. Journal of Research in Music Education, 59, 357–368.

Smith, S. M. (1982). Enhancement of recall using multiple environmental contexts during learning. Memory & Cognition, 10, 405-412.

Smith, S. M., & Rothkopf, E. Z. (1984). Contextual enrichment and distribution of practice in the classroom. Cognition and Instruction, 1, 341-358.

Smith, S. M., Glenberg, A., and Bjork, R. A. (1978). Environmental context and human memory. Memory and Cognition, 6, 342-353.

Thalheimer, W. (2006). Spacing Learning Events Over Time: What the Research Says, 43.

Tooman, T. (n.d.). Affective Learning: Activities to Promote Values Comprehension. Retrieved from http://www.soulsticetraining.com/commentary/affective.html.

Investigating the efficiency of fostering basic social skills by active learning using an objective assessment

Hideyuki Kobayashi*[,a], Koji Kawasaki[a] and Kuniaki Yajima [a]

[a] Department of General Engineering, National Institute of Technology (KOSEN), Sendai college, Sendai, Japan

*kobayashi@sendai-nct.ac.jp

Abstract

In this paper, we clarify the effect of active learning (AL) for fostering basic social skills using an objective investigation. There are many questionnaire-based methods for investigating the basic social skills. However, there are few objective assessments. PROG is an objective assessment the basic social skills. Thus, 1st year to 5th year students in our college are investigated their social skills from 2014 to 2019 using the PROG. In those results our education system is clarified effective for fostering students' basic social skills.

The concepts of Core skills in the UK and Employability skills in Canada have been proposed as skill sets required for working. Moreover, OECD conducts the PISA survey based on key competencies. Companies in Japan also expect universities to develop human resources with so-called basic social skills. In response, METI has proposed a definition of "the basic skills to become a fully-fledged member of society" in career education. Active learning is a method for fostering basic social skills.

Also, Sendai KOSEN has been proposed A^3 learning system since 2014. The A^3 learning system comprises AL, project/problem-based learning (PBL), and mastery learning (ML). AL is considered that effective for fostering basic social skills. In A^3 learning system, 1st year students study discussion, presentation and way of critical thinking. Furthermore, almost all lecture is corresponded the active learning method. Thus, the system is considered effective for fostering basic social skills.

PROG is an assessment that can objectively measure literacy and competencies. However, PROG has problems such as slightly lower Cronbach's alpha test value and not for Engineers skills. Therefore, objective assessments for engineers are needed for KOSEN.

Keywords: *Basic social skills, Active Learning, Objective Assesment, PROG*

Introduction

The concepts of Core skills in the UK and Employability skills in Canada have been proposed as skill sets required for working. Moreover, OECD conducts the PISA survey based on key competencies. Companies in Japan also expect universities to develop human resources with so-called basic social skills. In response, METI has proposed a definition of "the basic skills to become a fully-fledged member of society" in career education. Active learning is a method for fostering basic social skills.

Also, Sendai KOSEN has been proposed A^3 learning system since 2014. The A^3 learning system comprises AL, project/problem-based learning (PBL), and mastery learning (ML). AL is considered that effective for fostering basic social skills. In A^3 system, 1st year students study discussion, presentation and way of critical thinking. Furthermore, almost all lecture is corresponded the active learning method. Thus, the system is considered effective for fostering basic social skills.

In this paper, we clarify the effect of active learning (AL) for fostering basic social skills using an objective investigation. There are many questionnaire-based methods for investigating the basic social skills. However, there are few objective assessments. PROG is an objective assessment the basic social skills. Thus, 1st year to 5th year students in our college are investigated their social skills from 2014 to 2019 using the PROG. In those results our education system is clarified effective for fostering students' basic social skills.

PROG is an assessment that can objectively measure literacy and competencies. However, PROG has problems such as slightly lower Cronbach's alpha test value and not for Engineers skills. Therefore, objective assessments for engineers are needed for KOSEN.

Materials and Methods or pedagogy

The fostering of the basic skills to survive the society is attracting attention.

According to the National Centre for Vocational Education Research (NCVER) (2003), these skills are said to be core skills, key skills and common skills in the UK. The skills are called Essential skills in New Zealand, Key competencies, employability skills and generic skills in Australia, Employability Skills in Canada, Basic skills, necessary skills and workplace know-how in the United States, Critical enabling skills in Singapore, Transferable skills in France, key qualifications in Germany, Trans-disciplinary goals in Switzerland Process independent qualifications in Denmark and so on.

In Japan, Ministry of Economy, Trade and Industry (METI) called the skills “Syakai-jin Skills.” Syakai-jin means working people in Japanese.

OECD PISA (2003) conducts literacy in PISA Surveys, and DeSeCo (2005) conducts competency research under the name of key competences.

In Japan, METI (2006) has shown the importance of the same ability as "Syakai-jin Kiso Ryoku." “Kiso Ryoku” means basic power.

The quantitative evaluation of literacy can be measured by conventional tests. However, competencies cannot be evaluated on a questionnaire basis. Therefore, quantitative evaluation is difficult.

PROG which is a test made in Kawaijuku and Riasec (2011) is used in some Japanese institutions as a quantitative assessment of competencies.

PROG is a test that measures literacies and competencies quantitatively. The competencies in PORG is a method of taking a questionnaire to young executive candidates who are considered excellent in the company and raising the evaluation of students who chose the same answer as the result of the questionnaire, scoring and quantitatively measuring the competencies method.

Furthermore, Ka-Cheong Leung, Frederick K.S. Leung and Haode Zuo (2014) aims to measure generic skills in mathematics classes in Hong Kong.

Ito (2014) shows that Grade Point Average (GPA) and PROG of university students have a weak correlation.

Nahomi M. Fujiki, Yasuhiro Kashiwaba, Akiko Takahashi, Hideyuki Kobayashi, Yoshihiro Hayakawa and Shinji Chiba (2016) verified the effect of basic skills of working people on the introductory education using PROG.

As mentioned above, the attempt to cultivate generic skills in class and measure the effect is widely done all over the world.

National Institute of Technology (KOSEN), Sendai college (Sendai KOSEN) launched a program called A^3 Learning System to train the basic skills of working people in 2014. Akiko Takahashi, Yosuhiro Kashiwaba, Toshiaki Okumura, Toshihiko Ando, Kuniaki Yajima, Yshihiro Hayakawa, Motomu Takeshige and Tatsuo Uchida (2015) propose an advanced active autonomous learning system (A^3 learning system), an educational system based on the use of information and communications technology devices. The A^3 learning system comprises active learning (AL), project/ problem-based learning (PBL), and mastery learning (ML). In concrete terms, foundational learning in the software/hardware information fields and PBL from the software design stage to the system implementation stage were conducted using AL and two methods, respectively, by individual students and a group. Furthermore, the Progress Report on Generic Skills test was conducted to evaluate the educational benefits of the proposed system.

Figure 1 shows the models of the A^3 learning system we propose. By using active learning and advanced learning, students aim to create an environment where students can actively develop their abilities by advancing learning autonomously.

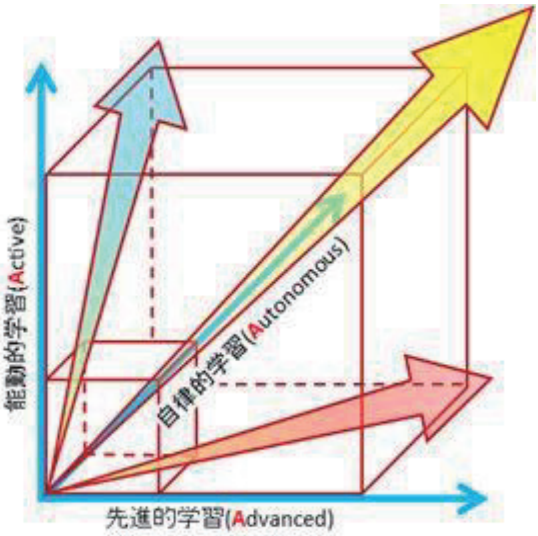


Figure 1 Model of A^3 learning system (Takahashi (2015))

In generally, the generic skills were only evaluated on a questionnaire basis. Therefore, quantitative evaluation was difficult.

However, PROG performs quantitative evaluation. Therefore, we use PROG to measure how much our A^3 learning system contributed to the development of generic skills.

A^3 Learning System

In response to changes in the image of human resources being trained in Sendai KOSEN, educational reforms have been conducted with the purpose of fostering more talented human resources who have improved their basic skills. Among them, we proposed Advanced Active and Autonomous Learning System (A^3 learning System).

A^3 learning System has Active Learning (AL), Project/ Problem Base Learning (PBL), and Self-paced Complete Mastery Learning (ML) as the basis of the education system.

In AL, students conduct independent classes to learn by themselves or among students. For this purpose, Sendai KOSEN incorporates elements of AL in almost all classes.

In addition, PBL fosters problem-solving ability, imagination, practical ability, project execution ability, etc. and conducts advanced learning.

In ML, students learn each unit at their own pace, and learn completely after learning. Maintain an environment that ensures that all students can acquire knowledge. For that purpose, the teaching materials are stored, and the start of the on-campus content server that can be used for self-study and learning management system (LSM) such as Blackboard is used.

In addition, the introduction of an education system that has not been conducted in junior high school has increased the confusion for students. Therefore, in introductory education we adapt to the A^3 learning system even from the lower grades by providing an opportunity to learn the skills necessary for so-called active learning, such as the way of presentation, the way of expressing opinions and the way of processing data. The environment was improved.

Competency survey using PROG

We introduced the A^3 learning system from 2014 and evaluated it by the quantitative method using PROG as its evaluation index.

Objective evaluation of literacy can be done by conventional tests. However, evaluation of competencies involves the subjectivity of students, so objective evaluation is difficult. Objective assessment of competencies is very important in assessing whether basic skills for working people have been established. PROG is a test designed to give high evaluation to students who gave similar answers to executive candidates for working people, and low evaluation to other students. Therefore, it is possible to evaluate competencies with a certain degree of objectivity. Therefore, in this paper, we evaluate the growth of the competency of Sendai KOSEN students by PROG.

The evaluation was conducted by continuing the follow-up survey in each grade and calculating the average value for each year.

Figure 2 shows the research results of literacy in the department of Information system engineering, Sendai KOSEN. Figure 3 shows the results of the competency of in the department of Information system engineering, Sendai KOSEN.

Results and Discussion

The horizontal axis of the figure shows each grade. The vertical axis shows the values of literacy and competencies. The maximum value is 7 for both literacy and competencies.

The results show the average value for each grade.

As the grade progressed as a whole, the results showed a tendency that both competencies and literacy increased. In particular, literacy was on the rise in almost all classes.

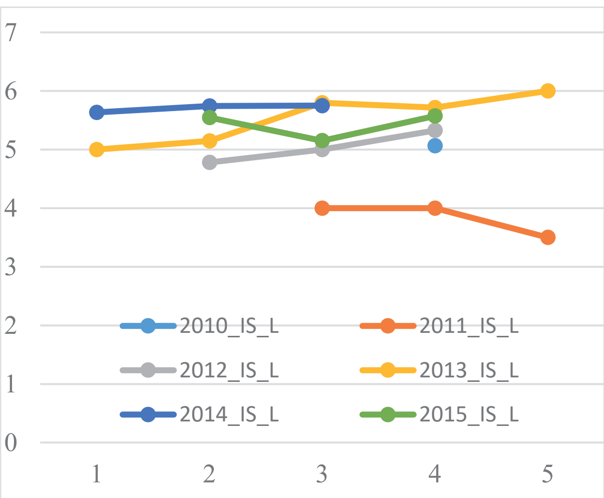


Figure 2. Literacies average (Dept. Information System)

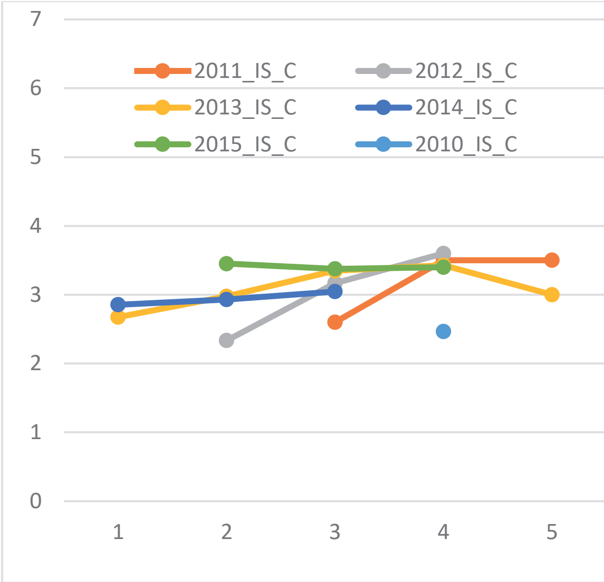


Figure 3. Competencies average (Dept. Information System)

Literacy can be complemented by classes. However, it was considered difficult to extend competencies by classes from the point of evaluation.

The competencies tended to be low for students who did the first test in 2014, but are very high in the next year. However, the growth of competencies from the first year to the next year is very high. It is clear that the introductory education of our school is very effective as the students who entered after 2014 have exceeded the third year's third year's competencies of the first year students as of one year.

According to the Shapiro-Wilk test, it was not normally distributed at the significance level $p < .05$.

Therefore, the test was performed at the significance level $p < .05$ by the Steel-Dwass method, which is a nonparametric method.

As a result of the examination, it was found that there is a significant difference between the literacy of 3-5 years and the literacy of 4-5 years of the 2011 enrollment. In addition, there was a significant difference in the competency of 2-4 years of students enrolled in 2012.

This survey has been conducted since 2014. It is the first time this survey has seen the process of growth up to 1-5 years. Also, the A^3 learning system was started in 2014.

Students who enrolled in earlstage of A^3 learning system have remarkable growth in competencies. Recent students are not remarkable. This indicates that the students who have been teaching AL since the introductory year have acquired basic skills for working people.

Moreover, it turned out that students from other than the introductory year have the effect of our A^3 learning system, as we can see that their competencies have grown to some extent.

Conclusions

In order to measure the growth of generic skills, we conducted a survey that introduced PROG continuously.

As a result, we were able to confirm the fostering of competencies before and after the introduction of A^3 at our school.

A^3 learning system was found to contribute to the growth of competency and literacy.

However, PROG itself is not a good test with Cronbach's alpha test value between 0.75 and 0.88.

Furheremore, the PROG test is an indicator that a higher score will be obtained if the same answer as an executive candidate after joining the company gives the same answer. Therefore, it can not be said that it is a correct answer as an index for attaining basic skills for working people.

However, as long as there is no objective index that is not questionnaire based, it is meaningful as a measure that can be used as objective data.

In the future, it is necessary to consider another index for measuring competency. In particular, since the PROG test is not an index that should be provided for students from engineering department, and it is not an index for students of KOSEN, it is necessary to create an index for students of KOSEN and engineering department.

In the future, it will be necessary to consider other indicators for measuring competency. In particular, since the PROG test is not an index that should be provided for students from engineering department, and it is not an index for students of technical college, it is necessary to create an index for students of technical college and engineering department.

However in this paper, Since the initial introduction shows a significant rise in competency ability and the trend at a stable level in recent years, it is considered that the development of adult student skills has been confirmed by active learning at our school.

In the future, we plan to create new tests.

Acknowledgements

In the presentation of this research, the members of the Organization Headquarters gave much support. Fourtheremore, Prof. Fukahori who is a professor from Kyusyu University gave me the useful advice. I show my gratitude here.

References

National Centre for Vocational Education Research (NCVER) (2003), "Defining generic skills At a glance,"

PISA. (2003), "Learning for Tomorrow's World," OECD,

DeSeCo.(2005)., "The Definition And Selection of Key Competencies," OECD, May.,

Ministry of Economy, Trade and Industry (METI), (2006), "Syakai-jin Kisoryoku," 2006

Kawaijuku and Riasec (2011), "PROG: Progress report on generic skills," https://www.kawaijuku.jp/jp/research/prog/point.html

Ka-Cheong Leung, Frederick K.S. Leung, Haode Zuo,(2014)"A study of the alignment of learning targets and assessment to generic skills in the new senior secondary mathematics curriculum in Hong Kong," Studies in Educational Evaluation, No. 43, pp.115—132, 2014

Ito Hiroshi (2014), "Assessing an Assessment Tool of Higher Education: Progress Report on Generic Skills (PROG) in Japan," IJERE, Vol.3, No.1, pp.1 –10, Mar., 2014.

M. Fujiki, Nahomi, Kashiwaba, Yasuhiro, Takahashi, Akiko, Kobayashi, Hideyuki, Hayakawa, Yoshihiro, Chiba, Shinji,(2016)" The practical program for bringing out generic skills of the first year students," TALE, pp.271—277, Dec., 2016.

Akiko Takahashi, Yosuhiro Kashiwaba, Toshiaki Okumura, Toshihiko Ando, Kuniaki Yajima, Yshihiro Hayakawa, Motomu Takeshige and Tatsuo Uchida, (2015), "Design of advanced active and autonomous learning system for computing education — A^3 learning system," 2015 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE), pp. 77—82, Dec. 2015

etc lab. – An Interdisciplinary Centre for Collaborative Design and Research to Create Social Impact and Change

Khiang Jian Hao Jason

[a] Ngee Ann Polytechnic,School of Design & Environment, Singapore
*Jason_KHIANG@np.edu.sg

Abstract

etc.lab is an Interdisciplinary Centre that is focused on empowering communities through design. It seeks to bring forth and realise student project works from Diploma in Product Design & Innovation, and Diploma in Sustainable Urban Design & Engineering at Ngee Ann Polytechnic. Within identified service-learning modules from the respective diplomas, students apply various design methodologies to co-create design solutions or spaces that would help provide and sustain livelihoods. This authentic service-learning experience requires students to empathize with stakeholders within communities with a real need before co-creating design solutions alongside the local or overseas community.

This lab is run by full-time teaching staff within the School of Design and Environment. The etc.lab experience is not just about working on projects with communities but also to develop each student so that they can demonstrate the NP's graduate outcomes of being "Passionate Learners" - by seeing the relevance of their learning to the real world and the impact it can have on others, "Big –hearted persons" by using the academic knowledge that they have to "give-back" to the community that is in need, and to be Global Smart Professionals – where students go into another community and to work in environments that are very different to their own.

Hence, each project is carefully curated and formulated by etc. lab to ensure that the experience would not only create a positive impact on less fortunate communities they work with but also to show students the content knowledge they have learnt about design can make a difference to others. Students are heavily involved in the projects as they are expected to make all design planning and decisions and lecturers only serve as advisors. This gives students the opportunity, to develop "life-skills" such as having initiative, being adaptable and taking responsibility.

The impact of the etc.lab has been very positive with students citing this experience as "memorable" and "transformational". Feedback from students and staff have indicated the change in the way students view their learning and also in the way they interact with the community. The positive impact of the experience were also documented in the willingness to contribute more to the communities they work with after the etc-lab projects.

Keywords: Service-Learning, Interdisciplinary studies, Experiential Learning

Introduction

etc.lab is an Interdisciplinary Centre from Ngee Ann Polytechnic (NP) that focuses on collaborative design and research to create social impact and change. Founded in May 2016, in School of Design and Environment (DE), etc.lab's vision is to create a better world by "collaborating to transform imagination into reality" The mission is to empower communities through design where the projects by etc.lab can make a strong impact and show students that design can make the world a much better place to live in.

By collaborating with practicing educational designers, industry partners and government agencies on real-life industry projects with the communities, DE's design students will also be able to gain invaluable and relevant working experiences that would diversify their design portfolios for educational and professional pursuits.

etc.lab adopts the "4E Strategy" for the 4 design labs that would enable etc.lab to fulfil its mission to empower communities through design.

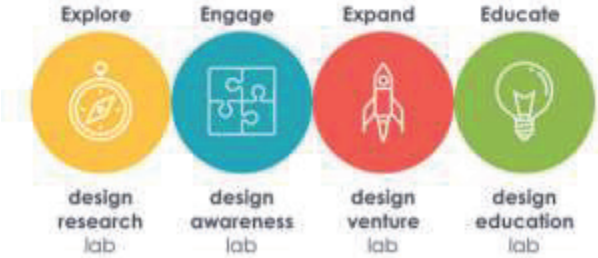


Figure 1: 4 design labs: 4E's

The objectives of the design labs are for students to apply design methodologies on different types of projects to expose our students to different domains of design, and each of these labs have their own area of focus.

(i) The **design research lab** focuses on exploration for new discoveries in emergent areas by developing new tools and processes for design through research in vernacular living, sustainable design and universal design.

(ii) The **design awareness lab** seeks to increase student's engagement and promote awareness of the value of good design to the community through organising and participating in design events.

(iii) The **design venture lab** seeks to expand the possibilities of our student's design abilities by promoting entrepreneurship and innovation in design for our students through industry collaboration projects and incubation of student projects.

(iv) The **design education lab** seeks to educate and cultivate creative confidence and design sensibilities in our students and the public through programmes such as designers-in-residence, design/build studio and workshops.

About etc.lab

etc.lab adopts Service-Learning (S-L) and Experiential Learning pedagogies in their curriculum. Each S-L project is carefully curated to ensure that the experience is beneficial for both students' learning and for the community.

The overarching principle here is that S-L allows for the development of an authentic learning platform whereby students encounter real-world challenges in the community and are tasked to work collaboratively with stakeholders to experiment and implement design methodologies and solutions to respond to these challenges.

According to (Jones, 2013), the importance of empathetic research and participatory workshops with stakeholders highlights the importance of co-creation within the design process. In a response to the increasing importance of co-collaborating and involvement of communities within the design process, we seek to look out to more interested communities and interested industry partners.

Figure 2: Design for care by Peter H. Jones shows how the design industry is evolving towards for community impact rather than "strange making"

According to TOUCH Leadership & mentoring's service-learning cycle, students will immerse themselves into identified communities to investigate and identify the real needs of beneficiaries. From the immersive experience, students will define and identify issues that requires solutions, establish objectives, plan and prepare for action. Student will apply their solutions, test and iterate along with the beneficiaries. Student are also required to reflect about their learning experiences throughout their project and how these experiences will impact their perspective of learning, their future profession and the communities that they have encountered.

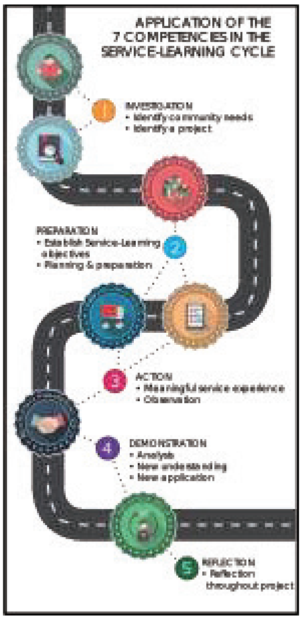


Figure : TOUCH leadership and mentoring service learning cycle

Throughout the TOUCH leadership & mentoring S-L process (TOUCH Leadership & Mentoring, 2016), students are given a chance to apply their design knowledge and taken through the different stages of **Investigation** by identifying community needs, **Preparation** and planning the objectives of the S-L experience, **Action** through organisation, **Demonstration** through implementation of the project and **Reflection** on the experience. They also use various design processes and methodologies including Design

Thinking and Participatory in Design while executing and proposing design solutions.

Students working on the projects for the community are supported by industry experts that are engaged by etc.lab to provide students with guidance for their projects. This interaction with industry professionals gives students the experience of working in the industry and allows them to develop professional attributes that will be needed in their future workplace. Students are also encouraged to work with peers from different specialisations so that they are able to gain interdisciplinary knowledge from one another.
etc.lab curates and plans the various S-L experiences for students to ensure that the project is aligned to curriculum, has a tangible benefit for the community and provide students with relevant industry experiences.

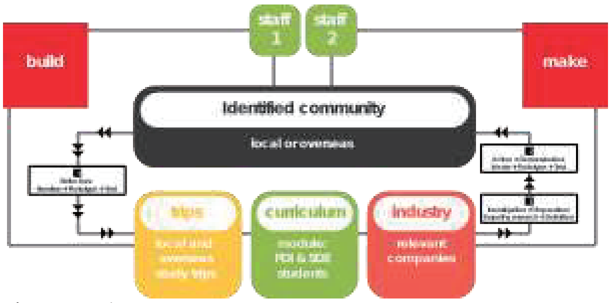


Figure 4:
How each project is being curated

Implementation of etc.lab
Phase 1 : Investigation & Preparation

For students undertaking the Diploma in Sustainable Urban Design & Engineering (SDE) and Diploma in Product Design & Innovation (PDI), the whole TOUCH process takes place in one semester.

Figure 5:
Investigation & preparation

The investigation stages occur before the start of the semester. Teaching staff managing etc. lab would reach out to local or overseas communities to identify and discuss community needs and identify possible project focus. Teaching staff would establish the S-L objectives and plan for the execution of the project within modules as part of students' curriculum.

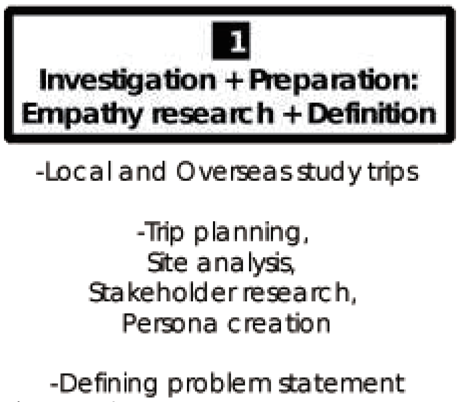


Figure 6:
Investigation + Preparation- Empathy research + Definition

The Investigation and Preparation stage for students starts at beginning of the semester where they visit the communities (local or overseas) and immerse themselves with the community to learn and fully understand the needs and wants of the community .

Before each trip, students will be briefed on the objectives of the project, the site, stakeholders and industry partners involved before being divided into groups, where they are to plan how they would do their on-site research during the visit to the community.

Students will need to analyse the given community/site using design thinking methodology or participatory-in-design knowledge as part of their research into the community and stakeholders. In this phase, students will also co-develop ideas with the stakeholders, where they will learn to empathize and clearly understand the needs and wants of their stakeholders and community before developing design solutions that are suitable.


Figure 7:
Students interviewing stakeholders in Tasikmalaya

Phase 2 : Action & Demonstration

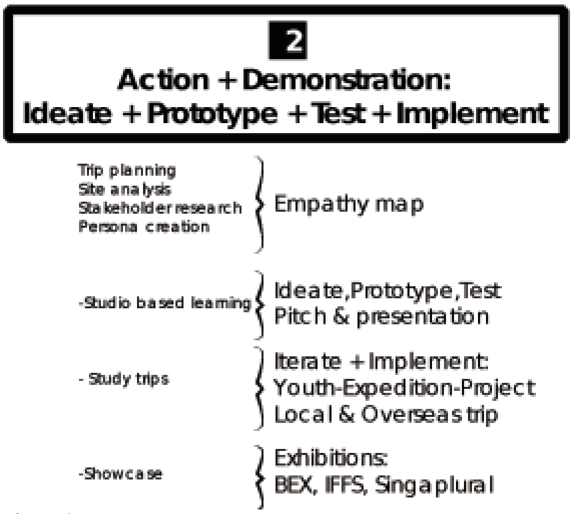


Figure 8:
Action + Demonstration- Ideate + Prototype + Test + Implement

Towards the end of the site visit, students will need to "Define" the issue faced by the community. This encompasses students' observations and understanding of their stakeholders during the trip and to create an "empathy map" consisting of the stakeholders' obvious needs and emotional needs.

When the students return to Singapore, they work within their teams to ideate and develop their ideas during in class and share them with their peers where they receive critique and comments to help them improve. The groups are constantly reviewing their ideas, create prototype and testing their ideas by pitching them to their peers and industry partners and receiving critique from them.

This process develops teamwork amongst the group and the collaborative experience within the studio which creates an environment where students learn to share and examine their ideas and direct their learning. Students will iterate their ideas & concepts based on feedback from classmates and industry partners.

When the students return to the community, they present their design concepts and solutions so as to seek endorsement and to work together to implement it. This co-creation and direct service process gives students the opportunity for meaningful involvement in the community where they are able to see how their designs would impact different communities locally and globally.

Figure 9:

Students presenting their design solutions (building on left and products on right) to stakeholders.

Figure 10:
Students and staffs co-creating solutions with locals/stakeholder

Figure 11:
Student reflection. Trips and Event

Phase 3: Reflection

Reflection is a vital component of S-L as it helps students to internalise and comprehend the meaning behind the service provided, see the relevance of their classroom learning and how it can have real impact on the community and to enhance students' understanding of social issues.

Etc.lab uses the Gibbs' Reflective Cycle (Graham Gibbs, 1988) to support students' reflection process.

Figure 12: Gibbs' Reflective Cycle

At the end of each milestone e.g. after each study trip students will reflect on their experience by Evaluating, Analysing, Conclude and Plan out the next course of action. This process guides students to review their own practice and prepares them to be more competent designers/architects with an understanding of needs of the community/stakeholders they serve.

Some examples of students feedback can be seen below in figure 12 where they demonstrate awareness of the importance of being "user-centric" in their design and the different environments that they are likely to work in future.

Figure 13: Product Design & Innovation (PDI) and Sustainable Design & Environment (SDE) Student's Service Learning Reflection

Extension of Learning : Post S-L Experience

Upon completion of each S-L project, etc.lab would identify opportunities e.g exhibitions to showcase students' project to share their design. The curation of the projects allows students to use their technical knowledge to re-interpret their design for a different audience while maintaining the design story and intention.

With support from etc.lab's staff, students lead the curation of each exhibit which include tasks such as communication with prototyping vendors, logistics preparation, schedule planning for duties to social media publications and prints. In additional, they will also need to work closely with their peers to build a pool of knowledge and resources about the exhibition in order to ensure that they have met the standards of a public showcase.

Through this experience, students will be able to develop key attributes required by the industry such ass communication skills, problem solving, team work and critical thinking as they lean to communicate the idea behind their design, receive critique and feedback from the industry professionals, work with their peers and lecturers, and work through the many issues and challenges that will present itself during the exhibition.

To date, etc.lab has showcase students' design at international design platforms like Singaplural, BEXasia and International Furniture Fair Singapore. In addition, two of the exhibited designs have been commercialised with industry partners.

Figure 14:
Product Design and Innovation Student, Benjamin Toh En Min, Presenting to Senior Minister Chee Hong Tat during Singaplural 2019 (photo credit: Singaplural) (Singaplural, 2019)

Figure 15:
Photos of successfully curated exhibition for Singaplural 2018(top left) International Furniture Fair Singapore 2019(top right) and BEX exhibition 2019(bottom center)

Developing the NP graduate – Big Hearted Professional

Through the opportunities presented through service-learning projects, PDI and SDE students have also developed one key outcomes for NP graduates - to be "big hearted professionals". Students have shown that they are more empathetic and able to manage design projects that are impactful and meaningful.

Student Feedback

"This experience has thrust me into "real life" and made me realize that I must always design with the intent to build. However, I need to have more empathy and think about the aesthetic quality of a building, not just ease of construction and material cost. In the future I must think that people will have to use my design and I need to think about how they would feel in the space. The soft qualities of designing a building are hard for myself to master."

Student
Trip participant 2016

Student Feedback

"It is a very different experience compared to studying in the classroom, ad is definitely an eye opener to learn more about other communities."

Student
Trip participant 2016

Fig 16: Student feedback

The experience curated by etc.lab also better prepares students to be designers/architects that are self-initiated and empathetic towards the community they serve. This can be seen in 2 examples where students who have graduated returned to Tasikmalaya where they had previously visited during a study trip to the village while they were still studying in SDE course, to help out with the construction of a kindergarten.

Figure 17: Sustainable Design & Environment (SDE) Students helping out with construction during their self-organised trip

Another initiative driven by DE from etc. lab was a donation drive for Lombok, Indonesia which was hit by an earthquake. Staff and students from etc. lab took the initiative to do a fundraising event which raise about S$22,000 that was used to supply basic food and resources for rebuilding purposes in the affected area.

Figure 18: Fundraising initiative driven by etc. lab garnered more than $22,000 in donations

Conclusions

As a design lab set up to provide our staff and students opportunities to work on real-world projects using design to effect social, economic, environmental change and transformation, etc. lab has demonstrated a responsiveness to changes in the local and global design industry. Since its inception, etc. lab has been influencing the curriculum, training and development for PDI and SDE students to ensure that they remain current and competitive in the changing design landscape.

Students themselves have also voiced their support of the programme which allowed them to develop professional skills and practices through these authentic projects with the community. This programme has not only provided students with opportunities to work on authentic projects and allow students to develop their professional competencies but also allowed students to develop a "big-hearted" mindset which is hallmark of an NP graduate.

References

Graham Gibbs, G. B. (1988). *Learning by doing: A guide to teaching and learning methods.* FEU.

Jones, P. H. (2013). *Design for Care: Innovating Healthcare Experience.* Toronto: Rosenfeld.

Singaplural. (2019, April). Singaplural. Retrieved from singaplural.

TOUCH Leadership & Mentoring. (2016). *https://www.touch.org.sg/docs/default-source/touch-services/tl-m/tl-m-s-l-brochure.pdf.* Retrieved from https://www.touch.org.sg.

Effect of PBL on Remote Controlled Robot Competition for Practical Engineering Education

T. Kato[*,a]

[a] Control and Information Systems Engineering,
National Institute of Technology (KOSEN) Kumamoto College, Kumamoto, Japan

*t.kato@kumamoto-nct.ac.jp

Abstract

The decline of the working population is a serious problem in Japan. Within this context, the National Institute of Technology (KOSEN) is required to educate effective engineers equipped not only with expert knowledge but also with independent mind and problem-solving skills. This study proposes a PBL (project-based learning) method for educating system engineers through remote controlled robot competition. Its educational effect will be examined by a student self-assessment survey and the evaluation of artifacts (student products) by expert academic staff. Results from the self-assessment questionnaire revealed that students felt that they had acquired expert knowledge, independence, and problem-solving skills through the experience. Working in teams, students developed original robot systems, indicating the effectiveness of the competition in fostering creativity, as well as the practical abilities to investigate and implement. technical elements. The robot competition required students to create remote controlled and camera equipped robots designed to break balloons. The task requires the incorporation of practical technology elements of system design such as hardware design, embedded programming, user interface creation, network construction, and so on. The target of this PBL program was fourth year students enrolled in the Control and Information Systems Engineering program. The duration of the program was about 5 months. While the self-assessment questionnaire items inquired the degree of achievement of learning goals defined by the KOSEN model core curriculum, the criteria for the evaluation of technical elements were developed by academic staff. The robot system that the student teams had created were each uniquely different. For example, one group built a system which allowed the controllers to share the video image taken by the camera loaded on the robot. Another group designed system with a launching structure which will allow the robot to break the balloon from a distance. The exchange of information through poster presentations after the competition also contributed to the enhancement of students' creativity. Results of the self-assessment questionnaire indicated that students felt that they had acquired new knowledge about robot design and technical elements, and had improved their team working problem-solving abilities in particular.

Keywords: *NIT (KOSEN), PBL, Project-based learning, Practical engineering, Robot competition, Problem-solving*

Introduction

The decline of the working population is a serious problem in Japan. So that, KOSEN is required to educate effective engineers equipped with autonomy. Especially, Some of KOSEN students belonging to robot contest club activity, ROBOCON, have gotten a high evaluation from many companies. Because they create new robot systems every year by only 4 or 5 months. This task requires not only high level engineering expertise but also autonomy.

This study proposes a project-based learning (PBL) method for educating system engineers through remote controlled robot competition which is looks like ROBOCON. Its educational effect will be examined by a student self-assessment survey and the evaluation of artifacts (student products) by expert academic staff. Results from the self-assessment questionnaire revealed that students felt that they had acquired expert knowledge, independence, and problem-solving skills through the experience. Working in teams, students developed original robot systems, indicating the effectiveness of the competition in fostering creativity, as well as the practical abilities to investigate and implement. technical elements.

PBL is conducted at various educational institutions and has shown a high educational effect. Koh and Chapman (2019) proposed one of teacher education program. Kaustar and Sarno (2019) presented the current development supportive tool for both lecturers and students that conduct PBL and Lab Based Education on Higher Education Institution. Shinde and Inamdar (2013) explained the importance of PBL in India.

The robot competition required students to create remote controlled and camera equipped robots designed to break balloons. The task requires the incorporation of practical technology elements of system design such as hardware design, embedded programming, user interface creation, network construction, and so on. The target of this PBL program was fourth year students of the Department of Control and Information Systems Engineering. The duration of the program was about 5 months. While the self-assessment questionnaire items inquired the degree of achievement of learning goals that are defined by the KOSEN model core curriculum, the criteria for the evaluation of technical elements were developed by academic staff.

Proposed robot competition PBL

The objective of this project is educating engineering expertise and autonomy through robot competition PBL which looks like ROBOCON activities. The contents must be included to experiments or classes, because not all of students have enough time to create robots after school.

Most of the experiments until 3rd-year students have been able to obtain some results if they follow the instructions. On the other hand, in graduation research that works in the 5th-year, there is no way of leading up to the correct answer, as it attempts to solve social and academic problems over the course of a year. Therefore, there is a big gap between the 3rd-year experiments and the graduation research.

The proposed robot competition PBL provides only fundamental information, such as usage of Raspberry Pi and Brickpi, and the network structure of the experimental room. Additionally, I introduced some of the important words of “Project management” at the start of the project. The overview of proposed robot competition is shown in Figure 1. This is one of first person shooter, FPS, game. The robots equip a camera, and the operators control the robots through laptop computers that are connected to local network. Students have to create the robot systems and control interfaces. These are both of hardware and software tasks. This is a system similar to robots that are active in society, such as rescue robots and planetary exploration robots. The robot competition PBL is conducted in a long-term experiment class for 4th-year student. And improvement process is included to educate autonomy, such as problem finding and solving sills, so that two times of competitions are held in this project. This is my policy that the improvement process is the most important for making things project. The effectiveness is evaluated through self-assessment questionnaire and students’ artifacts. Although it is necessary to design hardware in order to manufacture a robot, a wide range of knowledge such as motors and sensors, electric and electronic circuits for using them, batteries, strength of structures and materials, safety, etc. is required. On the other hand, since it is not easy to obtain such knowledge in a short period of time, in the creation experiment Raspberry Pi uses the interface board BrickPi which can use the parts of NXT and EV3 of LEGO, and the hardware of LEGO. As a result, hardware can be easily manufactured and corrected, and it becomes possible to experience the robot design efficiently and repeatedly.

Therefore, in robot development, not only the performance of a single robot, but also the steering interface for the pilot to exert their power is important. It is a task that demonstrates the essence of CI department students who have both hardware and software knowledge.

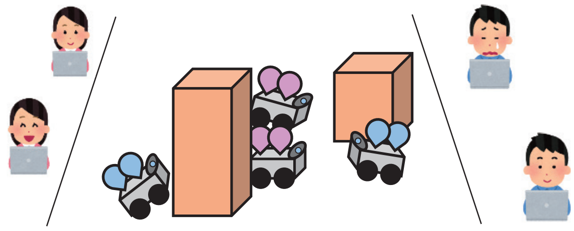


Figure 1 Overview of robot competition

Table 1 Schedule

Months	Contents
1	- Self-assessment questionnaire (Before) - Regulation announcement - Idea sheet submission
2	- Test run
3	- Competition (1) - Self-assessment questionnaire (Middle)
4	- Improvement - Competition (2) - Self-assessment questionnaire (After)

Evaluation

The proposed PBL program is evaluated by the quality of the robot itself and the remote control interface produced by the students, and the self-evaluation questionnaire. Table 2 shows the contents of the self-assessment questionnaire. This is created with reference to the achievement level table published in the model core curriculum developed by the National Institute of Technology.

Table 2 Contents of self-assessment questionnaire

Fundamental abilities	Mathematics
	Physics
	English
	Japanese
Technical abilities	Raspberry Pi
	BrickPi
	LAN
	Robot design
	Embedded programming
	Software design
	Programming
Personal generic skills	Identity
	Self-management
	Responsibility
	Teamwork
	Leadership
Comprehensive generic skills	Communication
	Consensus building
	Information collection
	Disseminate information
	Problem finding and Problem solving

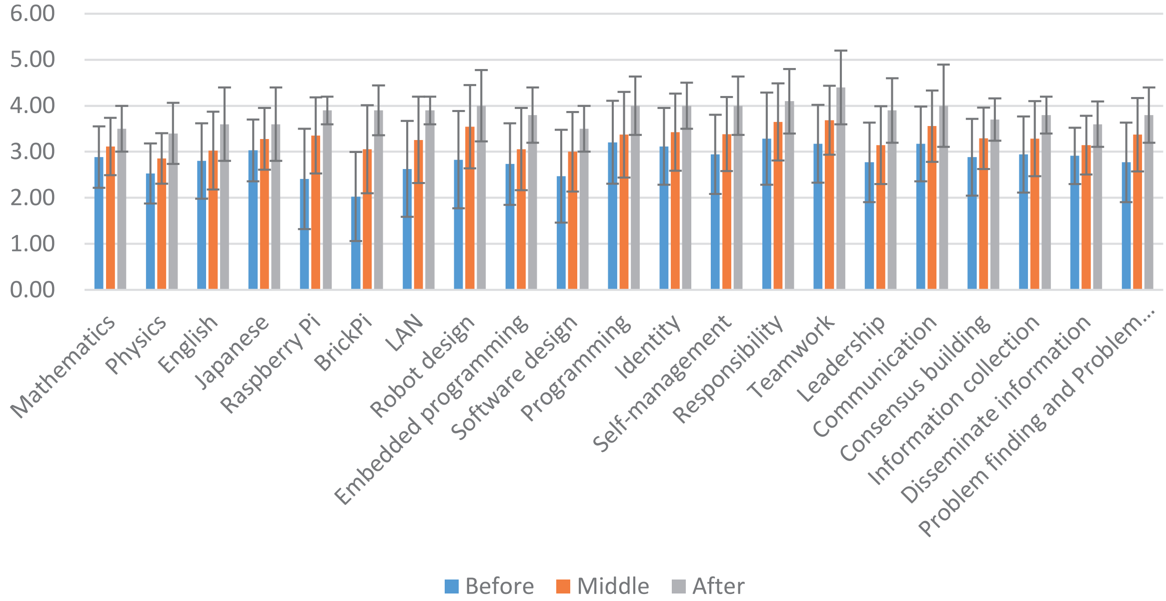


Figure 2 Result of self-assessment questionnaire

Results and discussions

Figure 2 shows the result of the self-assessment questionnaire. The blue, orange, and gray bars represent the value of "Before", "Middle", and "After". This result includes growth effect of their school life, because the term of this project is about 4 months. The contents of "Raspberry Pi", "BrickPi", "LAN", "Robot design" are not included for other classes and experiments. Especially, the growth of the gray bar shows the effect of the improvement process. Results of the self-assessment questionnaire indicated that students felt that they had acquired new knowledge about robot design and technical elements, and had improved their team working problem-solving abilities in particular. Figure 3 shows the example of robots that are the students' artifacts. The robot system that the student teams had created were each uniquely different. For example, one group built a system which allowed the controllers to share the video image taken by the camera loaded on the robot. Another group designed system with a launching structure which will allow the robot to break the balloon from a distance. The exchange of information through poster presentations after the competition also contributed to the enhancement of students' creativity.

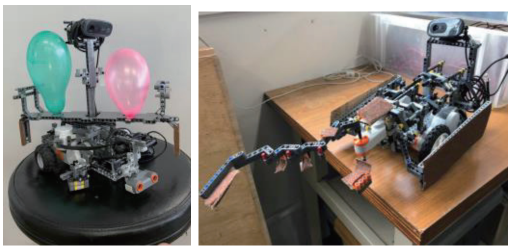


Figure 3 Example of artifact

Conclusions

In our school, we proposed PBL to foster students' independence through robot competition. As a result, the robot systems constructed by the students were unique and high quality in each team. The self-assessment questionnaire also showed that students felt their own growth on their own.

References

Koh, K., and Chapman, O. (2019). Problem-based learning, assessment literacy, mathematics knowledge, and competencies in teacher education. Papers on Postsecondary Learning and Teaching: Proceedings of the University of Calgary Conference on Postsecondary Learning and Teaching, 3,74-80

Kaustar, I. A., and Sarno, R. (2019). A Supportive Tool for Project Based Learning and Laboratory Based Education, International Journal on Advanced Science, Engineering and Information Technology, 2, 630 – 639

Shinde, V. V. and Inamdar, S. S. (2013). Problem Based Learning (PBL) for Engineering Education in India: Need and Recommendations, Wireless Personal Communications, 3, 1097 – 1105

USING LEARNING ANALYTICS TO ACHIEVE BETTER STUDENT LEARNING OUTCOMES IN BUSINESS STATISTICS

Eddie YEOU*,[a] and Ginno YONG [a]

[a] School of Business Management, Nanyang Polytechnic, Singapore
* eddie_yeou@nyp.edu.sg

Abstract

This research aims to evaluate if better learning outcomes in terms of student feedback and performance in the business statistics module can be achieved through learning analytics. Traditionally, lecturers teaching the business statistics module were only able to gauge the students' level of understanding by their performance in the mid-semester formative assessment. By that time, the scope of intervention by lecturers to help students improve was limited since the later topics of the module were built on their understanding of earlier topics. Students who were confused by earlier topics would find the later topics more difficult to understand. The deployed intervention used learning analytics and technology to uncover students' difficulties in concepts at a much earlier stage. This enabled the module lecturer to deliver just-in-time concept clarifications and explanations. Using this approach, the lecturer deployed a short questionnaire using Google Forms at the end of every lecture through which students keyed in their questions or comments on the lecture just covered using their smartphones. Data such as student admission number (for identification), student ratings on how much of the lecture (in %) they had understood and any question/comment they would want the lecturer to clarify were captured by the lecturer. By using descriptive analytics and data visualisation software such as Tableau, the lecturer would be able to identify the students who were facing difficulties, their main difficulties and questions for every lesson. The timely intervention by lecturers to address the students' difficulties improved students' understanding in the topics taught before the lessons progressed to the more difficult topics. In terms of results, the experimental group had performed better than the control group in terms of higher module average score and higher percentage of students who scored B and above. The experimental group also commented that the feedback channel and answers to their questions at the end of every lesson had been a good idea. In conclusion, educators could use learning analytics to deliver timely intervention and achieved better learning outcomes. The new approach also allowed educators to conduct curriculum review with ease as they were now informed of the areas or topics in their modules which students had the most difficulties through learning analytics.

Keywords: *Learning Analytics, Descriptive Analytics, Data Visualization*

Introduction

Business statistics is a module that trains students to solve problems using a systematic approach. The module imparts a lot of important skills to students such as complex problem solving, critical thinking and judgement & decision making (3 out of 10 skills required to thrive in the Fourth Industrial Revolution), as highlighted in the World Economic Forum's Future of Jobs Report 2018. Students generally find the module challenging due to the complicated calculations involved in the module topics, difficulty in the interpretation of the computed statistics and application of the statistical concepts to solve real-life business problems. The challenges are further exacerbated in a large-group lecture setting, which the lecturers generally do not have the means to know the extent which students have understood the lecture content just delivered nor the time for students to ask individual questions and clarify their doubts.

Traditionally, lecturers teaching the module were only able to gauge the students' level of understanding by their performance in the mid-semester formative assessment. By that time, the scope of intervention by lecturers to help students improve was limited since the later topics of the module were built on their understanding of earlier topics. Students who were confused by earlier topics would find the later topics more difficult to understand. In short, business statistics lecturers in a large-group lecture setting would need an effective mechanism to capture students' feedback and questions on their learning immediately, analyze the feedback quickly so that they could deliver just-in-time clarifications and answers to students' questions before their problems snowballed.

The study aimed to evaluate if learning analytics could provide an effective mechanism to capture and analyze student feedback promptly and facilitate just-in-time intervention and assistance by lecturers to clarify students' difficulties and questions, through which better learning outcomes in terms of student feedback and performance in the business statistics module could be achieved.

Literature Review

Learning analytics is defined as the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs (Ferguson, 2012). (Pardo, 2014) suggested 5 main phases of work that educators involved in learning analytics design should undertake: 1. Data capture; 2. Reporting through data visualizations; 3. Prediction to provide answers to previously formulated questions; 4. Actions to change learning activities; and 5. Constant refinement of the above phases. As the focus of the current intervention was to provide an effective mechanism to capture and analyze student feedback promptly to facilitate just-in-time intervention and assistance by lecturers, the phases particularly important were 1. Data capture; 2. Reporting through data visualizations and 4. Actions to change learning activities. Thus, the current research would focus on capturing student feedback on their learning during lectures, descriptive analytics and data visualization to analyze student degree of understanding of the lecture content and timely intervention and assistance by lecturers to clarify students' difficulties and questions.

In descriptive analytics and data visualization, Elias (2011) identified the digital analytics dashboard as a critical tool for instructors to perform pedagogical evaluation and improvement due to its ability to package and present a large amount of information to facilitate instructors' understanding and decision-making.

In terms of what to include in the learning analytics dashboards, Verbert et al. (2014) found that students preferred learner dashboards that tracked more metrics to present a more comprehensive description of their learning activities and descriptive analytics by data visualizations to provide insights on their learning. The study also found that student-produced artefacts (such as blogs, forum, responses to questions, help requests) were the most commonly tracked learner metrics across a wide range of learner dashboards.

In terms of how to present information in the learning analytics dashboards, Charleer et al. (2016) and Wise et al. (2016) recommended the use of learning analytics dashboards to provide concise overview information of useful learning metrics, with features to drill into the overview for details in the data that are helpful for both instructors and learners. The studies also recommended the student dashboards to include the mean activity scores of the cohort as students found it useful to be able to make comparisons with peers and used the comparisons for self-reflection and guidance in their learning activities.

Methodology

Based on the results and suggestions by the studies above, a learning analytics intervention approach was adopted in the teaching of 2 lecture groups (the experimental group) in the BM3034 business statistics module in 2018 semester 2. The results obtained from the experimental group in terms of student performance and feedback would be compared with that from 2 other lecture groups (the control group) to evaluate if the better student learning outcomes could be achieved through the learning analytics intervention approach.

BM3034 business statistics module is a 60-hour compulsory core module for all year-one business students from the School of Business Management (SBM), Nanyang Polytechnic. The experimental group comprised 171 year-one Diploma of Business Management students from 2 randomly assigned lecture groups who took the module in 2018 semester 2. The control group comprised 162 year-one Diploma in Business Management students from 2 other lecture groups who took the same module in 2018 semester 2. The lecture groups were randomly assigned to be the experimental and the control groups respectively and all 4 groups were taught by the same lecturer. The 2 groups of students were homogenous across characteristics such as gender, age and mathematical abilities. (All students must obtain at least a GCE 'O' levels C6 grade in mathematics, or a GCE 'N' levels B4 grade in mathematics and a pass in mathematics in foundational bridging programmes.) The module materials (lecture notes and examples as well as tutorial questions and practice) were the same for both groups.

Only the experimental group was taught using the learning analytics intervention approach while the control group was taught without learning analytics intervention.

Under the learning analytics intervention approach, for data capture, the lecturer deployed a compulsory short questionnaire using Google Forms at the end of every lecture through which students keyed in their feedback and questions on the lecture just delivered using their smartphones. Data such as student admission number and class (for identification purpose); student ratings on how much of the lecture content they had understood (in %); thoughts and feelings on the lecture just delivered (using key adjectives such as easy, difficult clear, confusing, interesting, boring, helpful, ineffective); and any specific question(s) they would want the lecturer to clarify were captured by the lecturer.

For data analysis and reporting, the lecturer used descriptive analytics, text analytics by word cloud and data visualization software such as Tableau to analyze the data captured efficiently. For data items such as students' degree of understanding of the lecture content, the lecturer used the Tableau software to visualize individual student's understanding vis-à-vis the experimental group's average understanding to monitor individual students progress in understanding vis-à-vis the group's average understanding across weeks and lecture topics. The lecturer also used the software to filter out the students who indicated weak understanding across the lecture topics consistently to arrange remedial lessons for these students before the final exam. For data items such as students' thoughts and feelings on the lecture just delivered, the lecturer used text analytics software (word cloud) to capture the top 5 student sentiments (top 5 adjectives used by students) for every lecture across the weeks and the lecture topics. Individual student's sentiments as well as the top 5 student sentiments for every lecture were captured by the system.

For intervention actions, before delivering the lecture on a new topic, the lecturer would answer all the questions posted by the students in the previous lecture and clarify any doubts posted by students. A student dashboard was created to track individual student's progress in their understanding of lecture content vis-à-vis group's average understanding across weeks and lecture topics. Individual student's sentiments as well as the top 5 student sentiments for every lecture across weeks and lecture topics were also tracked in the dashboard. The output of individual student's dashboard was e-mailed to each student at the mid-semester to provide feedback to them on their progress in the module so far for their self-monitoring and reflection. The student dashboard also helped the lecturer to filter out weaker performing students to arrange for special remedial lessons to help these students before the final exam.

A lecturer dashboard was also created to allow the lecturer to track students' average understanding and top student sentiments across weeks and lecture topics. This provided useful feedback to the lecturer to highlight the lessons or topics which students found most challenging and difficult to facilitate curriculum review and/or teaching pedagogical review and enhancement by the lecturer.

A comparison between the learning analytics intervention approach (used for the experimental group) and the approach without learning analytics intervention (used for the control group) was shown in table 1 below.

Table 1. Learning Analytics Intervention Vs Approach Without Learning Analytics Intervention for Lectures

Learning Analytics Intervention Approach	**Approach Without Learning Analytics Intervention**
1. <u>Data Capture</u> Compulsory feedback by students on their degree of understanding, sentiments and specific questions on the lecture content captured for every lecture.	1. <u>Data Capture</u> Feedback on students' understanding only available after the mid-semester formative assessment.
2. <u>Data Analysis and Reporting</u> Individual student's understanding and sentiments vis-à-vis the experimental group's average understanding and group's sentiments for every lecture promptly analyzed by descriptive analytics using Tableau and text analytics by word cloud.	2. <u>Data Analysis and Reporting</u> Analysis of individual student's understanding delayed and only available after the mid-semester formative assessment.
3. <u>Intervention action</u> Just-in-time intervention by lecturers to answer students' questions and clarify their doubts from the previous lesson before their problems snowballed.	3. <u>Intervention action</u> Delayed intervention by lecturers after the mid-semester formative assessment.

Results

The module performance (average mark and percentage of students who scored B and above for the module) of the experimental group was compared with the control group. The experimental group had performed better as compared to the control group. 42.1% of the students in the experimental group had scored B and above for the module, compared to 40.1% of students in the control group. The overall average mark scored by students in the experimental group was also higher at 63.3 marks compared to 62.9 marks for students in the control group.

Based on the compulsory end-of-semester feedback data collected from all students taking the module in the semester (measured on a 4-point ordinal scale: 1-Strongly Disagree, 2-Disagree, 3-Agree, 4-Strongly Agree), there was slightly better feedback from students in the experimental group, compared to students in the control group, that the lecturer had taught the lectures well and explained the module content clearly.

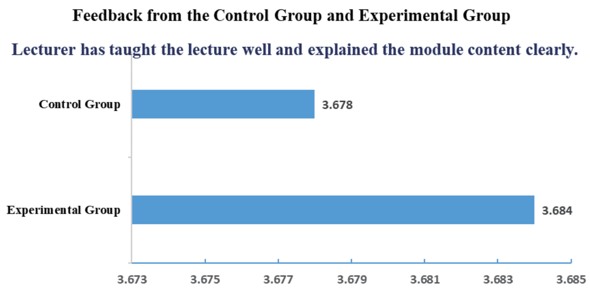


Figure 1. Comparison of Semester Feedback Score between the control group and the experimental group.

Students in the experimental group also provided qualitative comments that they had found the just-in-time learning analytics intervention approach to be very helpful in addressing their difficulties and questions promptly before their difficulties escalated.

Discussion

Based on the comparison of the module performance and feedback by students from the experimental and control groups, the learning analytics intervention approach had proved to be a more effective teaching pedagogy as compared to one without learning analytics intervention. The new approach was more proactive in soliciting student feedback on their understanding and sentiments for every lesson, which was especially useful in a large-group lecture setting. Technology, data visualization and text analytics allowed the lecturer to analyze the data collected promptly to provide useful insights on the effectiveness of the teaching in every lesson. The timely feedback also allowed the lecturer to provide just-in-time concept clarifications and addressed students' difficulties from their previous lessons immediately before their problems snowballed. The dashboard feedback for individual student on his/her progress vis-à-vis the experimental group's progress in the module at the mid-semester benchmark allowed students to self-reflect and provided enough time for them to improve or seek help should the need arose.

The lecturer dashboard also provided useful insights to the lecturer on where the student difficulties were and what could be done to ease student pain points and problems. This enabled lecturers to conduct curriculum review and/or teaching pedagogical review and enhancement with ease based on the analytics. The improved understanding of the module topics by students through the lecturers' just-in-time concept clarifications had translated into better module performance and feedback by students from the experimental group.

Conclusion

Learning analytics can provide effective ways to enhance module delivery as seen in the study above. To design and deliver engaging and effective learning experiences for students, educators require constant and up-to-date feedback from their students to inform them where and how to improve. Technology and advancement in learning analytics techniques have facilitated the analysis of students' feedback and thereby provided educators better and up-to-date insights on where and how to fine-tune their pedagogies and interventions to achieve better learning outcomes. It is therefore important for educators to be open to kick-start and try out any relevant learning analytics technique to uncover any useful insights on their modules and teaching to design better teaching and learning experiences both for themselves and their students.

References

Charleer, S., Klerkx, J., Duval, E., De Laet, T., & Verbert, K. (2016). Creating effective learning analytics dashboards: lessons learnt. *Adaptive and Adaptable Learning, 9891,* 42-56.

Elias, T. (2011). Learning analytics. *Learning,* 1-22.

Ferguson, R. (2012). Learning analytics: drivers, developments and challenges. *International Journal of Technology Enhanced Learning, 4(5/6),* 304-317.

Pardo, A. (2014). Designing learning analytics experiences. In *Learning analytics* (pp. 15-38). Springer, New York, NY.

Verbert, K., Govaerts, S., Duval, E., Santos, J. L., Assche, F., Parra, G., & Klerkx, J. (2014). Learning dashboards: an overview and future research opportunities. *Personal and Ubiquitous Computing*, *18*(6), 1499-1514.

Wise, A. F., Vytasek, J. M., Hausknecht, S., & Zhao, Y. (2016). Developing Learning Analytics Design Knowledge in the" Middle Space": The Student Tuning Model and Align Design Framework for Learning Analytics Use. *Online Learning*, *20*(2), 155-182.

World Economic Forum. (2018). The future of jobs report 2018. World Economic Forum, Geneva, Switzerland.

DEVELOPMENT OF ESD STUDENT-CENTERED DELIVERY CLASS

Y. Nishii[*,a] and S. Kuwata[a]

[a] Department of Applied Chemistry and Biotechnology, National Institute of Technology, Niihama College, Niihama, Japan

*nishii@chem.niihama-nct.ac.jp

Abstract

It is effective for students to learn social skills outside school. Also the experience of teaching is the best way to learn something and use the acquirements effectively. In this class (DeMaE class), students become teachers and do experiments regarding with science to let elementary or junior high school students interested in science. Furthermore, students become facilitators and do workshop regarding with SDGs to let them learn about sustainable development. Before doing the class, they also revise the content of the class to make DeMaE class better. Throughout all this DeMaE activity, they can improve not only skills of communication and presentation, but also the ability to manage to deal with the sudden happenings at the cite and obtain the knowledge of SDGs. In addition, they make team including 4 to 5 people to do DeMaE class, which creates teamwork during activity. For local schools, there are a lot of merits as well. "Student teachers" can help school teachers to make spare time by doing the class as a substitute. Student teachers are familiar with elementary or junior high school students because of near age to enhance understanding of the content of the class.

All elementary and junior high schools in Niihama city are UNESCO schools. They are enthusiastically doing SDGs activities, like environmental education, clothes and PET bottle recycling, the Olympic medal making project from waste, disaster prevention, volunteer in nursing home, human rights lecture and so on. Our students can develop new ESD delivery classes by collaborating with these activities in local schools. Thus DeMaE class is strongly related with local education and can also contribute to local education.

In 2017 and 2018 DeMaE classes were held total 57 times and students participated about 300 persons. Fifteen new DeMaE themes were made and all of them were regarding with SGDs. From the results of self evaluation in DeMaE activity by students, it was clear that DeMaE class is the efficient method to foster social skills.

Keywords: *ESD, SDGs, student-centered, delivery class, outside school, communication, presentation, facilitator, teacher*

Introduction

<Student-centered delivery class>

To learn social basic skills, student-centered delivery class has been conducted for more than 10 years. Our students (Kosen students) preside the class, become lecturers and instruct experiments in the class. It is effective to learn the above skills that the students make presentation in front of the class and teach and communicate with elementary and junior high school (E-JH as abbr.) student. In addition, doing such kind of activity outside school is good for Kosen students. At outside school nobody can help them and they need the dealing skill with the problems in the cite more. We call this kind of delivery class as "DeMaE".

<Making DeMaE related with ESD>

In 2017 "Fostering local next generation's engineers based on social implementation education" by Kosen initiative 4.0 research fund launched. As one of the three sections, ESD-DeMaE was set for fostering social basic skills in lower grade. Here, ESD stands for Education of Sustainable Development. In this class, concept of ESD was put into the former DeMaE. The aims of ESD-DeMaE is that E-JH students learn SDGs and Kosen students also learn SDGs through making and doing ESD-DeMaE.

In fact, all E-JH schools were accredited as UNESCO school in 2017, where student can learn based on ESD. By collaborating with those schools, we have been developing ESD-DeMaE for two years. In this paper, those activities are reported.

Methodology

<Collaborating system>

To proceed ESD-DeMaE, the collaborating system between E-JH schools and Kosen was constructed as shown in Figure 1. By electing a coordinator from a retired principal, he played a bridge role between E-JH and Kosen. The seeds of ESD from Kosen were proposed to E-JH teachers and the needs from E-JH were received. He also arranged us to attend to ESD meeting in Niihama city board of education, making opportunity to exchange opinions for DeMaE. After doing DeMaE to E-JH schools, we received feedback by questionnaire for improvement.

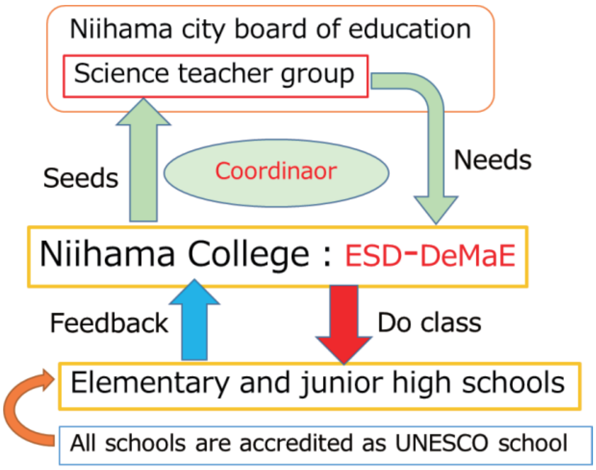


Figure 1 Collaborating system

<Needs survey>

Hearing to E-JH teachers was conducted through the coordinator in order to gather needs in 2017. I visited three E-JH schools and interviewed to science teachers.

<Preparation flowchart of ESD-DeMaE>

According to the following procedure, ESD-DeMaE was prepared.

①E-JH teacher offers DeMaE to Kosen on Website.
②Kosen teacher recruits students to participate DeMaE.
③Kosen students learn SDGs related with DeMaE theme.
④Students make presentation by their ideas.
⑤Improve and modify by Kosen teacher
⑥Rehearsal
⑦Do ESD-DeMaE

As teacher's roles, select students (above ②), provide SDGs materials and information and place to study (③), give advice to improve and modify presentation (⑤, ⑥), help at the cite if any big trouble happens. Average time to make new DeMaE is 3-6 days.

Photo 1 making presentation Photo 2 advice to modify

Results and Discussion

<Needs survey>

The opinions from E-JH teachers are listed as follows,

・*Ideas to know DeMaE widely*

Kosen should make more opportunity for E-JH teachers to know DeMaE. For example, to distribute DeMaE brochure at a large E-JH meeting and introduce it. To improve DeMaE homepage.

・*Improvement of DeMaE brochure*

The coordinator advised to improve DeMaE brochure from the view point of E-JH teacher. New brochure showed the relationship between E-JH's field in text and DeMaE theme clearly. SDGs logos were pasted on brochure to show the relations clearly.

field→

SDGs→ *logo*

Figure 2 Example of DeMaE brochure

・*Making new themes*

E-JH teachers offered to make DeMaE related with disaster prevention, earthquake, fuel cell, clean energy, programming and so on. Table 1 shows the lists of new theme made in 2017 and 2018.

Table 1 New themes in 2017 and 2018

2017 (5 themes)	2018 (10 themes)
Programming for beginners	Ethical fashion
Programming study 2	Save the earth by our action
Programming study 3	What is better aid and support?
Programming with SCRATCH	Let's think about world education
Fair trade	Let's see the world cuisine
	If the world were a village of 100 people
	Job for women engineers
	Problem solving using programming with MESH
	Problem solving using programming (energy efficiency)

・*The improvement of present themes*

For themes of "Experiment with liquid nitrogen" and "Experiment with force of air", the additional presentation was made to show the relationship between SDGs and its theme. For “Wind generation, mechanism of generation” and “Handmade cells”, the lecture from view points of environmental and use in disasters was added.

<List of DeMaE conducted>
In 2017 and 2018, 21 and 37 DeMaEs were conducted respectively

Table 3 DeMaE conducted in 2017

Theme in 2017	times
Wind generation ~clean energy~	1
Experiment with liquid nitrogen	4
Handmade cells using kitchen stuff	3
Experiment with force of air	3
Experiment with LED	1
Mechanism of generation ~electricity and magnet~	1
Programming with SCRATCH	1
Programming study	3
Responsible for consumption and production (ESD type)	4
	21

Table 4 DeMaE conducted in 2018

Theme in 2018	times
Experiment with liquid nitrogen	7
Handmade cells using kitchen stuff	5
Recycle paper making	1
Easy Programming	1
Programming using tablet PC	1
Responsible for consumption and production (ESD type) ~Indonesia issue~	1
Wind generation ~clean energy~	1
Experiment with LED	1
Experiment with force of air	1
Ethical fashion and SDGs	1
Experiment with atmospheric pressure	6
Programming study 2	1
Mechanism of generation ~electricity and magnet~	4
Observation of microbe by digital microscope	3
Experiment with conductor and insulator	3
	37

<Examples of DeMaE>
Table 5 shows typical time schedule of DeMaE. Middle period (10-20, 20-40) can be changeable depending on the content of theme.

Table 5 Typical time schedule of DeMaE

min	typical content
0-10	Self introduction and Ice break
10-20	Experiment or lecture in front of class
20-40	Team experiment or discussion
40-45	Share results and opinions to class

Theme “Responsible consumption and production”

Firstly samples of chocolate and coffee beans are distributed to each group. E-JH students look at them carefully and try to find the difference from ordinary ones. Kosen students facilitate discussion and make them notice the mark of fair trade. After sharing opinions in group, E-JH students give presentation to the class. Then, they learn the relationship between coffee price and child labor. They summarize “what you learned and what you can do for that” individually, then share ideas in group and class.

Photo 3 Let’s find fair trade mark!

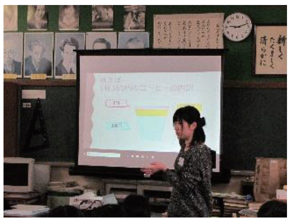


Photo 4 lecture by student Photo 5 Share ideas in group

Theme “Ethical consumption”

・*Indonesia quiz*
This quiz is to find the relationship among 7 photos, 7 items and 7 explanation cards about Indonesia. E-JH students can learn how Japan relates with Indonesia and the environmental problem there.

Photo 6 Items and cards about Indonesia

Photo 7
SDGs related with the quiz

Photo 8
Let's match items, photos and cards

・*Ethical fashion*

E-JH students learn about what is ethical consumption and how to act. Also they understand how useful and important for sustainable development it is. They propose realistic action in group, "What you can do today".

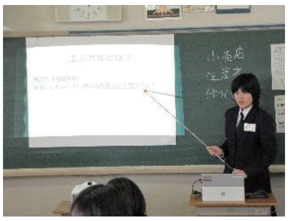


Photo 9
What is ethical consumption?

Photo 10
Propose "What you can do today"

<Questionnaire for E-JH students>

E-JH students evaluated DeMaE for 4 levels, very good, good, not very good, not good. In 2018, 99 % of 552 students answered positively. This indicates the high satisfactory to DeMaE and good quality of contents.

Comments from questionnaire

"We can make presentation and discussion a lot. That was good. The society of sustainable development can be made by our contributions. So, I swear to buy something with ethical mindset".

"I could have confidence to my own opinion because Kosen students respected our opinions during discussion. It was first time to know fair trade mark on items. I was surprised that employee's salary is incredibly low, which results in unfair price of items".

"Through studying ethical fashion, I realize that fair trade is very important in order to reduce the inequity on earth".

"I learned the method to create society for sustainable development and various problems in the world"

"It was good opportunity to think about the present earth again and how to live from now on"

From the above comments, it is clear that E-JH students learn SDGs deeply.

<Self evaluation for Kosen students>

Self evaluation by Kosen students (about 150) was taken for following 10 terms in 2018.

Table 6 List of self evaluation terms

	Evaluation terms
1	Active attitude
2	Responsibility to society
3	Contribution to society
4	Communicative skill
5	Team work skill
6	Technical and presentation skills
7	Creativity
8	Problem proposal and solving
9	Problem dealing skill in the cite
10	Learn SDGs

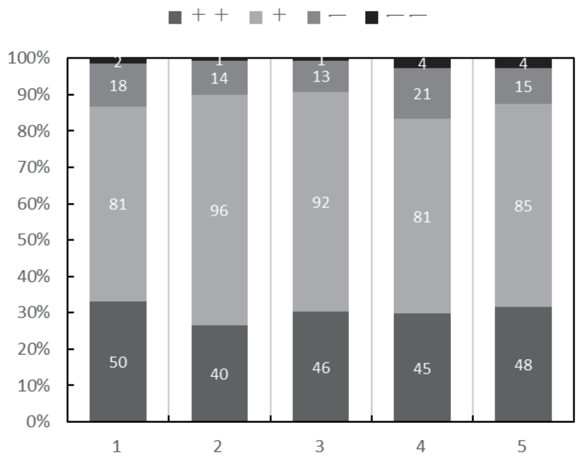


Figure 3 Results for terms 1-5

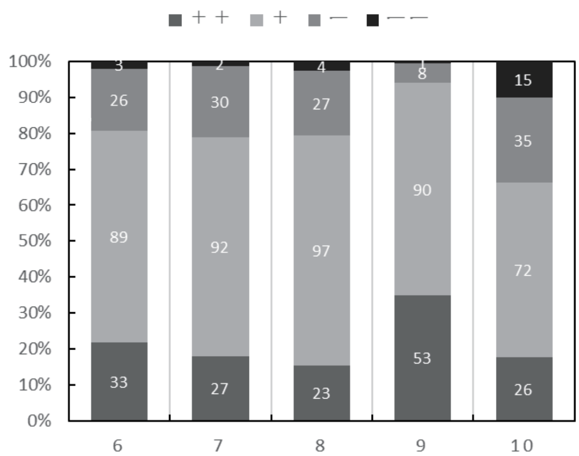


Figure 4 Results for terms 6-10

For terms of 1, 2, 3, more than 85% Kosen students answered positively. Many students understood good attitudes to tackle the problem and meanings of DeMaE. Terms of 4, 6 had more than 80% favorite answers. They felt the importance of presentation and communicative skills. Terms of 5, 7, 8 indicate the exertion of that skills in DeMaE activity. In term of 9, more than 95% students answered positively, and they evaluated themselves that they felt the problem dealing skill in the cite is very important, and could get such ability through DeMaE activity. Only 65 % students took favorite answer in term 10. Some students could not understand the relations with SDGs depending on some DeMaE themes. We should show the relation between SDGs and DeMaE theme clearly to Kosen students.

Comments

Common comments for Kosen students from 5 different majors were "To teach something to E-JH students, I should understand it deeply and need to prepare to the class well" and "It was tough for me to teach to Elementary students who have less knowledge and I felt importance of communicative skill". This indicates DeMaE contributes Kosen students to foster various kind of skills.

Followings are the students' individual comments

Student K : "Theme I conducted was about ethical consumption. When I started to prepare DeMaE, I didn't know about it and SDGs at all. So, I learned a lot not only when I conducted DeMaE but also the preparation period. At the DeMaE day, I felt that talking with JH student at first sight was exciting and playing DeMaE teacher role was fresh and stimulus".

Student M : "When I heard I have to do DeMaE about ethical fashion instead of experimental type DeMaE, I was so surprised and I don't know how to do that. It was hard to make presentation and practice by ourselves, but after DeMaE I felt it was good experience for me because JH students became interested in it."

Student I : "Because I participated from editing ESD-DeMaE materials, I could consider to JH students to understand SDGs easily. I could enhance creativity by thinking about JH students' ability when making DeMaE. At the DeMaE day, it was good experience for me that it was tough to communicate with JH students at my table."

Student H : "I learned the difficulty of teaching to others. To teach others something, I have to understand it deeply. So I studied SDGs more deeply. By making good atmosphere, I could spur many opinions from JH students."

Conclusions and in the future

By collaborating E-JH schools through a coordinator, we could know needs from E-JH schools. Utilizing those needs, we created 15 new DeMaE themes in 2 years. Also DeMaE brochure and homepage were improved by showing the relationship between SDGs and themes. For Kosen students, they got a lot of skills by doing DeMaE activity. They exerted presentation and communicative skills and especially learned problem dealing skill in the cite. All of results of self evaluation indicate that ESD-DeMaE is effective opportunity to learn social basic skills.

We would like to export this DeMaE format to oversees and collaborate with poly-technical colleges and universities in the future. Since our Kosen concludes an academic exchange agreements with them, we are planning to try ESD-DeMaE in National United University in Taiwan and Southern Cross University in Australia with their students as lecturers.

Acknowledgements

Our project was aided by Kosen Initiative 4.0 research fund in National Institute of Technology (Kosen), Japan.

References

Beppu, T., Hara, M., Minoda, A., Asada, J., Tanabe, K. and Kouda, N. (2017). Problem based learning for improving students' engineering design ability. *Journal of Japanese Society of Engineering Education*, 65-1, 32-39

Ishida, K., Horiuchi, H., Haramiishi, Y., Furuya, N. and Ohuchi, H. (2016). Evaluations of educational effect on the development of an interdepartmental education program for PBL creative design and manufacturing. *Journal of Japanese Society of Engineering Education*, 64-5, 34-39

Ito, T. and Oyama, A. (2006). Efforts of Creative Improvement on Creativity Education, *Journal of Japanese Society of Engineering Education*, 54-2, 9-14.

Hasegawa, H., Yamaguchi, T., Ohta, A. and Maki, T. (2005). Problem-Based Learning in the Laboratory Course in Physical, Inorganic, and Analytical Chemistry. *Journal of Japanese Society of Engineering Education*, 53-1, 105-108.

Honda, M. (2005). Approach to the Problem-Based Learning in the Experiment in Organic Chemistry. *Journal of Japanese Society of Engineering Education*, 53-1, 100-104.

Kawashita, T., Fukuda, T., Shimono, T., Nambu, Y., Morishita, K. and Matsuo, S. (2005). The trial of Integrating Students with Different Specialized Fields in Problem-Based Learning Activities at Advanced Engineering Corse of College of Technology. *Journal of Japanese Society of Engineering Education*, 53-6, 63-68.

Kiriyama, S., Konishi, M. and Hanabusa, T. (2006). The measurement of Abilities Needed for Planning in PBL.

Journal of Japanese Society of Engineering Education, 54-2, 110-115.

Kudo, K. (2016). Report on the working group of studying the methods to introduce education fostering generic skills into curriculums. *Journal of Japanese Society of Engineering Education*, 64-6, 142-145

Morimoto, J. and Mizuno, T. et. al. (2019). Education of university student stuff members through implementation of a regional vitalization event, *Journal of Japanese Society of Engineering Education*, 67-3, 8-13.

Nagashima, M., Kondo, Y., Tanaka, H., Miyachika, K., Akiyama, M., Ishibuchi, N. and Hayakawa, M. (2006). Practice and Educational Effect of a Project Based Learning Program Collaborated with Local Enterprises. *Journal of Japanese Society of Engineering Education*, 54-2, 87-91.

Ohta, Y., Haga, M., Fujita, K., Kawamoto, A., Nomura, Y., Tsuda, Y. and Tsujino, K. (2006). A trial of the Educational Method for Attaching Improvement to the Originality and Creativity in the Lower Graders. *Journal of Japanese Society of Engineering Education*, 54-2, 15-20.

Shoji, R. and Suzuki, M. (2019). A case study of social implementation education in chemistry field in Kosen – Winning prize of social implementation education at the forum 2018-, *Journal of Japanese Society of Engineering Education*, 67-2, 92-94.

Takemata, K., Matsuishi, M., Matsumoto, S., Furukawa, T. and Yamakawa, T. (2006). Creative Engineering Education in Collaboration with Community. *Journal of Japanese Society of Engineering Education*, 54-2, 81-86.

Tamura, K. (2004). The present conditions and a future problem of science learning support in our area for a primary schoolchild and a junior high student, *Journal of Japanese Society of Engineering Education*, 52-1, 104-108.

Tateno, T. and Yang, M. (2006). Practice and Effects of Project-based Learning Class for New Product and Project Design with Research Activity. *Journal of Japanese Society of Engineering Education*, 54-2, 76-80.

Tsuda, Y., Nakashima, H., Tsuji, Y., Watanabe, K. and Ooka, H. (2005). The Beginning Lecture and the Improvement of "Experiments in Innovative Chemistry" as an Entry Subjects at the Department of Biotechnology and Applied Chemistry in National College of Technology. *Journal of Japanese Society of Engineering Education*, 53-6, 58-62.

Yasuno, T and Kamano, T. (2006). A Challenge to Environmental Making for Positively and Continuous Learning in Engineering Design Education. *Journal of Japanese Society of Engineering Education*, 54-2, 92-97.

COLLABORATIVE PARTNERSHIP WITH STUDENTS FOR EFFECTIVE ENGINEERING SERVICE LEARNING PROJECTS

Andrew Kor Seng Giap

Temasek Polytechnic, School of Engineering, Singapore

senggiap@tp.edu.sg

Abstract

The paper introduces an educational approach to encourage and motivate students to go on overseas community service learning project in Temasek Polytechnic. It is based on a collaborative partnership between the school and the students doing the overseas' service learning project where it is important for them to understand and meet the school's expectations. These expectations include having their hearts' desire to serve the community by adding values to enhance their livings and their environments; understanding the key learning areas and its contribution to the community and the world, making appropriate decision to resolve problems encountered. 10 key elements for the change was adopted forming part of the learning outcome together with the support given through the engineering curriculum in various engineering courses. The change lays the path toward a more student-centred approach to learning and contributing to the community. The objective of the service learning project for students is to enhance the related performance indicator for the students' mastery of engineering knowledge using the skills in solving the real world practical problems. Many engineering service learning projects with similar performance indicators have been designed and implemented, such as the final year projects, students' industry internships and project-based assignments within the curriculum. However, they have shortcomings that need to be solved by different approaches in learning for students pursuing different engineering courses. The proposed method is to bridge the gap sealing any missing learning objectives, partially resulting from a lack of knowledge and readiness to approach the real world for solving problem. Study of these concerns results in adopting the 10 key elements for change yielding towards effective communication of project details among staff, students and the overseas host of the project. It encompasses the project implementation and proper dissemination of project problem solving, calling for solutions to students coming from the various engineering courses and meeting school and students' expectations. With such adoption, it can help the students learning better and the school determining effective outcome of the engaged learning environment. Based on various designed engineering course curriculum, students use their knowledge and skill during the course of their study to fulfil the learning benchmark including the deployment of engineering applications in the real world, both locally and overseas. A group of more than 20 engineering students who went on a 2 week's overseas engineering service learning project, building a library for the orphanage centre in Myanmar, was evaluated after adopting the 10 key elements for change. Results and outcome showed positive and encouraging improvements in terms of their behaviour and attitude towards their contributions in the project. This further encourages the staff to wanting to provide more project opportunities for other students in Temasek Polytechnic. The PMI's PMBOK – Project Management Institute's Body of Knowledge guidelines was used for this finding.

Keywords: *Safety, Purpose, Autonomy, Connectedness, Expertise, Trust, Heart, Edification, Integrity, Niche*

Introduction

There are various ways of managing team of students embarking on overseas community project. The success of the overseas community project and its outcome will depend on the learning behaviour of the students and the expectations among themselves; and how both the school and students can collaborate contributing towards its success. In Temasek Polytechnic, students who are feeling hungry for learning acquire their knowledge learning from classroom to apply the value-added aspects in the community both doing projects locally and overseas. Formation of the students' team and understanding of their roles working in the team can effectively contribute to the success throughout the service learning journey. We hope that many students are encouraged and motivated to learn by adopting these 10 key elements during their overseas exposures.

Before students participate in the overseas community project in Temasek Polytechnic, the team objective in mind is to build up the values of student's learning by preparing them and keeping them informed of the important knowledge and requirements in advance. The 10 key elements for change was adopted after many rounds of organizing overseas service learning trips in the past involving the students. The intention was to have many students and staff to benefit and add values to themselves from the various trip activities. The team wanted a learning culture that can move towards effective escalating and transforming students. We share the adopted learning experience and the changed culture we experienced so that many others can find them useful in their work.

Materials and Methods or pedagogy

Based on Alexandra Cote (2018) citing the different types of project management methods, the plan to encourage and motivate student learning skills in our engineering service learning project has adopted using the guide from PMI's PMBOK – Project Management Institute's Body of Knowledge. Structural guideline was followed by the team before and during the implementation of the service learning project. The Initial meetings and discussions with the overseas partnership team provided the first important step for us to ensure securing the resources, its project details and the viability of the project's concept aligning with the objectives for the benefit of our students contributing to the community. Good connection and networking relationship with the overseas partner is very important to justify a feasible, scalable, projected long term collaboration, the safety and purpose of the project relevant to the engineering fields. To ensure relevant requirements are accountable for, a pre-assessment trip and a reconnaissance was conducted by the staff involved to determine the practicality of the project and its working environment overseas. The details required in the planning and budgeting stages were considered in the next agenda of the PMBOK's requirement. The students were recruited through interviews to ensure that those interested in the project understood and knew their expectations and requirements for the project. Training based on the needs of the project were identified and training was conducted for them. The 10 key elements for change will be discussed next on how students in the team are instructed to carry out the service learning task.

The motivation that has given to our team to develop the 10 key elements for change was when we saw the challenging learning experience faced by our students. Hence, we wanted to find an improved and effective solution to overcome the challenges. Some of these challenges include the lack of learning values due to behavioural related matter of students, mismatch of expectation between the school and the students, lack of motivation and the lack of sharing and adding values to other students. After a thorough discussion with a team of staff and students, we analyzed and thus, the 10 key elements for change were introduced. They are safety, purpose, autonomy, connectedness, expertise, trust, heartfelt, edification, integrity and niche strength. The details of these points are explained and elaborated to facilitate our sharing experience in the engineering service learning projects involving students.

1. According to Dan, W. G. & Jack, B. N. (2013), there are challenges in the deficient safety learning environment for the environmental safety signals are reliable indicators so that treat will not occur, and thus relieve individuals from a state of anticipatory anxiety. The most important aspect to creating a community project overseas is a safe and healthy learning environment, so that students taking part in the project can do and get along well, can enjoy and celebrate the success of the project together in the team. They can get motivated and contribute selflessly toward the society much more. Safety is the key aspect of everything in the learning environment. A safe working environment bring forth values in learning and provides the opportunities for students to expand their creations and ideas working for the community and with the people in the team. This allows them to express their thoughts and ideas freely, safely and be bold to work together in the team even when there are various unknown factors during the project planning stage. If the safety aspect of the project in question is not considered carefully, the latter nine key elements for change for the service learning activities will be adversely affected. Ensuring safety in the program and always placing safety as utmost important to assure the working team. Safety is not only concern about the people we are working together, it also concerns about the working environment physically, psychologically and mentally preparedness. You need to give the assurance to the team members so they do not have any anxiety thinking about the safety concerns or whether safety is being compromised in one way or another.

2. We cannot undermine the purpose of the community contribution towards various social concerns including health, poverty, hunger and security. The purpose of the project will help to promote the key objective of the service learning activities that requires thorough and comprehensive identification of the process for execution. Purposeful mindset produces good outcome of delivering the projects and at the same time to building communities on the basis of justice, mutual respect and equality. Without emphasizing the purpose of the community project will jeopardise the intent of the service learning project. This requires educator to create the learning path during the service learning journey through purposeful connection throughout the project phase. In the event of any conflict arises among the team members, where there bounds to happen in terms of arguments, debates and disagreements in making decisions at work, it is important that these students be reminded of the purpose of the project. In that way, the students are able to reconcile their thoughts and to take corrective actions linking back to the objective of the whole project. Clearly specifying the purpose of the project can encourage and motivate the students to achieve moving towards the overall project outcome. It can also encourage togetherness and teamwork among the students regardless of any conflict and dispute that may occur in the team. This further help to promote good cooperation and collaboration among the student leaders appointed during the course of the project. Based on the

case study by Haines, K. (2017), it illustrated the good outcome of the purposeful interaction in the international classroom by emphasizing the importance of the purpose of the project being discussed.

3. Autonomy is giving the right to the students to exercise their initiatives to do the thing right. Students must be given with the opportunity to lead others by contributing their thoughts and solutions during the project learning journey. Other students in turn are encouraged to provide further thoughts on these initiatives with synergized solutions. In the safe working environment, the students are more willing to come forth to test their ideas and can becoming more self-directed and self-motivated working together in the team. These students can develop responsible and self-initiated learning attitudes and behavior. The main focus is to develop them into a holistic nature of individual learning and produce most effective practices during the service learning journey.

Both Yuyun, Y & Nenden, S. L. (2017) presented an applied linguistics journal stating that project based learning promotes learner's autonomy. This is encouraging as we want our students to exercise their autonomy to think about their problems encountered, giving them the space to providing potential solutions for discussions among the team members. A reversal of concept was adopted here having to get to exercise their autonomy during the duration of the service learning project. We give them the authority to initiate ideas and to help one another to reverberate every fruitful thoughts. This, we found, has boost the performance of the team's strength and productivity. They became motivated and encouraged to contribute more to the project, even if they make mistakes which happened in the safe working environment. In addition, Barbara, M. (2019) shared the values of developing responsible and autonomous learners can produce a key to motivating students in classroom. We have also identified that giving the autonomy to the students in service learning project, they have become more willing to come forth to contributing their effort in the project. Many of them also indicated to us that they are interested to do more of the community projects in the future.

4. Our students participating in the service learning project come from different courses of study. They may not be familiar with one another when they come forth to join the team. We get them connected in terms of bringing diversities together as one team and be able to help them to know one another to enhance doing the project. The key element of connectedness is important for students coming from different courses to work together for a common service learning project. The integral whole is better than all its individual strengths. This combines the students' voices from various groups adding values to one another with cross-disciplinary learning opportunities. The results add values to diversities among the students creating meaningful learning experience to solve the problems together. Students from different courses come together to share specific knowledge that are unique in them, adding values to one another, sharing their strengths, synergistically combined efforts to contribute towards the project's objective as a whole. In this way, significant learning experience and sharing among them are feasibly acknowledged and achievable. Connecting them together is to build a culture of all differences coming to one place of doing one common thing. Elina, L., Josephine, M. & Hanna, P-A. (2015) stated the importance of global connectedness in higher education for students to share values of cross-cultural learning experience. They had explored the sense of global connectedness that were enhanced by creating opportunities for cross-cultural exchange in higher education. This serves as connectedness is a key important factor to bring students of differences in various groups to come together for contribution to the team project. Learning to connect with others in the team can also develop leadership attributes among the students.

5. Expertise and skills are among the individual strength contributing towards the success of the community projects. Everyone has their unique gift in them to do and perform tasks of their strength. When they are combined as one team, many single contribution play every important part towards the outcome. Every student has at least some level of skills sets learnt in classroom. Even though their ideas may be refreshing and non-matured sometimes, the sparkle of their thoughts have given the others the opportunity to expand and consider potential new solutions to problem solving for the community. Those skills are the assets to the working team. It benefits the staff, students and the community themselves. Chi, M.T.H., Glaser, R., and Rees, E. (1982) stated the every individual is different and they can add up the individual expertise building and strengthening one another to solve problem effectively and efficiently. Therefore, it is important to consider the individual expertise and skills to help supplement one another in the working team.

6. Trust among the team members bring more people to the community to contribute, to create, to communicate, to mentor, to do things that are beyond the call of duties among the students working in the team. In the event that some of these tasks need to be executed beyond the normal working schedule, people of trustworthiness and whom they trust can out-perform much more with much better outcomes and results than many others. It brings the high level of cohesions among the people around them. They can infest more values and continue to add values to anyone working together in the team. All these are not possible in a team without the trust among the team members. With trust, all uncommon become common, all complications become simple and easy producing good outcomes with strengthening connections and overcoming challenges of all odds. Trust among the team members can be challenging at times to be built up and we nurture to maintain trust once it is being built up and formed within the team. However, it takes a split second to break up the trust among the people. In such situation, hope and friendship will be at stake. For the team of students who went with me to

Myanmar doing the community service learning project, I emphasized the importance of trust with them for open communications and discussions. Create an open space of thoughts, sharing, opinions, and reasoning are some of the key routes to building trust among the team. If you do it appropriately from the start, the effect of trust-building effort and outcome among the team can be amazingly eye-exploding. Dennis, R., Michelle, R. & David, H. (2017) emphasized the importance of trust in the team and why trust is critical to team success. Building trust among the team can provide and produce results far above beyond the team's expectations. You may be deceived if you trust too much, but you will live in torment if you don't trust enough – Frank Crane, American minister and author. When our students are allowed to take risks, exercise their creativity, communicate ideas openly, and work alongside their counterparts as partners in a team spirit of collaboration, you will see that their satisfaction surveys skyrocket. Moreover, they are self-motivated and wanted to go back to do more tasks and serving the community, adding more values to others. This in return motivating us as staff wanting to provide more opportunities for other students to learn and benefit from the same experience with them.

7. A heart for serving the community of a person is the key element that I will consider during the team member selection interviews. People with the heart to serve willingly and unselfishly will help to build strength and bring down tedious working effort tremendously. Serving others with unselfish thought and with willing-hearts can provide high level of satisfaction among the team when compared with serving others and areas of mandatories. The heart connects to your mind, in turn connect to the sense responses and follow by the desire to take the next step of actions, producing the results of good outcomes. Heart connections of working as a team are very much associated with falling in love doing and executing the task in the team. In fact, when we do fall in love with the work we do, it is a sure sign of a heart connection of the service we provide to others. Dr Martin Luther King, Jr. stated that to serve in agreement is you need a heart full of grace, extracted from Randall, S. H. (2019).

8. Everyone in the working team needs to be edified to commit towards a synergetic team performance. Edification within the team among the students helps them to stimulate further thinking and logical reasoning when come to problem solving. It is important to acknowledge the utmost performance on the teamwork or contribution made by individual student. Even praising the members who have done well for the work can further improve their contributions and skills, by edifying one another. Wisdom provides appropriate solutions at the right timing and also acts as catalyst to impute energy into the thinking process. In various occasion, positive perception and good understanding of the situation often be seen as an ability to reveal the truths and the facts from the different angle of spotlight looking into the situation. Students learn by receiving sparkle of wisdom and learning values to allow them to permeate into them. They can be enriched with knowledge and can achieve key target of motivation to ignite the thinking processes. Tradie (2019) in his leadership dynamics journal had mentioned about the easy ways to build team culture, loyalty and devotion by the process of edification among the working team members. To make the working team powerful and self-motivated, very often they need driving forces to bring up their level of contributions. They need encouragement and respect for betterment of their contribution and results produced. It is important to acknowledge their contributions in the team so that their effort and results are recognized. These students would like to return back to the community and willingness to do much more for others. This is powerful and very encouraging among all members working in the team, simply by the act of edification among themselves.

9. Integrity is about the personality of the student related to their action to be taken when working on the project. The student has to be honest with no compromise on their characters and their ethical values at work. Nigel, S. R. (2012) examines the rights at the core of the concept of integrity of the person with the right to life. The integrity of the person is very important that explains the quality of a person being honest with valuable personal moral principles. People with integrity will believe in others, help others, and have honest background relating to work group. We highlight to the students of exhibiting and demonstrating integrity in their personal characters. Not all the times that the staff are doing the right thing. Sometimes, they can go wrong and students with integrity usually help the staff by alerting them and informing them of the erroneous situation encountered. When we conduct interviews with the potential students showing interest to join the overseas community project, it is important that these students stand firm in terms of their integrity. Connection with self and others is an important component of parts and parcels of serving the community as a team. We need to learn how to connect ourselves with others promoting many benefits of working relationship in a team. Impossible solutions to problems can be made possible in different respective ways. In this case, integrity of the person is important in order to maintain the appropriate connection of the relationship at work.

10. Everyone in the team is unique in their strength and values to be added to the group. The niche strength that each student has can produce the relevant components of the whole project. The niche strengthened area of each student in the team can go hand-in-hand with the success of the project work. There are limited resources in the community project and not everyone is able to fix the whole problem with one solution all by oneself. Therefore the individual strength can contribute towards the complete and synergetic outcome of the whole project. Niche of one skill can produce good outcome. Niche is the space that you can get connected with people and work around you so that your contribution towards that objective can be maximized and be multiplied to excel in various forms. This mainly

is to add values to support the team and to fill in gaps that are missing in areas of needs in the project work. Everyone in the team is believed to have different niche and strength. The team working cohesively to contribute towards the project work is definitely an advantage. Dan, S. (2017) mentioned about the niche marketing ideas for specialized business placing all people working together in a highly specialized niche can maximize the impact and make its mark. The service learning community project is also a niche areas of work where students from various strength and niche skills come together to build up an impactful project producing good outcomes.

Results and Discussion

We saw improvements in motivating our students who went for the recent overseas community project with us after we have adopted the 10 key elements for change.

Some of the students' feedback were extracted and stated here:

1. Through this Taunggyi project, I find that it has impacted me greatly in various ways. …..…purpose of the trip and is a huge responsibility for me. …… I hope I would be able to do something that is meaningful and impactful for them. And I find that through this process I have learnt the importance of flexibility and adaptability as not all the things planned would go smoothly which we have to think of alternative solutions. And importantly flexibility as I understand that everyone who is part of this project ……….. if I could make good use of some of their ideas even though it may differ from the original plan that my team has planned.
2. ……………….I was touched when the kids took initiative to queue up orderly, bowed and thanks me for giving out the goodies …….. I found myself learning much more from the kids there instead ……………….
3. …through this trip I find that I learnt more about myself by reflecting on the things I have done and what are some things that I can improve on. This trip has taught me to be grateful and appreciative on the things that …………. Focus on the needs first instead of the wants. One thing that touched my heart was that the kids were so happy that we were building a library for them and that over the days spent at the orphanage they would constantly check on our progress. ……And I know that these actions would make huge changes in their lives therefore, this drives me to continue to help others that need help both internationally and locally.

Conclusions

In conclusion, the 10 key elements for change were discussed and shared with values and strength in a team working towards the overseas community project. Individual differences are recognized and their diversities can come together and settled in one common area. An evaluation of the recent team of students doing their service learning in Myanmar had returned with positive feedback and good outcomes. They are more cheerful in handling challenging situation during the service journey with more willing to accept and reconnect back to the team many times. More importantly, they showed their interest to get involved in more such community services in future.

Acknowledgements

My thanks go out to the support I received from Temasek Polytechnic, the School of Engineering and especially the management team of the Student Development Department. I am also very grateful to the accompanying colleagues and all those students from the School of Engineering who went with me to serve the overseas community project at Myanmar in March 2019. Working on the project with them had given me the opportunity to develop the 10 key elements for change, the adoption of which can benefit not only our students from various courses, but also it can benefit many others embarking on the project management.

References

Alexandra, C. (2018) *Project Management Methods, Methodologies, and Frameworks — A Guide for Beginners.* Retrieved from: https://medium.com/paymo/project-management-methodologies-the-complete-guide-fba376ef288a

Babara, M. (2019) *Developing responsible and autonomous learners: A key to motivating students.* Retrieved from: https://www.apa.org/education/k12/learners

Chi, M.T.H., Glaser, R., and Rees, E. (1982) *Expertise in problem solving*. In R.J. Sternberg (Ed.), Advances in the psychology of human intelligence: Volume 1 (pp. 7-75). Hillsdale, NJ: Erlbaum.

Dan, S. (2017) 7 *Niche Marketing Ideas for Specialized Businesses*. Retrieved from: https://www.wordstream.com/blog/ws/2014/10/28/niche-marketing

Dan, W. G. & Jack, B. N. (2013) *Uncertainty and Anticipation in Anxiety – An integrated neurobiological and psychological perspective*. Retrieved from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4276319/

Dennis, R., Michelle, R. & David, H. (2017) *Why Trust Is Critical to Team Success*. Retrieved from: https://www.ccl.org/wp-content/uploads/2017/05/why-trust-is-critical-team-success-research-report.pdf

Elina, L., Josephine, M. & Hanna, P-A. (2015) *Global connectedness in higher education: student voices on the value of cross-cultural learning dialogue*. Retrieved from: https://www.researchgate.net/publication/276831248_Global_connectedness_in_higher_education_student_voices_on_the_value_of_cross-cultural_learning_dialogue

Haines, K. (2017) *Purposeful interaction and the professional development of content teachers: Observations of small-group teaching and learning in the international classroom*. in J Valcke & R Wilkinson (eds), Integrating Content and Language in Higher Education: Perspectives on Professional Practice. Peter Lang, Frankfurt am Main, pp. 39-58. https://doi.org/(...)26/978-3-653-07263-1

Nigel, S. R. (2012) *Integrity of the person.* Retrieved from: https://www.oxfordlawtrove.com/view/10.1093/he/9780199654574.001.0001/he-9780199654574-chapter-12

Randall, S. H. (2019) *Now is the Time to Help Yourself by Helping Others: 10 Ways to Serve Your Community*. Retrieved from: http://www.empoweringretreat.com/community-service.html

Tradie (2019) *Two Easy Ways to Build Team Culture, Loyalty and Devotion. The Servant Leadership Series, Part 3*. Retrieved from: https://www.leadershipdynamics.com.au/two-easy-ways-build-team-culture-loyalty-devotion-servant-leadership-series-part-3/

Yuyun, Y & Nenden, S. L. (2017) *Project-based learning in promoting learner autonomy in an English as a foreign language (EFL) classroom.* Retrieved from: https://www.researchgate.net/publication/320133548_Project-based_learning_in_promoting_learner_autonomy_in_an_EFL_classroom

GENESIS@BME: AN INTEGRATED APPROACH TO TECHNOLOGY EDUCATION IN BIOMEDICAL ENGINEERING

Wai Sing ONG* [a], Hock Wei SOON [a], Tji Leng CHUA [a], Kannathal NATARAJAN [a], Peck Ha KHOO-TAN [a], Shirley WILLIAMS [b], Hui Leng TAN [b]

[a] Ngee Ann Polytechnic, School of Engineering, Singapore
[b] Ngee Ann Polytechnic, Centre for Learning & Teaching Excellence, Singapore

* Email: ONG_Wai_Sing@np.edu.sg

Abstract

Biomedical engineering (BME) is a multi-disciplinary field that requires expertise from many different areas of engineering and sciences. As part of the healthcare industry, BME receives a lot of attention in view of the ageing society today. Biomedical engineers often work alongside physicians, surgeons and patients when to designing new medical instruments as well as to establishing new clinical procedures and guidelines. Hence, a solid technical foundation with a strong awareness of community needs are the essential attributes of a biomedical engineer.

Recognising this, the team responsible for the Diploma in Biomedical Engineering (BME) at Ngee Ann Polytechnic (NP), Singapore, embarked on a curriculum enhancement project, entitled Genesis@BME to ensure the infusion of a community focus and real-world project exposure in the BME curriculum. Genesis@BME helps to nurture biomedical engineering professionals who care for and contribute to the development of society. Key elements of the project include providing students with real-world project experiences with a strong community focus. These project features were integrated into the 3-year curriculum in five phases. They are :

Phase 1: Exposure to the needs of the community through a community service trip.

Phase 2. Empathy Building via Design Thinking at a local community

Phase 3. Building Confidence in technical skills via integrated project

Phase 4. Crafting creative ideas by community visit with actionable projects.

Phase 5. Innovate and create solutions in Final year project.

This paper will discuss how each phase was implemented and its significance in shaping biomedical engineering diploma graduates who are both grounded in the knowledge and skills required for this field, and who have a heightened sense of interest in and empathy for the people and communities that are served by their work.

Keywords: *Biomedical engineering, community focus, design thinking*

Introduction

A study conducted by (Lang, 1999) indicated that Engineering graduates find it difficult to apply their knowledge acquired from school into practice and lacked perspectives on the issues that concern their profession, such as economic, environmental and social issues. Their education has nurtured technically competent Engineers who lack the essential soft skills such as communication and teamwork (Mills, 2003) that would enable them to be more engaged and understand the needs of their users/clients and the changing environments that they will work in.

Biomedical Engineering is often referred to as 'hidden profession that saves lives' as it is a role that requires passion and spirit to alleviate other people's suffering through technology. However, being technically competent as a Biomedical Engineer is not sufficient to meet the needs of the changing healthcare sector, which is increasingly more automated and integrated with advancements in technology. In addition to these changes in the biomedical industry, Biomedical Engineers must also be aware of the changing needs of the society such as the ageing population which will have a significant impact on the healthcare industry. Biomedical Engineers need to be sensitised to and understand the changes in the industry and society so that they can design appropriate tools and technology to meet what is required.

Hence, educating Biomedical engineers (BME) should not only focus on imparting content knowledge (developing head knowledge) but also on developing empathy and compassion (shaping the hearts) so that they can create (using their hands) the right technology and tools to support the people who need them most.

Genesis@BME

Given the changing expectations of Biomedical Engineering graduate, the School of Engineering (SoE) at Ngee Ann Polytechnic (NP) introduced a programme within the Diploma of Biomedical Engineering (BME) that will nurture Biomedical Engineering graduates to have a good technical foundation through real-world project exposure as well as a heart for the community by infusing Service-Learning components into the curriculum experience. In this programme – Genesis@BME - students are given opportunities to develop an interest in the wellbeing of the community and the ability to apply BME domain knowledge in a real-world environment.

Methods

Genesis@BME is implemented in 5 phases in the 3-year BME programme. These phases are [THL1]:

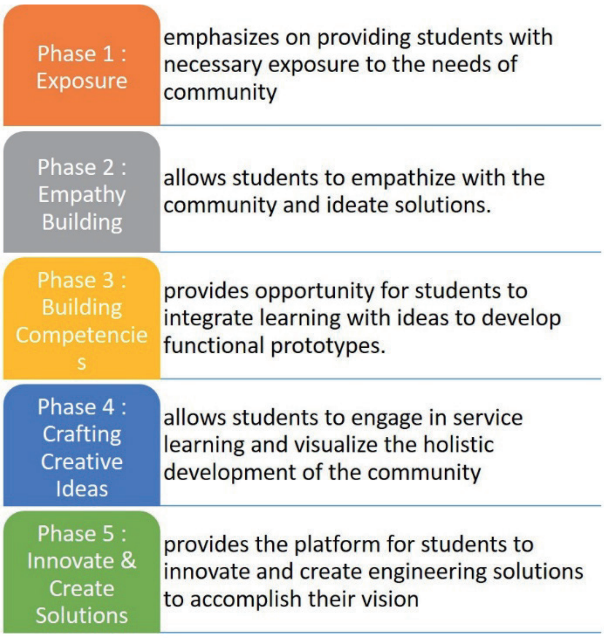


Figure 1: The 5 phases of Genesis@BME

Phase 1: Exposure

In this phase, students are provided with necessary exposure to the needs of a community through a short visit to trigger awareness of different communities and their needs.

In 2015, students took part in a community service visit to Malaysia as part of the freshmen induction programme. The intent was to create awareness of societal responsibility in students. Students spent 4 days in rural Malaysia where they were engaged in various community activities that aimed to develop their ability to

- appreciate the needs of the less able; and
- empathise with the less fortunate and render assistance.

Students were exposed to a different community through visits to the village including the schools to interact with students and to find out more about how local students learn with limited resources, visits to the villagers' homes to find out more about life in the village and what their needs are.

Figure 2: (Clockwise from top left) Students playing with village children, interactive games with home residents, clearing up the library of the home, briefing for students and children before games start.

While the interactions with the local community may have been short, they served well as significant first touchpoints for the BME students to be immersed in a different ccommunity with a different way of life and different needs. The intention was to introduce the concept of "Empathy" to the students and to trigger a desire to help those less fortunate. Feedback from the students after the trip indicated that they did start to be more aware of others and especially of those who have much less than themselves. Students also agreed that they had the desire to help others who were less fortunate than them.

Table 1: Result survey from a community service trip in 2015

Community Service

	SA	A	D	SD
OBJECTIVES				
The trip has been able to:				
1. make me appreciate the needs of the less abled	52	48	0	0
2. develop in me a desire to help others less fortunate than myself	46	53	1	0
3. build up confidence in me	46	52	2	0
4. allow me to make new friends and bond with fellow students	79	20	1	0
5. turn me into a better team player	49	47	5	0

I feel that the trip is enjoyable as it bond the class. The community service is also very meaningful

The trip was meaningful and allowed me to understand more about the less fortunate. Also, I learnt that I am given many privileges which I should cherish

Phase 2: Empathy Building

The phase builds on "Exposure' experienced in Phase 1 and aims to "deepen" the empathy experience in students by getting them to propose solutions for the community. Using the Design Thinking Process, students need to address some of the community issues they observed during their interactions with the local community in Phase 1.

The essence of the 3-day Phase 2 experience is that students would engage in opportunities to deepen empathy for the community. This deeper engagement would also allow students to frame their thinking and observations of the community needs into the correct context (in a local community centre) and develop ideas that are based on the actual needs of the community.

Upon return to the campus, students will be introduced to the concepts and practice in Design Thinking. The Design Thinking process is shown in the figure below:

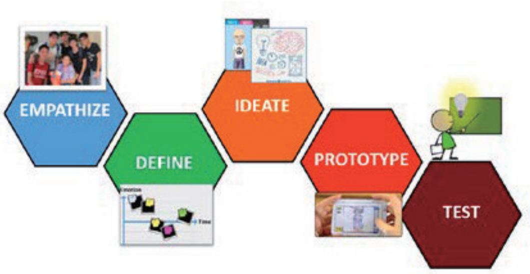


Figure 3: Design thinking phases and their various tools: Empathize (Field Trip), Define (Journey Mapping), Ideate (Persona creation), Prototyping (Cardboard prototyping), Test (Presentation)

Students will define and reframe the problem framework using a journey map that makes use of observations from the field visit. Students will then go through the process of ideation, where they will list down creative ideas and options through brainstorming and collaboration with other students in the team. Students may also use "Persona creation "as a tool to help students to visualise the possible needs of the users and help them angle the solution to be optimal. Once the idea is finalised, students will proceed to build a simple visual representation of ideas for communication, to test-out their proto-type and gather feedback. Lastly, they will make a final presentation to the lecturers at the end of three days to present their ideas and prototypes to address the needs of the local community as part of an assessment.

At the end of Phase 2, students would not only gain one more opportunity to engage with the community, but they would also have the chance to start to ideate solutions to issues that they have identified interacting with the community. This experience would reinforce the student's inner desire to help serve the community.

Below are some of the examples of the students' presentation.

Figure 4: (Clockwise from top left) Student's journey map, Prototyping of idea, Presenting and critic of ideas.

Phase 3 – Confidence Building

In the past 2 phases of Genesis@BME, students may have innovative ideas and solutions to support the needs of the community, but they lack the technical competencies and ability to integrate their learning to turn their ideas into reality. In Phase 3 – Confidence Building, students will be allowed to hone their technical skills to develop engineering solution and to adopt the necessary technical and cognitive skills that would enable them to complete a project from conceptualisation to prototype.

Phase 3 is a 3-day programme that is scaffolded to encourage students to 'think out of the box' and foster their analytical and cognitive abilities. This phase intends to ignite students' interest in creating their own biomedical devices and build up their confidence to achieve desired learning goals. This project also provides an integrated learning platform via a real-world project where students get to connect their learning in various modules and appreciate the link between what they learn in school and how it can be applied in practice. In addition, through the development of this project from start to prototype, students would need more than just their technical knowledge to achieve their outcome. They would also need to learn how to think critically and creatively, solve problems, work as a team and also communicate their ideas to others – traits and attributes that a future biomedical engineer is expected to have.

Phase 4: Crafting Creative Ideas

Phase 4 focuses on Service-Learning that allows students to envision the holistic development of the community. Having gained the confidence and ability to develop solutions for the community in the previous phases, students are better prepared for more in-depth engagement with the community and ideate solutions for societal welfare. The students will be involved in Service-Learning (S-L), where knowledge and skills gained in the classroom are applied to work on projects that meet the needs of the local community, which in this context was elderly. The objective of the project is to create awareness in the usage of technology (Electronic Equipment) for senior citizen (or specific needy group) in promoting wellness, health monitoring and creating a safer living environment.

The project scope requires the students to:

- Find out more about the needs of the community and their living style through survey/ interview/community service.
- Build a journey map to identify pain points observed.
- Share findings gather from the community persons where students will document their findings in the form of reflection, and then they will share it with peers or lecturers.
- Suggest solutions as a follow-up. Students have to propose a solution (with embedded system components, e.g., phone app, microcontroller programming) and implement it (simulation or hardware implementation).

The students will be involved in this phase of Genesis@BME for about five weeks where they will spend the first 2 weeks identifying the target community and interviewing them to clarify the needs of the elderly before they spend the rest of the project timeline on developing a prototype to solve an identified issue observed.

This S-L experience has continued the momentum of developing "compassion" in the students as they were confronted with the reality of the issues faced by the elderly such as their struggle with dementia, fall, and issue of loneliness (staying socially active). Students, in their way, developed solutions that would bring some relief to the elderly through their projects.

Some of the projects developed by the students included an Integrated GPS remote control which will support the elderly to travel on their own without the worry of not being to find their way home. This would allow the elderly to remain independent despite their age. Another project was the CuMed, where students designed a pillbox that would alert the elderly to take their medication. Both projects received positive feedback from the community when presented.

Figure 5: Students spending time with the elderly as part of their Service-learning Project

Phase 5: Innovate and Create Solutions

In this final phase students are expected to demonstrate their ability to innovate and create engineering solutions through the final year biomedical project design (BPD) module. The objective of this module is to provide students with the practical experience in the design and implementation of a project in healthcare applications of engineering. Through the projects, students will be able to demonstrate their engineering knowledge gained in the various academic subjects and professional attributes such as critical thinking, presentation skills etc.

At the end of this module, students should be able to work creatively and take the initiative to bring a project to completion. The scope of students' work may include design and fabrication of printed circuit board, wiring, assembly and testing of the final prototypes, troubleshooting electronic circuits and making enhancement to the prototype design, Matlab coding, database coding, server and client system testing and web-based implementation and overall integration of the working project for final presentation.

During this phase, students work with community partners, healthcare personnel, research institutions and
hospitals where they will gain experiences that gave further insights to in terms of potential career and business opportunities. Some of the projects that students collaborated with industry partners include:

- Automated vision acuity project with National University Health System Eye Centre.
- Blephasteam Device Monitoring System with the Singapore Eye Research Institute (SERI).
- Home lighting remote control for the wheelchair bound –with Paya Lebar Wellness Centre
(PLWC).
- Handwashing reminder system with Singapore National Eye Centre (SNEC).
- Panic Button for elderly with Bukit Batok Residents Committee and PLWC.

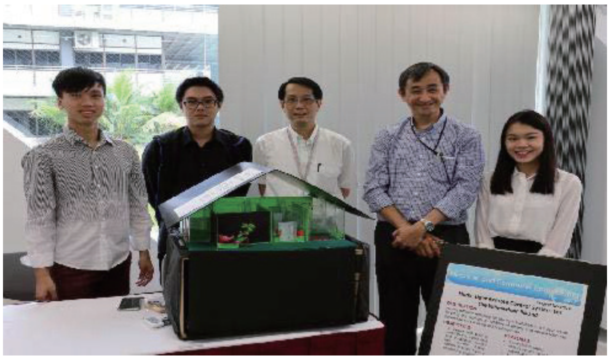


Figure 6: Students and supervisors showcasing their work in a school event.

Areas of improvement

While there have been successes in Gensis@BME in terms of developing students' awareness of the community needs, there were also challenges in the implementation of this programme.

Long Term partnership

One area of difficulty when working with community and industry partners is the identification and sustainability of these partnerships. It is challenging for any industry partner to work with any educational institution, as this often requires preparation and human resources which the partner can ill-afford. While some partners may be willing to host for one or two sessions, many are unsure about a long term partnership which can be disruptive. Genesis@BME was able to overcome these issues by establishing a long-terms working partnership with Paya Lebar Wellness Centre, who has fully supported the BME diploma since the inception of this program.

Continuous Engagement of students

To better engage students on empathy, a continuous stream of activities can be implemented as a "filler" activity between the different phases of Genesis@BME. One program was the use of "Empathy suit" experience, which took place between Phase 1 and 2. The "Empathy Suit" provides "obstruction" and "restriction" to body movements which can mimic a stroke patient or physically disabled person. Students who put on the Suit would have a simulated experience of not having full control of their body and would be able to better identify with the challenges that stroke patients or a disabled person may go through. These experiences sustain students' exposure to empathy from Phase 1 and allowing them to be more ready for further engagement with the community in Phase 2.

Conclusions

While the Genesis@BME has evolved through the years to ensure currency with the changes in the industry, the intent to nurture BME graduates with compassion has not. The structured implementation of Genesis@BME has nurtured the cognitive abilities of learners by scaffolding and integrating different phases of knowledge construction, allowed students to empathise with the community and seek knowledge independently. Genesis@BME also promoted effective teamwork through structured collaborative learning activities. As a result, by the end of the three years, many students would be able to leverage their knowledge in Biomedical engineering to develop solutions to the benefit of the community.

Acknowledgements

The team would like to acknowledge the community partners that have worked with us: Kulim Eco-trail retreat, Paya Lebar Wellness Centre and lastly the students who made this possible.

References

Lang, J. C. (1999). Industry expectations of new engineers: A survey to assist curriculum designers. *Journal of Engineering Education, 88(1)*, 43-51.

Mills, J. a. (2003). Is problem-based or project-based learning the answer? *Australasian Journal of Engineering Education, 3(2)*, 2-16.

A Class for Human Resource Development Capable of Corresponding to Diversification of Energy

K. Yamada[*,a]

[a] Department of Maritime Technology, National Institute of Technology, Toyama College, Japan

*keisuke@nc-toyama.ac.jp

Abstract

This report will introduce an effort to make students understand energy properties and consider energy issues in the world. Most of engineering course students will work as a ship engineer, while others will work as a plant manager after graduation. In any case, they will have to manage enormous and various kinds of energy. To be active as an engineer for realizing a sustainable society, they must have not only practical skills to handle machines but also knowledge and understanding of social backgrounds (diversification of energy, environmental problems etc.). So, the instructor deals with these topics in class.

The procedure is as follows. First step is that students study trends of technological development, energy properties and issues (natural gas, unconventional fossil fuel, biofuel, renewable energy etc.). In the first week, each student is given a topic, and are required to do research beforehand. From the second week, students explain details of the given topic to others. For example, the student who researched shale gas, explains the special drilling technology and regional environmental problems caused by drilling. After the explanation, the instructor makes a supplementary statement and answers the questions from students. At the end of class, students do exercises (explanation of technical words, calculation exercise, research of statistical surveys). Through this class and exercise, students can acquire broad knowledge of various energies.

The next step is that students have opinions about energy issues and express them. Before the exam, students are shown essays by the instructor and are required to write counterarguments and their own opinions. Then, they write debate format essays on the exam day. Student's essays are evaluated based on logicality, objectivity and creativity. This class may be difficult for students. However, they get to research and consider energy issues actively. Moreover, they become able to express their opinion about energy issues and understand what to do as an engineer in the future.

Keywords: *Diversification of energy, Energy properties, Thinking skills about energy issues, Peer instruction, Debate format essay*

Introduction

Many of the graduates of the department of maritime technology work as navigators or engineers for large ships such as cargo ships, oil tankers, LNG tankers and so on. There are many machines in the engine room, such as diesel engines, pumps, generators, boilers, and fresh water generator and so on. To be able to operate large ships safely and systematically, the engineers maintain these machines with a small number of people. In addition, some work in maritime manufacturing industry and plant management industry by taking advantage of their experiences in the engine room. In any case, the students of the engineering course will deal with a huge and diverse energy. In order for engineers to contribute to the realization of a sustainable society in the future, it is necessary not only to be able to handle machines, but also to be able to respond to technological innovation. Furthermore, it will be necessary to be familiar with energy diversification, environmental issues, and social situations in Japan and abroad in the future.

For example, heavy oil has been used as fuel for the main engine of large ships. In recent years, some engines are operated by heavy oil and natural gas, in some cases by only natural gas depending on the operating conditions. In addition, it is needed to switch the fuel oil at Emission Control Area (ECAs) as defined by annex VI of the MARPOL protocol (IMO). In this way, fuels are diversifying in the maritime industry. Changes in the international situation are expected to change energy importing countries and routes. Furthermore, by stricter regulation of emissions from ships, it is necessary to install and operate a high-performance exhaust gas post treatment device (Muraoka, 2008). In this way, engineers are required to do a wide range of tasks, such as the sophistication and diversification of technology, changes in the situation, and responses to environmental regulations. To be able to do these tasks, I think that it is necessary to achieve the following goals.

1) Students understand the characteristics and social background of various energies multidirectionally.
2) Students must to be able to think about what they can do to realize a sustainable society.

This is a small-scale effort by one teacher. By continuing it, however, it is confirmed that the students' interest and understanding of the energy issues were deepened remarkably. This paper will report on the implementation of this effort and the state of the students.

Methods or pedagogy

Outline of the class: In this subject, we dealt with "energy diversification and usage technology", "environmental problems, and social problems". The details of each theme are shown in figure 1.

The flow of this class is as follows:

- Basic knowledge of energy characteristics and usage technologies (explanation by the teacher, 40 min.)
- Advantages and disadvantages (explanation by the student, 10 min.)
- Supplemental Explanation, effects on the environment and society (explanation by the teacher, 20 min.)
- Exercise and commentary (20 min.)

Explanation by the student: In the first week, each student is given a topic. Students explain the topic to the other students. The following rules were established for students:

- Explain two advantages and two disadvantages.
- Treat only objective facts. Don't say personal opinion.
- Put one statistical data in the explanation.

As an example, I will give an overview of the class when methane hydrate was treated. The advantages and disadvantages explained by the student are as follows:

- The existence in Japanese territorial sea has been confirmed.
- Methane has less carbon dioxide emissions per calorific value than petroleum.
- Methane hydrate is near the bottom of the sea, and sand and mud are often mixed with it. It is difficult to put into practical use at the moment and it cannot be profitable.
- There is a risk that methane will be spread into the atmosphere in some trouble. Methane has about ten times the greenhouse effect of carbon dioxide.

After the explanation, there were three questions from other students.
1) How do we recover the methane hydrate that exists on the bottom of the sea?
2) Which country does have methane hydrates?
3) How is the amount of methane hydrate calculated?

The student answered these questions as much as possible. The teacher gave a supplementary explanation to inadequate point, and the potential of methane hydrate on Japan in the future and the challenges ahead.

Exercise: Next, we conducted an exercise about methane hydrate. Exercises are as follows.
1) Show the area where methane hydrate reserves have been confirmed.
2) Check the tank volume of LNG vessels, the annual gas consumption of Japan as a whole, the amount of methane hydrate in Japanese territory. Calculate how many years of methane hydrate is in existence.
3) Show the area where methane hydrate can be stable.

Figure 2 shows the exercise sheet answered by the student. After working on it, the teacher explained questions.

For other themes, procedures in the class are generally the same. Teacher has created exercises that students are needed to connect the information obtained from various subjects, such as geography, economy, chemistry, geology, mechanical engineering, statistics.

Through classes and exercises, students understood the characteristics of various energy, usage technology, and social situations. This is the first stage of the target described at the beginning.

Debate format essay: From here, it is the second stage of the target. The teacher requires students to be able to think about various energy issues and express

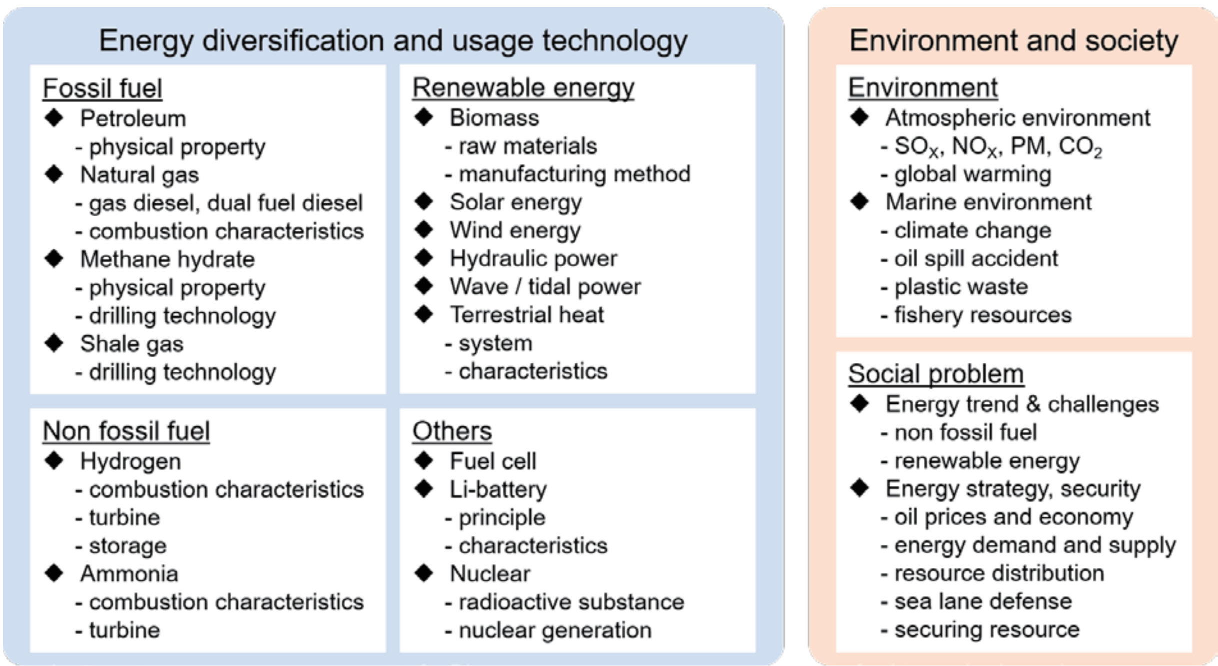
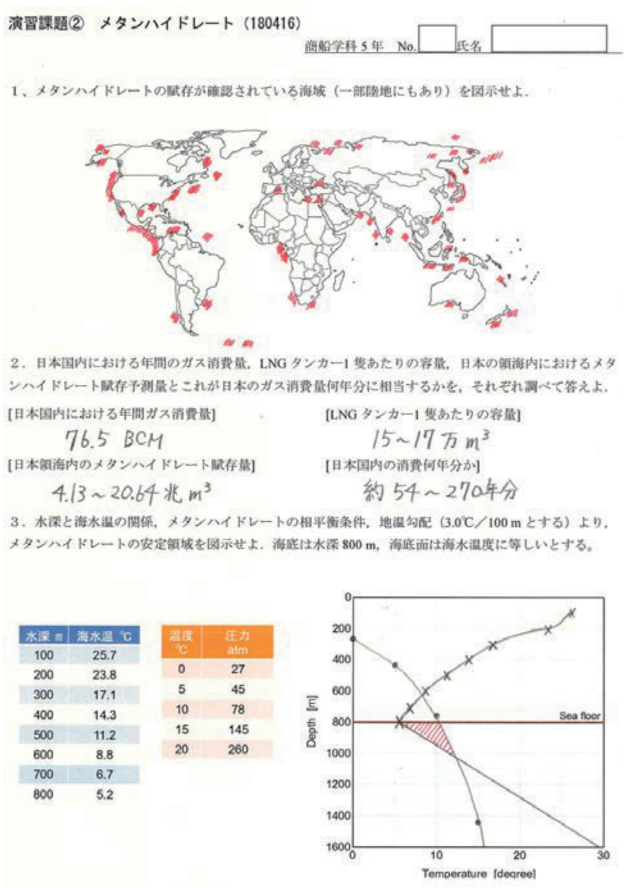


Figure 1 Topics covered in this class.

their opinions. To tell the truth, it is desirable to conduct a debate on energy-related topics, but it is difficult to do within limited class time. Then, the debate format essay was conducted as part of the examination. Teacher showed students an essay which was prepared in advance. Students write counterargument against it and their thoughts. The following is an outline of the debate format essay.

Question: In the near future, it will be extremely difficult to secure oil, and prices are expected to rise. Up to now, we have mainly used heavy oil in marine diesel engines, but we must consider a new propulsion system that doesn't use heavy oil. The following is a proposal to use biofuels as an alternative fuel. Counter this proposal and express your thoughts on the new propulsion systems you would like to recommend, including the following three perspectives.

1. The reason why you choose alternative energy.
2. Overview of technology for converting alternative energy into propulsion.
3. What should we make efforts to protect the environment and secure alternative energy?


演習課題② メタンハイドレート（180416）

商船学科５年 No. 氏名

1、メタンハイドレートの賦存が確認されている海域（一部陸地にもあり）を図示せよ.

2．日本国内における年間のガス消費量，LNG タンカー1 隻あたりの容量，日本の領海内におけるメタンハイドレート賦存予測量とこれが日本のガス消費量何年分に相当するかを，それぞれ調べて答えよ.

[日本国内における年間ガス消費量]
76.5 BCM

[LNG タンカー1 隻あたりの容量]
15～17 万 m³

[日本領海内のメタンハイドレート賦存量]
4.13～20.64 兆 m³

[日本国内の消費何年分か]
約 54～270年分

3．水深と海水温の関係，メタンハイドレートの相平衡条件，地温勾配（3.0℃／100 m とする）より，メタンハイドレートの安定領域を図示せよ．海底は水深 800 m，海底面は海水温度に等しいとする。

水深 m	海水温 ℃
100	25.7
200	23.8
300	17.1
400	14.3
500	11.2
600	8.8
700	6.7
800	5.2

温度 ℃	圧力 atm
0	27
5	45
10	78
15	145
20	260

Figure 2 Exercise sheet answered by a student.

Table 1 Proposal for alternative energy.

Natural gas (Single fuel / dual fuel engine)	24 students (48 %)
Hydrogen (Gas turbine)	7 students (14 %)
Ammonia (Gas turbine)	2 students (4 %)
Nuclear (Steam turbine)	7 students (14 %)
Electric propulsion (Li-battery, Solar energy etc.)	10 students (20 %)

This question has been carried out three times in the past, and total of 50 students wrote essays. The alternative energies proposed by them are shown in table 1. Natural gas is increasing in use in large ships, technology has been established to some extent. For these reasons, it is relatively easy to explain, and about half of the students proposed natural gas as a fuel to replace heavy oil. Both hydrogen and ammonia are used as fuel for gas turbines. There were many proposals to make it an electric propulsion ship by gas turbine power generation. Nuclear power is attractive because it doesn't require refuelling for a long period. There were some opinions that it is necessary for Japan to maintain nuclear technology, and nuclear ships will help to pass on technology. As mentioned above, a variety of opinions were expressed from the students.

Scoring policy: Scoring standards are as follows.
1) Are the rebuttal and the reasons for the choice of alternative energy are logically stated?
2) Is it explained appropriately that the technology for obtaining the ship's propulsion from alternative energy?
3) Is it explained logically what to do and what is concerned about the effort to protect the environment and secure alternative energy?

Understanding and impressions

At the first class and last class, I surveyed the students about their understanding, interest and impression of energy topics. The results of the questionnaire are as follows:
Question 1: Do you understand various types of energy usage technologies and development trends?
Question 2: Do you understand advantages and disadvantages of various types of energy?
Question 3: Have you come to see the energy article?
Question 4: Have you changed anything as a result of taking this class?

The aggregated results of Question1-3 are shown in figure 3. Even before the class, many students said they knew a little about various energy technologies and development trends. After the class, the number of students who knew them well increased significantly. The level of understanding of the advantages and disadvantages of energy was similar trend. Many students watched energy news only a few times in a week or a month. After the class, half of the students come to watch energy-related news almost every day.

The following are examples of answers to Question 4.

Student A: I will work on a ship that carries oil and natural gas in the future. I could understand that technology and social situations change with the times, and engineers will be needed to work in response to these.

Student B: I learned the advantages and disadvantages of various types of energy. In the news, the merit of the new energy is reported a lot. However, it is also able to infer the negative impacts which are not be reported. It comes to be able to see the energy issues in balance.

Student C: I knew about the energy issues, but I have never discussed it with anyone. I felt it was important to observe things from a broad perspective when I refute the opinions of others and assert my opinion.

Conclusions and future work

As mentioned above, I was able to make students realize that energy issues are strongly related to their life and their future work. Students learned basic knowledge of energy, thought over energy issues, and had the experience of communicating their opinions simulatively. In addition, some students actively investigate topics that may be involved in their future work at a higher level than in class. I'm considering the following process as my future works:

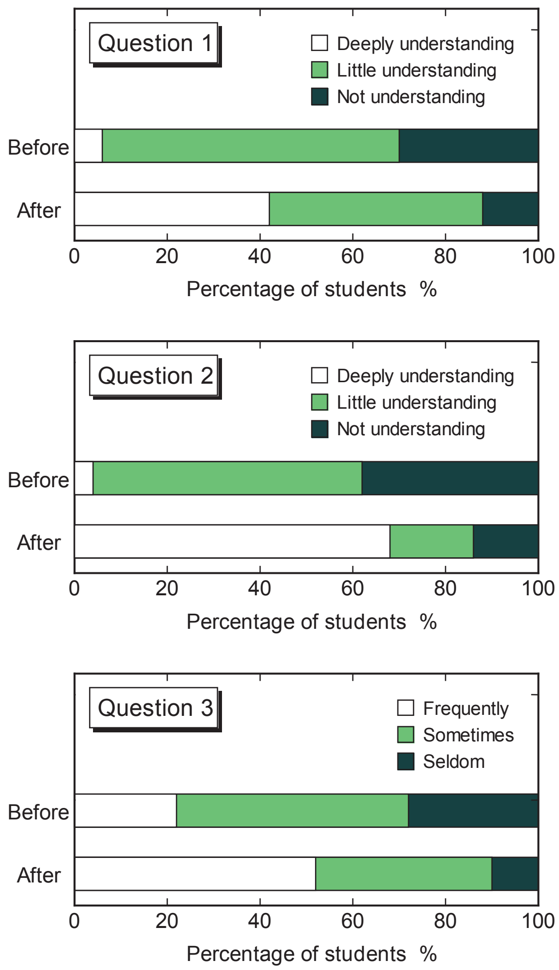


Figure 3 Survey results before and after class.

- Give lower grade students the opportunity to take energy education and raise awareness from an early period.
- Listen to actual experiences in the field from graduates and give feedback on this effort.

References

International Maritime Organization (IMO). *Annex VI – Regulations for the Prevention of Air Pollution from Ships.* Retrieved from http://www.marpoltraining.com/MMSKOREAN/MARPOL/Annex_VI/index.htm

International Maritime Organization (IMO). *Prevention of Air Pollution from Ships.* Retrieved from http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Air-Pollution.aspx

Muraoka, E. (2008). *Recent Movement of International Rules Regarding Air Pollution Prevention from Ships in the International Maritime Organization*. Papers of National Maritime Research Institute, Vol. 8-2, 183-190.

DEVELOPMENT AND PRACTICE OF ULTRAVIOLET SENSOR TEACHING MATERIAL FOR IMPROVING ANALYSIS SKILLS FOR SELF-STUDY

N. Kakuda*

Department of Electronic Control Engineering, National Institute of Technology, Yonago College, 4448 Hikona, Yonago, Tottori 683-8502, Japan

*E-Mail Address of the corresponding author: kakuda@yonago-k.ac.jp

Abstract

Engineers who train to develop embedded systems comprising sensors must acquire a wide range of skills such as using individual devices and mathematical analysis of data. However, often educators are biased towards conventional classroom-style methods of presenting knowledge. Therefore, in this research, we develop and review the introduction of simple ultraviolet (UV) sensing teaching material for the students to carry out self-study in addition to the class lecture.

The teaching material comprises the following three components: 1) microcomputer board: Arduino UNO and liquid crystal display monitor for voltage indication; 2) sensor: UV and visible light sensors to raise interest in UV protection as a medical issue; 3) UV light absorbent material: commercial UV cut creams and self-made zinc oxide thin film. This teaching material can be battery powered.

These materials were introduced into a two-credit class, "Sensor Engineering" [named *Gakusyu* unit of credit in National Institute of Technology (KOSEN)]. This class is a 30-hour class and a 60-hour self-study. Fourth-grade students used this teaching material to measure the UV intensity and the amount of sunlight in various places during various weather conditions after school and on holidays. The analysis was set to graded difficulty, and the contents were the characteristics of the data sheet, calculation of UV intensity, and numerical analysis of UV absorption characteristics. Students were assigned a report and presentation regarding field work using this teaching material.

From the questionnaire used to assess the class performance, we found 45% of the students spent 20–30 hours and 37.5% spent more than 30–60 hours for analysis and reporting using this teaching material. This is a roughly valid learning time because it is a value excluding self-study time for homeworks and the written test (more than 30-40 hours). Additionally, 20% of the students found that the difficulty of analysis considered by the students was just right, whereas 52.5% found the analysis a little difficult, suggesting the difficulty level of the materials was appropriate for the grade.

Keywords: *Teaching material, sensor engineering, electronic device, Gakusyu unit of credit, self-study, active learning*

Introduction

The fourth Industrial Revolution is showing signs of progress in the current environment through the development of innovative information technology such as fifth-generation cellular network technology, artificial intelligence, and the Internet of things (IoT). Even Japan, a country known for its manufacturing industry, proposes the 5th Science and Technology Basic Plan or "Society 5.0" to envision the future.

With an aging rate of 27.7%, Japan is now a member of critically aging societies with a seriously low birth rate of 1.42. It is hoped that innovative discoveries in information technology will improve productivity and will help the resolution of social issues as well as boost economic development in Japan.

The National Institute of Technology (KOSEN) has advocated creative education since its establishment and has fostered engineers who are both realistic and inventive by incorporating many practical sessions into its curriculum. This emphasis on applied education is a major feature of the KOSEN system used in the field of engineering by many Japanese higher education institutions. The KOSEN schools are mandated to nurture engineers who can play an active part in Society 5.0 and beyond.

An embedded system consisting of sensors, microcomputers, and actuators is a core component of the IoT. In order to become engineers who have the requisite expertise in embedded systems, students have to master an extensive knowledge of electric and electronic engineering, information engineering, and mechanical engineering. They must also be able to apply experimental skills and analysis methods. In addition, they are required to improve their universal soft skills (ethics, coordination, communication, problem finding/solving, etc.) as an engineer who will work for and within society. Group experiential training is said to be effective in improving these abilities.

The department to which the author belongs requires

78 credits for lectures and 20 credits for experimental and exercise-based classes in special subjects. Problems of implementation exist even though only a few units comprise experiments and activities. A limited number of teachers are charged with such classes, and thus the relationship between the lecture subject and the topic of the experimental session can become tenuous and unclear. More teachers must be asked to supervise practical sessions if the problem is to be resolved. However, this solution is not realistic because of the existence of other and varied problems such as the increased burden on teachers. In addition, students can not immediately apply the knowledge they have accumulated during lectures to experimental classes. As described above, lecture-only classes lead to a decrease in learning efficiency. At KOSEN institutions, the offered courses are generally in the range of 60 credits for the *Gakusyu* unit which comprises 15 hours of class-based learning and 30 hours of self-study. The self-study component accounts for two-thirds of the *Gakusyu* unit of credit and it is thus important for students to effectively use this time in order to achieve their learning goals.

In the above context, the current study created instruction material introducing experimental applications to be practiced during the self-study hours ascribed to each lecture class. It also examined the effects of the introduced teaching material through which students were able to conduct experiments during the time set for self-study and could work on quantitative analyses, reporting tasks, and presentation tasks based on data they had obtained on their own.

Materials and Methods

For the practical training, the students set a theme that was likely to be of interest to them to allow them to train independently. The theme they selected was "protection from ultraviolet (UV) rays for self and for children." Awareness about UV protection would enable students to learn about the subject from the medical and welfare perspective. In addition, the topic would allow students to learn that UV rays penetrate the skin and lead to an understanding of UV absorption inside the semiconductor substrate. Thus, it was expected that using this theme, students could be made aware of medical and welfare applications using sensors and microcomputers.

Figure 1 shows the simple UV sensing instruction material developed for the present study. This teaching resource comprises the following three components: 1) Microcomputer board: Arduino UNO compatible machine and liquid crystal display for voltage indication; 2) Sensor: UV sensor (ML8511) and visible light sensor CdS cell to increase interest in UV protection as a familiar medical welfare task for students; and 3) UV absorbing material: Commercial UV cut cream and self-made zinc oxide thin film. By imbibing this teaching material, students were able to perform the following actions: 1) measure UV intensity and illuminance and 2) drive with 4 AA batteries.

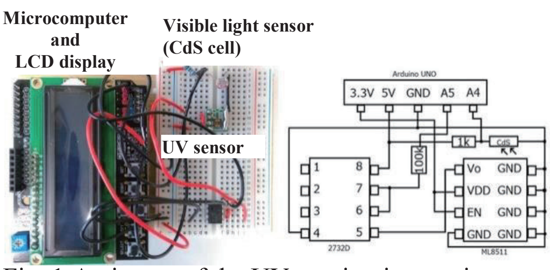


Fig. 1 An image of the UV sensing instruction material.

The class was conducted for the curriculum entitled "Sensor engineering" meant for fourth-year engineering students. This course is expected to fulfill two credits of the *Gakusyu* unit and encompasses 30 hours of classroom instruction along with 60 hours of self-study. The experimental practice session was executed for 16 hours, 14 hours after the classroom lecture on sensors. In addition, the self-study time allocated to the independent practice, analysis, and presentation of related tasks was assumed to be around 28 hours. The training session was conducted in the form of group work in units of 3 to 4 people. The experimental and analytical skills targeted for acquisition were presented to the students in the following manner: 1) You should combine a measuring circuit consisting of a sensor and a microcomputer and measure electrical data (voltage, current etc.); 2) Based on the characteristic graph of the sensor data sheet, you should utilize a formula to convert electrical data to UV light intensity and illuminance; 3) You must then calculate physical quantities from the obtained data using a spreadsheet software (Microsoft Excel); and 4) You must submit an assignment by the due date and manage your own schedules as group members.

Figure 2 illustrates the characteristics of the UV sensor ML8511 and of the zinc oxide thin films. As an

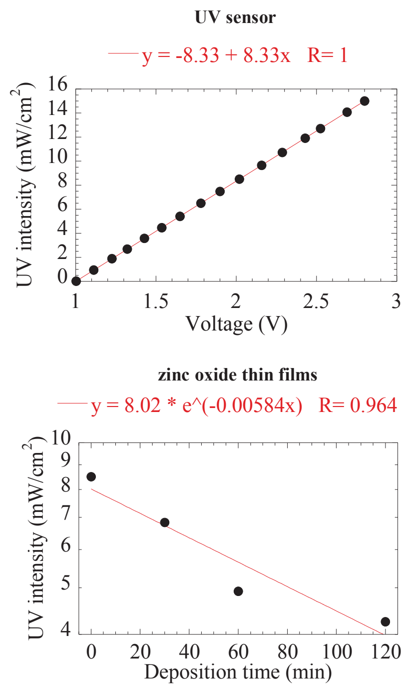


Fig. 2 The characteristics of the UV sensor ML8511 and of the zinc oxide thin films.

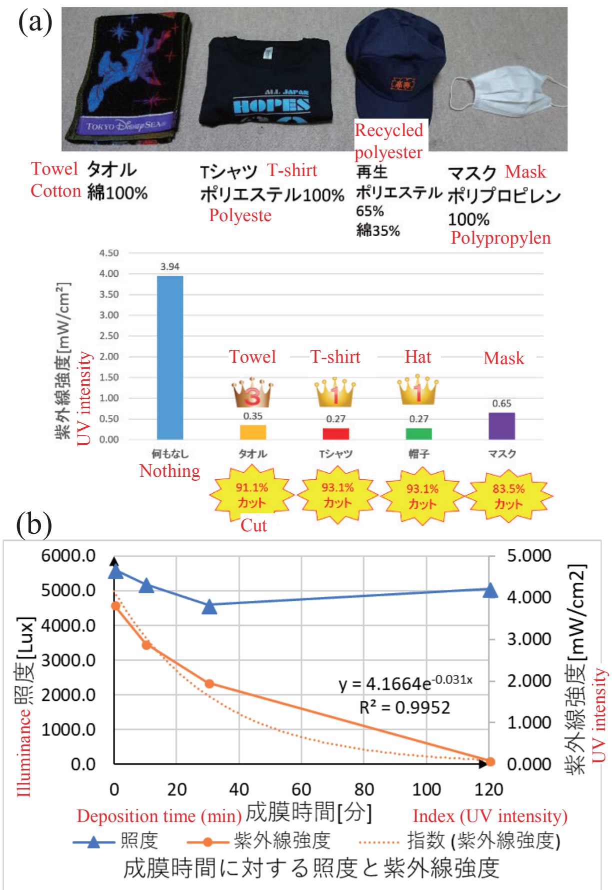


Fig. 3 Examples of the results of the analyses performed by students. Red words were English transration.

analysis task, students created these graphs using Excel and computed the formulae. The degree of achievement was evaluated through student submissions according to the deadline for the report, the contents of the report, and the delivery of group presentations of goals 1) to 4).

Results and Discussion

Figure 3 demonstrates examples of the results of the analyses performed by students. The participating learners were able to choose what they wore on a normal day and to quantitatively analyze their own UV absorption [Fig. 3 (a)]. In addition, students illustrated the relationship between the thickness of the zinc oxide thin film and the amount of ultraviolet light and illuminance and the zinc oxide thin film and the amount of ultraviolet light absorption was expressed by a mathematical formula [Fig. 3 (b)].

Figure 4 evinces the results of the questionnaire survey conducted for students after the end of the practical training class. 45% of the students took 20–30 hours and 37.5% took 30–60 hours in response to the question, “How many hours did you spend on practical training outside of class time?” [Fig. 4 (a)]. As mentioned earlier, the researchers assumed this time to be around 28 hours; however, many students studied for much more than the expected duration. Therefore, the practice obtained from the use of the designed teaching material may be considered to be appropriate for the subject adopted for

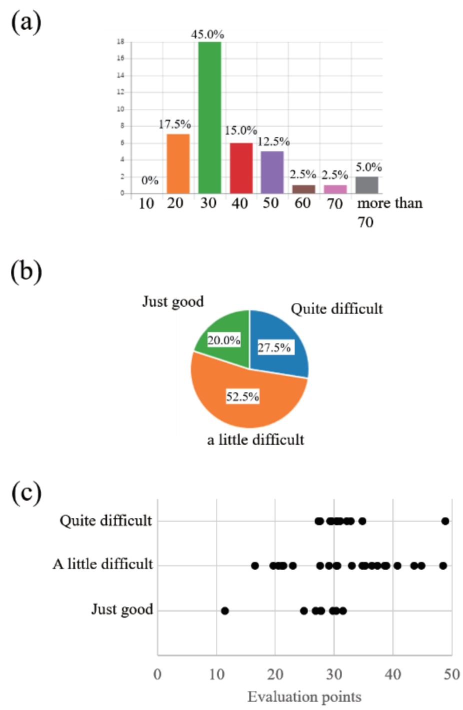


Fig. 4 the results of the questionnaire survey conducted for students after the end of the practical training class. (a) How many hours did you spend on practical training outside of class time?, (b) What was the level of difficulty of analysis in the practical training? (c) the relationship between the score obtained by the students in the practical training and the degree of analysis difficulty they reported.

the *Gakusyu* unit of credit. In addition, 52.5% students marked “a little difficult” in response to the question, “What was the level of difficulty of analysis in the practical training?” This result evidences that the researchers were able to set the analysis requirements to a somewhat difficult level for the majority of students [Fig. 4 (b)]. Figure 4 (c) displays the relationship between the score obtained by the students in the practical training and the degree of analysis difficulty they reported. Although it is necessary to note that the number of samples was small, it was found that the scores attained by students who selected “very difficult” tended to be higher than the scores achieved by students who chose “just good” and “a little difficult.” It may be that the students who found the assignments difficult worked hard enough to realize that the analysis was not very simple. On the other hand, students who selected “just good” tended to attain relatively low scores. Thus, it is deduced that student perceptions of “just good” are not preferable for the achievements of the learning goals. Therefore, it is necessary for the teaching materials to be ameliorated through the adjustment of tasks to be analyzed and the enrichment of the explanatory content so that the training is as beneficial as possible and the students find the content a little difficult to master.

Conclusions

This study designed and delivered teaching material pertaining to UV sensors to improve the analytical skills of students. The created resource was used during the self-study time component and was executed in practical classroom sessions. Since students expended more than the assumed amount of time on the training, this teaching material was deemed appropriate for the particular course, which adopts the *Gakusyu* credit system. The majority of the students found the assigned analysis a little difficult, and this level of difficulty seems generally to have been appropriate. The researchers will further improve the teaching resource to additionally advance the achievements of the learners.

References

Cabinet Office of Japan. (2016). *Society 5.0.* Retrieved from https://www8.cao.go.jp/cstp/society5_0/index.html (in Japanese).

Cabinet Office of Japan. (2018). *Section 1 Aging Situation of Aging Society White Paper (Overall Edition) 2018 (1).* Retrieved from https://www8.cao.go.jp/kourei/whitepaper/w-2018/html/zenbun/s1_1_1.html (in Japanese).

Ministry of Health, Labour and Welfare of Japan. (2018). *The general condition of population statistics annual report annual total number (round numbers) in 2018.* Retrieved from https://www.mhlw.go.jp/toukei/saikin/hw/jinkou/geppo/nengai18/dl/gaikyou30.pdf (in Japanese).

Yotsuyanagi Takao. (2005). *How to count new units and prospects of KOSEN.* Retrieved from https://www.jasso.go.jp/gakusei/archive/dtog/__icsFiles/afieldfile/2015/11/16/daigaku504_19.pdf (in Japanese)

Ministry of Education, Culture, Sports, Science and Technology. (2019). *Establishment Standards of KOSEN.* Retrieved from https://elaws.e-gov.go.jp/search/elawsSearch/elaws_search/lsg0500/detail?lawId=336M50000080023&openerCode=1 (in Japanese)

Partnership and Collaboration in Engineering Education

INTERNATIONAL EXCHANGE PROGRAM FOR DEVELOPMENT OF GLOBAL HUMAN RESOURCES AND JOINT RESEARCH

O. Yanagisawa*[a], G. Davaa[a], K. Kuzume[a], T. Tsutsui[a], T. Ito[a]
O. Jambal[b], S. Khayankhyarvaa[b], Ts. Byambadorj[b] and O. Dashdondog[b]

[a] National Institute of Technology (KOSEN), Yuge College, Japan
[b] Mongolian University of Science and Technology, Mongolia
*E-Mail : osami@yuge.ac.jp

Abstract

Development of global human resources is one of the most important issues in National Institute of Technology (KOSEN) in Japan. The international exchange program has been developed intensively to achieve this goal since an official agreement between KOSEN, Yuge College (Yuge) and Mongolian University of Science and Technology (MUST) in Mongolia entered into force in 2014. MUST 3rd grade students and instructors visited Yuge in 2018 for 13 days and performed several research and cultural exchange activities. We implemented a buddy system that makes pairs of students from Yuge and MUST in order to let the each pair work together in a same lab. The system worked very well as it helped them to have a lot of English conversations and stimulated mutual understanding between the students. In addition to the student oriented exchange programs, a nonnative English speaker instructor from Yuge had performed a lecture in English on a technical subject (Electromagnetism) which is taught on a regular basis. It is very important to train the instructors to teach their subjects in English as they will continue to help the students in the future. It was seen that the professional development and research of the lecturers should be one of the keys for the future joint programs. An exchange program between the instructors who teach a same subject might be a first step, because it was shown to be a tremendously effective way if we consider the cost related problems for school management. During the exchange programs this time, we provided one day trip to Peace Memorial Park, Itukusima shrine and Onomichi old down town. MUST students could understand Japanese culture and geography very well. Hosting MUST gave a chance to many Yuge students to study English without any extra personal cost. It is very important to learn English and also to understand inter-cultural background to be able to communicate with international colleagues in the future. A questionnaire survey on the exchange program in 2018 has been performed for Yuge and MUST students, especially on communication, research project and educational effects. Statistical results of the survey will be presented. We conclude the program was successful to enhance the motivation of the students to become global workers.

Keywords: *Development of global human resources, International student*

Introduction

Development of global human resources is one of the most important issues in KOSEN in Japan. Yuge has been offering several international exchange programs that were carried out with the following partner institution. These include MUST for electric and mechanical technology department, NYK-TDG Maritime Academy (NTMA) in Philippines as part of "NYK Mirai Project" and Kauai Community College (KCC) in USA for maritime department, Nakhon Phanom University (NPU) in Thailand for information technology department.

The maritime technology departments in the five KOSEN (Toyama, Toba, Oshima, Hiroshima, Yuge) face modern challenges to improve the classical maritime English education which is typical in Japan. With the aim to enhance the motivation and ability of students to become skilful ship officers and managers overseas, three government sponsored projects had been carried out recently. These are "All maritime college study method improvement project" in 2006 – 2011 and "Maritime human resources developing project" in 2012 – 2017 and "Next generation maritime human resources developing project" in 2018 – present. Joint research project, **"**Joint Development of the Robot for Automatically Measuring the 3D depth profile of the Mekong River" was hold**.**

Also several international exchange programs have been developed to achieve this goal since an official agreement between Yuge in Japan and MUST in Mongolia entered into force in 2014. Joint research project, **"**Monitoring PM (particulate matter) 2.5 at Yuge island and Ulaanbaatar city" was held in the previous years**.** Yuge has sent four 4th grade students and an instructor to MUST for an international exchange program carried out for 14 days in August 2018. MUST sent four 3rd grade students and two instructors to Yuge for 13 days in November 2018 and joined graduation research, specialized subject and basic subject at regular classes, and cultural exchange activities. Experience of staying in Mongolian countryside gave deeper undestanding of nomad cultures. Also experiencing the

Year		15	16	17	18
Dispatch	Student	8	3	-	-
	Instructor	2	1	-	-
Acceptance	Student	5	4	-	4
	Instructor	2	1	-	2

Table 1 Number of participants for exchange program.

life near the ocean gave deeper undestanding of sea and Japaneses cultures. In this paper, we will focus on international exchange programs that MUST visited to Yuge.

Materials and Methods or pedagogy

Daily schedule of this program is shown in Table 2. We implemented a buddy system that makes pairs between Yuge and MUST students in order to let each pair work together in a same lab. The system worked very well as it helped them to have a lot of English conversations and stimulated mutual understanding between the students.

Day	Activity
1	Arrival to Hiroshima air port
2-3	School festival Introduction presentation of school, culture and geography Serving typical Mongolian food, Buuz Boarding to training ship
4-8	Welcome party Introduction presentation of themselves, school, culture and geography Join graduate research Join specialized and basic subject at regular classes, Experience of ship manoeuvre simulator
9	Trip to Peace memorial park and Itsukushima Shrine in Hiroshima city
10	Shopping at Fukuyama city
11	Join graduate research
12	Trip to Senkouji park, old down town and hot spring in Onomichi city
13	Departure form Hiroshima air port

Table 2 Day schedule of the program

Buddy system which makes a pair between Yuge and MUST student was employed to take care MUST students. They attended classes together and had meals together at canteen. They attended the same school activities with the buddy.

MUST students boarded on the school training ship, Yuge Maru for one round trip of Yuge island. Yuge 5th grade students explained about the training ship in English. They tried the ship handling. Seeing and feeling the sea became a precious experience for the Mongolian students who live in an inland country.They participated in ship manoeuvre simulator training too.

At the school festival MUST students served typical Mongolian dish, Buuz. They performed introductory presentation on their school, culture and geography in English with posters for visitors. Also at the welcome party they had presentations introducing themselves, their school, town, culture in English to Yuge students.

They participated in the specialized and basic subjects at regular classes nevertheless most of the classes were taught in Japanese. They also participated the traditional Japanese hand writing class. It was a good opportunity to experience the Japanese culture.

During the exchange programs this time, we provided one day trip to Peace Memorial Park, Itukusima shrine in Hiroshima city, and old down town, Senkouji

Photo 1 Board on school training ship, Yuge maru

Photo 2 Ship handling of MUST students

Photo 3 Explanation in English by Yuge 5th grade students at the training ship engine control room

Photo 4 Experience of ship manoeuvre simulator

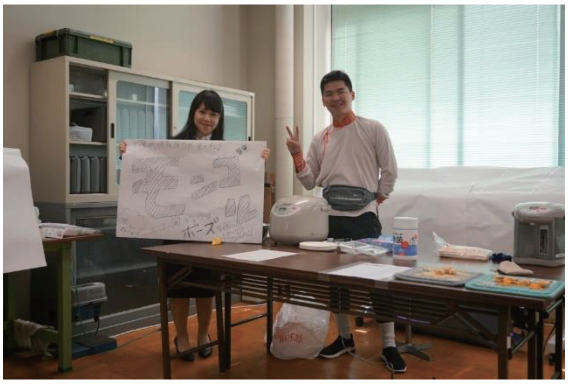


Photo 5 Mongolian dish, Buuz by MUST students tasting at the school festival

Photo 6 Introduction presentation by MUST students at welcome party

Photo 7 Traditional Japanese hand writing class with MUST students

Photo 8 One day trip to Itsukushima shrine with MUST students

park and hot spring in Onomichi city. The students had a special experience that they used English to communicate.

Each MUST student joined a graduation research at different laboratories. A student at Yuge helped the exchange student to do the graduate experiment or research. It made them use English.

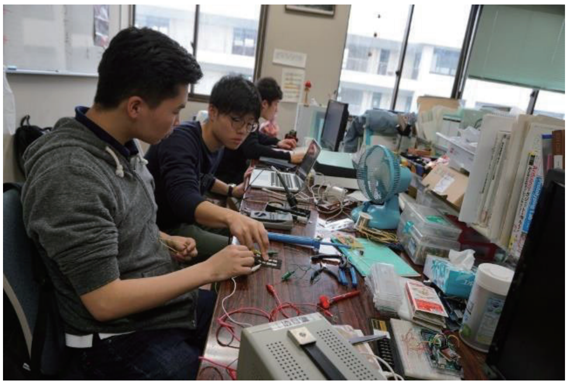


Photo 09 At Kuzume lab., assembly electric circuit of pressure sensor control unit.

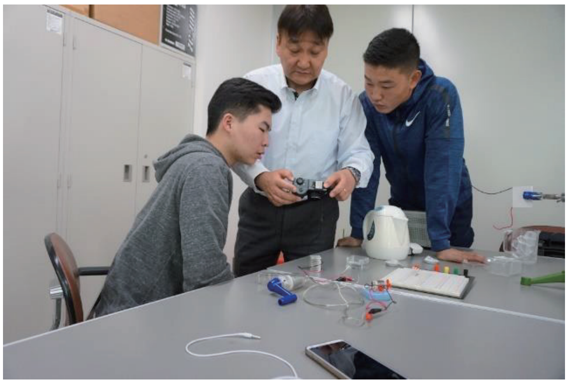


Photo 10 At Ito lab., measurement of PM 2.5 form Stirling engine with coal

Photo 11 At Yanagisawa lab., measurement of scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDXS) for multiferroic $0.7BaTiO_3$-$0.3Pr_{0.65}Ca_{0.35}MnO_3$ core shell ceramic for the multi-functional application devices

Questionnaire for Yuge and MUST students for the program in Yuge in 2018 was performed to evaluate educational effect of the program as shown at Table 3.

Choose one number from below for each question.

1: Very false 2:False 3:Neither true and false 4:True 5:Very True
About communication:
Q. 1.1 Can you recognize English pronunciation?
Q. 1.2 Can you understand English meaning?
Q. 1.3 Could Yuge student ask questions from you in English?
Q. 1.4 Were you able to perform the project in harmony?
Q. 1.5 Could you communicate and understand well your buddy student (personally)?
Q. 1.6 What kind of topic was easy to communicate?
1:Hobby 2:Reserch project 3:Technical subject 4:General subject 5:Social system 6:Culture
Q. 1.7 What kind of topic was difficult to communicate?
About research project:
Q. 2.1 Was the research project successful?
Q. 2.2 Could you proactively participate the project?
Q. 2.3 Was the issue of project proper?
Educational effect for the program:
Q. 3.1 Could you enhance your understanding for Mongolia [Japanese] through the program?
Q. 3.2 Are you more motivated to communicate with a foreigner now?
Q. 3.3 Are you more eager to study English now?
Q. 3.4 Are you more motivated to work internationally now?

Table 3 Questionnaire for Yuge and MUST students for the program in Yuge in 2018

In addition to the student-oriented exchange programs, a non-native English speaker instructor from Yuge had performed a lecture in English on a technical subject (Electromagnetism) which is taught on a regular basis at maritime department 2nd grade class. It is very important to train the instructors to teach their subjects in English as they will continue to help the students in the future. It was seen that the professional development and research of the lecturers should be one of the keys for the future joint programs. An exchange program between the instructors who teach a same subject might be a first step, because it was shown to be a tremendously effective way if we consider the cost related problems for school management. Questionnaire for Yuge students on the lesson was performed to evaluate the educational effect is given in Table 4.

Photo 09 A non-native English speaker instructor from Yuge performed lectures in English at regular class.

Q. 1. Write down good points of the lecture.
Q. 2. Write down difficult points of the lecture.
Q. 3. Self-evaluation during the lecture.
Q. 4. Understanding of the lecture
Q. 5. Evaluation for the lecture.
Q. 6. Could you listen teacher's English pronunciation?
Q. 7. Could you understand teacher's English meaning?
Q. 8. Can you answer a teacher's question in English?
Q. 9. Can you present a teacher's task in English?
Q. 10. Do you like this class style?
Q. 11. Are you more motivated to study abroad?

Table 4 Questionnaire for Yuge students on Electromagnetism class taught in English

Results and Discussion

Yuge and MUST students could communicate very well in English with their buddy at laboratory as shown in Fig 1 and 2. They are mature as 2nd and 3rd grade students at university and some of them have experience of international exchange programs or abroad study. They can also manage non-English communication like gesture, showing picture and so on. Communication skill is not equal with English skill. Hobby and culture are easy topics to communicate because of the common background. Research project and technical subject are difficult topics because of no common background.

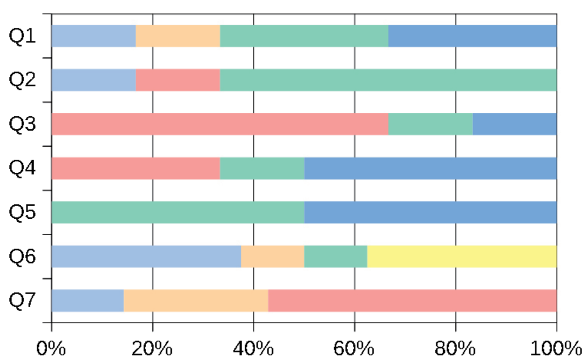


Fig. 1 Statistical results in percentage of the questionnaire survey about communication for Yuge students for the program at Yuge in 2018.

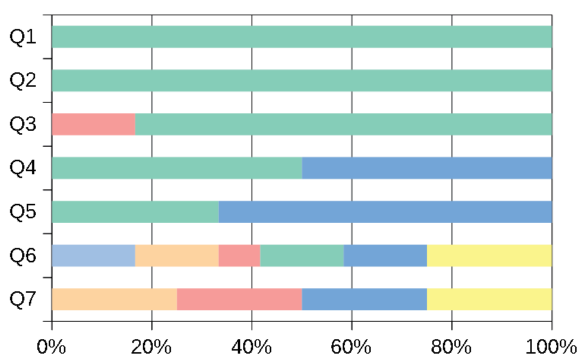


Fig. 2 Statistical results of the questionnaire survey about communication for MUST students

The research projects held at each laboratory were very successful as shown in Fig 3 and 4. This type of program is very good for international exchange programs. In small groups, there were many communications between Yuge and MUST buddy student. We will do a new joint research project in the near future.

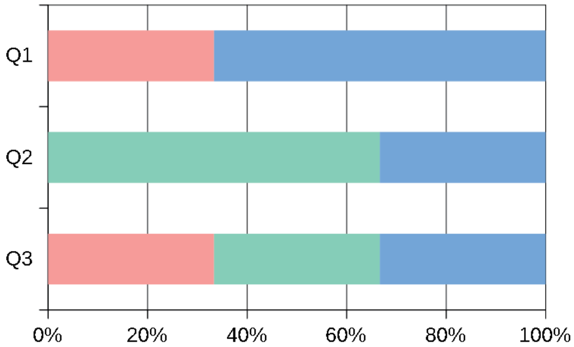


Fig. 3 Statistical results of the questionnaire survey about research project for Yuge students

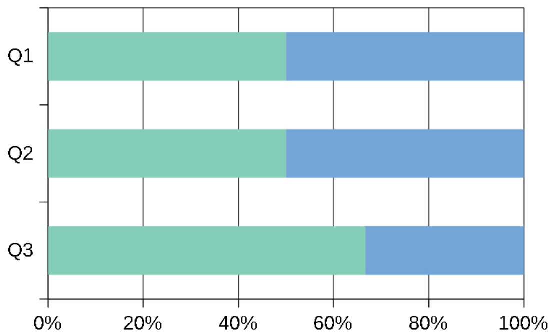


Fig. 4 Statistical results of the questionnaire survey about research project for MUST students

All sectors show remarkable motivation enhancements for Yuge and MUST students as shown in Fig. 5 and 6. Hosting MUST gave many Yuge students a good opportunity to practice English without any extra personal cost.

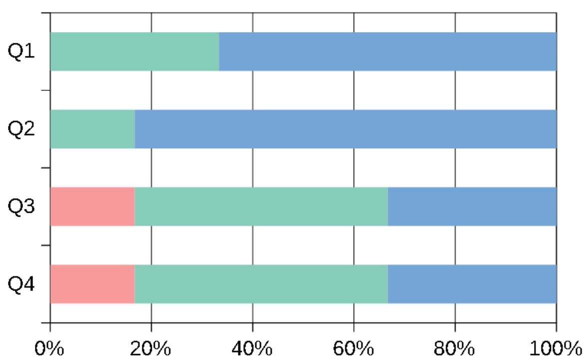


Fig. 5 Statistical results of the questionnaire survey about educational effect for MUST students

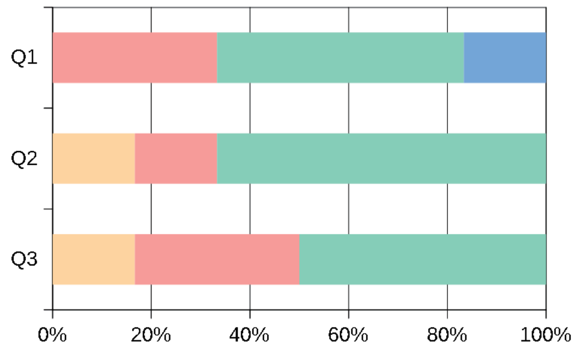


Fig. 6 Statistical results of the questionnaire survey about educational effect for MUST students

A lecture in English by non-native English speaker instructor was the 1st time at Yuge. As seen in Fig.7 it was favourable even though Yuge 2nd grade students had difficulty in English at the class. There are many tasks to consider for this kind of classes. Instructors need more preparations for class. More classes are needed to students to get used to this class. This kind of class is very important to prepare the students as global human resource and international exchange lectures are desirable in the future.

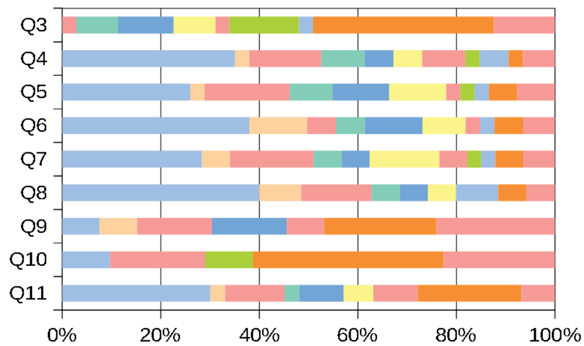


Fig. 7 Statistical results of the questionnaire survey for Yuge 2nd grade students for lectures in English

Conclusions

5th grade Yuge and MUST students could communicate very well in English with their buddy at their laboratory. This experience of international exchange program enhances English communication ability and international common background.

Research projects at each laboratory were successful. In small groups, there are many communications between Yuge and MUST buddy student. There will be new joint research projects in the near future.

All sectors show remarkable motivation enhancements for Yuge and MUST students. Hosting MUST gave an opportunity to many Yuge students to practice English while doing their daily activities.

The lectures taught in English by a non-native English speaker instructor is a good start and was successful. There are many tasks to consider for this kind of classes. Instructors need to be prepared. More classes are needed so the students get used to English lectures. This class was a very important start to have international lecture exchange in the future.

Hosting MUST also stimulated mutual understanding and helped many Yuge students to enhance their interest and understanding overseas as well as to improve their English. It is very important to learn English and also to understand inter-cultural background to be able to communicate with international colleagues in the future. We conclude the program was successful to enhance the motivation of the students to become global workers.

Acknowledgements

The projects were supported by the Japan Student Services Organization (JASSO) Student Exchange Support Program; grants from "Shimanami Techno Partners", Yuge College Fund for Advancement of Science and Technology and Mongolian University Science and Technology.

References

Ganbat, D., Kuzume, K., Fujimoto, T., Sarangerel, K., Boldbaatar, D. & Odonkhishig, B. (2017). Measurement of the air pollutants in Ulaanbaatar city –International exchange program between National Institute of Technology, Yuge College and Mongolian University of Science and Technology-, *Memoirs of the National Institute of Technology, Yuge College,* 39, 63-69.

G. Davaa, O. Jambala and K. Kuzume (2017). Developing Deeper Interests in Global Environmental Challenges. *ISATE18 Proceedings, 338–349.*

O. Yanagisawa1, J. Park, K. Fukudome, H. Ohyama, and R. Suzuki. Collaboration of international English educational programs to train international ship officer in Maritime Colleges in Japan. (2019). *ACEE2019 Proceedings.*

O. Yanagisawa1, J. Park, H. Ohyama, and S. HIDA. Implementation of an International Maritime English Educational program at Maritime Technology departments in five NIT in Japan. (2018). *IMEC30 Proceedings.*

J. Park and O. Yanagisawa1. An international approach to improving the English proficiency of teachers in Japanese Maritime Colleges. (2019). *ACEE2019 Proceedings.*

S. Kubota, Y. Imai, T. Kyoden, K. Kinoshita, K. Maehata, O. Yanagisawa and K. Ishida. Development of Essential Personalities for Future Maritime Professionals - Education Programs Developing English Communication Skills-. (2018). *NAVIGATION, 203, 8-13*

H. Ohyama, T. Homae, S. Kubota, O. Yanagisawa and J. Park, Development of Essential Personalities for Future Maritime Professionals -International Internship Programs Developing Global Adaptability - (2018). *NAVIGATION, 203, 14-18*

T. Tabusa, T. Mukai, K. Kuzume, P. Supachai, K. Daosakul, (2014). Joint Development of the Robot for Automatically Measuring the 3D depth profile of the Mekong River -International Exchange Program Between Yuge National College of Maritime Technology and Nakhonphanom University-, *kosen kyoiku (37), 647-652.*

A trial of cooperative education program based on PBL with local communities at National Institute of Technology (KOSEN), Tomakomai College.

S. Nihashi[*,a], M. Muramoto [a], T. Suda [a] and A. Watanabe [a]

[a] Department of Engineering for Innovation, National Institute of Technology (KOSEN), Tomakomai College, Tomakomai, Japan

* sohey@tomakomai-ct.ac.jp

Abstract

National Institute of Technology (KOSEN), Tomakomai College opens a class of cooperative education based on PBL for the first-year students of the advanced course. For the cooperative education program, we had difficulties every year in the selections of companies and theme because those were based on personal relationships with the faculty staff. Since last year (2018), we have conducted a new trial to relieve the difficulties. Tomakomai College has a "cooperation association", which mainly consists of local companies. This association was established to encourage education and research of the college and to contribute for local community development through activities of technical support and re-education of engineers for local industries. We had asked the association to help for finding the companies that can do PBL by cooperating with us, and then we found six companies. This is twice as large as that in 2017 when there was a bias in the business type of the selected companies such as two chemistry and one information technology companies. This is mainly due to the specialty of the faculty staff and their relationship with companies. However, this was much improved in 2018. Last year, we conducted the program with two construction-related companies, two metalworking manufacturing industry, one office machine sales, and one chamber of commerce and industry. Accordingly, we were able to set a wide variety of themes. The results from the program were introduced in the middle and final briefing sessions. Especially, the final session was held in the first part of a symposium which was consisted of two parts. The symposium was held to commemorate the partnership agreement between Tomakomai College and local companies. The theme was "cooperative education based on PBL working with the local community". Many audiences including from the association member companies joined to the session. The presentations were generally well received, with many questions and comments from the participants. Also, some companies participated in the session had asked to join the cooperative education program for the next year. This is quite helpful to sustain our program.

Keywords: *cooperative education, PBL, local communities, local companies, advanced course*

Introduction

National Institute of Technology (KOSEN), Tomakomai College opens a subject of "off-campus training" for the first-year students of the advanced course. This subject aims to develop practical skills. The first-half semester is conducted as an internship with companies or public research institutes. A cooperative education based on problem-based learning (PBL; Wood, 2003) is conducted during the second-half semester. In the internship program, firstly, we give guidance and pre-training. The students learn the purpose and meaning of internship. Usually, information of internship from companies or public research institutes arrives at the college from May to June. This information is notified to the students through BBS on the college intranet. If there are some candidates on internship training in a certain initial period after the notification, we select an applicant for the internship among the candidates. The internship program is offered to students not only at the advanced course but also at 4th year of the KOSEN (associate degree) education course. The internship program is a required subject for advanced course students, while it is an optional course for the KOSEN course students. Information of the internship program is posted via the same BBS for students of both courses. We give priority to an advanced course student when students of both courses apply for the same program. If the initial period has passed, a candidate can apply to the internship program on a first-come-first-served basis. Also, there are cases where a student finds out an internship directly from such as a company website. The internship training is held during the summer holidays. The training period is from one to two weeks. Students prepare and submit a report after the training. And then, they make a presentation at the reporting seminar. In summary, the internship program consists of guidance, pre-training, more than a week internship training, report, and presentation.

As a subject of "off-campus training" in the second-half semester, we have conducted a cooperative education based on PBL with companies, local government, and their related organizations for several years. The locations of the companies cooperating to the subject are mainly in Tomakomai and the surrounding area. In the class, students work on a task given by the local company with the support of the employee. In the first week, the faculty staffs of the Tomakomai College explain the schedule and make groups for the 20–30 students. The number of groups depends on cooperating companies. The tasks are directly explained to the students by people from the companies in the second week. After these, the students examine and discuss the task for 12-weeks. A mid-reporting seminar is held to check the progress. The students communicate with the corresponding people of the companies by e-mail or telephone for working on the task. Although the number of times is limited, the students can visit the companies. A final reporting seminar is held in the 15th week, which is the final week, by inviting the related people from the companies, and the presentations are evaluated. The companies that cooperate with us had been selected and requested based on personal relationships with the faculty staff of the advanced course. This leads to difficulties in the selection of companies every year. The numbers of the companies had been limited to only 2–3, and accordingly, there was a bias in their business types.

Tomakomai College reorganized the KOSEN education course in 2016 (Figure 1). The five specialty departments were united to one which is “Department of Engineering for Innovation” (Nakano, 2017). The first-year students have the same lectures regardless of their potential specialty (we call this as “mixed class”). And then, they belong to five specialty divisions from the second year. One of the features of this reorganization in 2016 is the establishment of "Frontier Course" in addition to the 5 specialty courses for the 4th- and 5th-year students. This Frontier Course aims to develop "Hybrid Innovation Human Resources" with knowledge of management and specialized skills. A subject "Business III" for the 5th-year students, which is going to implement from 2020, will be conducted jointly with the "off-campus training" for students of the advanced course. Here, the advanced course students are expected to take on the role of leaders. It is necessary to increase the number of companies that can cooperate with us to achieve the project mentioned above. This paper introduces a new trial at Tomakomai College for finding participant companies.

Method

We are trying to change a method to find out companies that can join cooperative education with us to increase the number of participant companies. Specifically, we have asked the outer association related to the college (“cooperation association”, described below) to find participant companies. This is different from the previous way, which mainly depends on a personal connection of the faculty staff. We expect that we can set a wide variety of themes in this new method. Further, the new one can lead to saving the time of the faculty staff.

The cooperation association was established to encourage education and research of the college and to contribute for local community development through activities of technical support and re-education of engineers for local industries. The cooperation association mainly consists of local companies. Recently, the number of association members has been increasing. The membership number was 148 in 2018, and soared to 185 in June 2019. Along with this, the members in other areas in Hokkaido and outside Hokkaido has also increased.

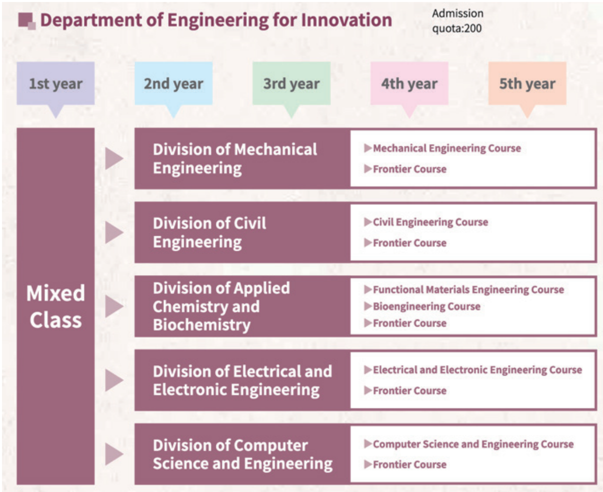


Figure 1. Schematics of the new KOSEN education system in Tomakomai College since 2016 (from Guide Book of National Institute of Technology (KOSEN), Tomakomai College, 2019).

Results

We have started to ask the cooperation association for finding participant companies from 2018. We sent an invitation letter to the members by way of the association in May. Because cooperative education starts from the second-half semester (October), we set the deadline for the application in July. This is due to make time to discuss and prepare the cooperative education program. However, in 2018, there were no applications by the deadline. This would be because the companies couldn’t fully understand the content or necessity of the cooperative education program. Also, it can be considered that we couldn’t sufficiently explain what kind of merit is brought to the companies by conducting the cooperative education program. Based on this situation, we asked the leader of Frontier Course of Tomakomai College, who had many opportunities to meet with various companies, to explain the cooperative education program to companies and request to participate in it. Finally, we found six companies that can do PBL with us. The themes were set to solve a task in local companies or to contribute to the local community. Because there were 26 students in 2018, we can make groups with 4–5 people for each theme. The experiences of the task solution process in a group with the supporting from people working in a society like a company engineer should be quite meaningful for the students who will work at a community in the future. The business type and the theme of each participant companies are summarized below. The specific name of the companies is not shown arbitrarily here.

- Company A: Surveying and construction consultant, "Use and diffusion of geospatial information"
- Company B: Office equipment sales, "Produce our town"
- Company C: Metal processing industry, "Construction of monitoring system for laser punch complex machine"
- Company D: Building related work, "Consideration for the spread of outside heat insulation method in condominiums"
- Company E: Metal products manufacturing industry, "Development of B to C products using a copper alloy"
- Organization F: Chamber of Commerce and Industry, "A town planning vision of Tomakomai by Tomakomai College students"

Four of all six companies and organizations are located in the local area, Tomakomai. The remaining one is in Sapporo, and the other is in Otaru, all of which are relatively nearby of Tomakomai. In 2017, the cooperative education program was conducted with three companies for 23 students. A number of the participated companies in 2018 is twice as large as that in 2017, when there was a bias in the business type of the selected companies such as two chemistry and one information technology companies. On the other hand, in 2018, we were able to set a wide variety of themes.

The tasks were directly explained to the students by people from the companies in the second week. A corresponding person of the companies who want to check the progress came to a mid-reporting seminar held in the college. The results from the cooperative education program were introduced in the final-reporting seminar which was held on February 2019 as a part of symposium whose title is "cooperative education based on PBL working with the local community" (Figure 2). The symposium was held to commemorate the partnership agreement of Tomakomai College with "Tomakomai City" and "Chamber of Commerce and Industry of Tomakomai" in October and November 2018, respectively. About 100 people had participated in the symposium from local companies, including member of the cooperation association. The symposium consisted of two sessions. The first one is the final-reporting seminar. The presentations were generally well received, with many questions and comments from the participants. Also, some companies participated in the session had asked to join the cooperative education program in 2019 (the next year). The second session was a panel discussion whose theme was "cooperative education based on PBL working with the local community - effectiveness and issues of the education". The four panelists, mainly composed of people from other colleges, explained the current situation and issues of the cooperative education program that each organization had been working. And then, active discussions on the cooperative education program were held.

Figure 2. A photo of the final-reporting seminar of the cooperative education program which held as the first session of a symposium: "cooperative education based on PBL working with the local community".

In 2019, we are currently recruiting participant companies. We sent an invitation letter to the member companies through the cooperation association in May. We have received five inquiries by the end of June. In late June, the general assembly of the cooperation association was held in Tomakomai. In this assembly, the director of the advanced course of Tomakomai College explained the cooperative education programs directly to the member companies. Application for the program by potential participation companies is earlier than last year (2018). This is probably because the companies have understood the content and necessity of the cooperative education program to some extent because many companies listened to the presentation by students in the final-reporting seminar last year. Further, the companies also have understood what kind of merit is brought to them by conducting the cooperative education program. The business type of each potential participants in 2019 are summarized below. The theme is considering now. The specific name of the companies is not shown arbitrarily here.

- Company A: Information technology company
- Company B: Information technology company
- Company C: Machinery tool company
- Association D: Local store association
- Company E: Japanese restaurant company

Two of the five companies are located in Sapporo. Other two companies are located in Tomakomai. Because the other one is in Tokyo, they still have been considering participation. Remote companies have increased for this year at the present. The number of students in 2019 is also 26. If this recruiting process has gone well, we expect that we can find out six companies as in the case of last year.

Summary

This paper introduces a new trial at the advance course of Tomakomai College for finding local companies that can participate in the cooperative education program. For carrying out the program, we had difficulties every year in the selections of the companies and theme. This is because the selection was based on personal relationships between the faculty staff and companies. Thus, the numbers of the companies had been limited, and accordingly, there was a bias in their business types. In Tomakomai College, the cooperative education program with local companies in the advanced course is going to conduct jointly with the 5th-year students of the KOSEN course from 2020. For achieving the new program, it is necessary to increase the number of companies that can cooperate with us. Further, the reclute of the companies should be made systematically, not by personal relation. From 2018, Tomakomai College has started to ask the cooperation association for finding participant companies. However, we couldn't find out the companies last year with this procedure. This would be mainly because the companies couldn't fully understand the content or necessity of the cooperative education program. Also, it can be considered that we couldn't sufficiently explain what kind of merit is brought to the companies by conducting the cooperative education program. On the other hand, in 2019, we have still been recruiting participating companies, but we have already received inquiries from more companies than last year. This improvement is considered to be due to the fact that the results from the cooperative education program were introduced in the final-reporting seminar as a part of symposium whose title is "cooperative education based on PBL working with the local community" last year (2018). Many audiences including from the association member companies joined to the seminar. We could introduce the approach of our students to the cooperative education program in the seminar. And accordingly, the companies would be able to understand the details of content and state of the cooperative education program. We consider that it is quite important to introduce the content of the cooperative education program to the outsiders to continuously carry out the program. Based on this, in 2019, we plan to make the final reporting seminar of the cooperative education program for inviting many people as in the case in 2018.

Tomakomai College have opened a satellite office "C-base" on October 12, 2018 (Figure 3). This "C-base" plays a role as a window of technical and management consultation for the local community. The main purpose is to help to solve problems of local companies with help by experts from Tomakomai College, Tomakomai City, and Tomakomai Chamber of Commerce and Industry. For the convenience of companies, the "C-base" was set up in the center of Tomakomai City, not in the site of Tomakomai College, which is located at suburb. We are also considering to utilize the "C-base" for finding companies that can participate in the cooperative education program in the future.

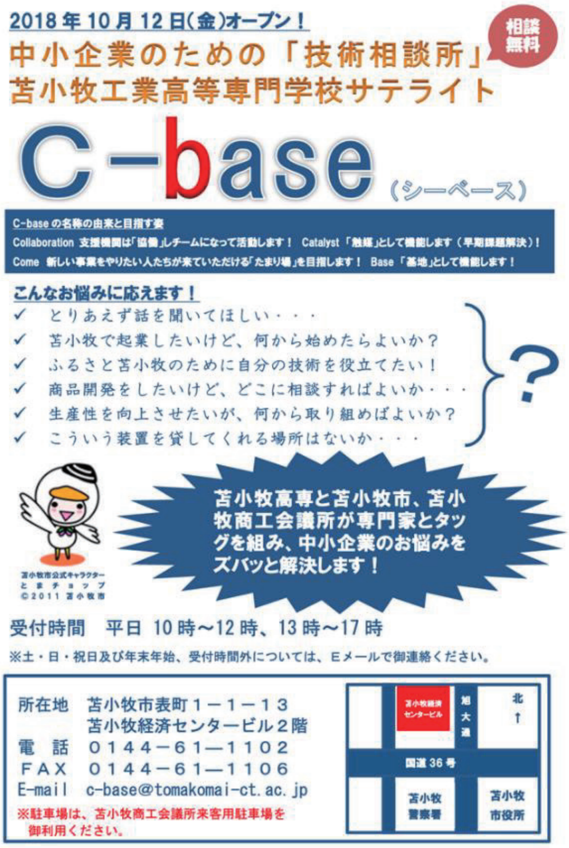


Figure 3. Hand out for introducing "C-base" (in Japanese) from website of Tomakomai College (https://www.tomakomai-ct.ac.jp/collaborate/consulting).

Acknowledgements

We appreciate the "cooperation association" of Tomakomai College for helping with us conducting our cooperative education program.

References

Wood, D. F. (2003). "ABC of learning and teaching in medicine: Problem based learning". *BMJ.* 326 (7384): 328–330. doi:10.1136/bmj.326.7384.328.

Nakano, W. (2017). Advancement of Education System in a College of Technology, *Memoirs of National Institute of Technology, Tomakomai College*, No. 52, 25-29 (in Japanese with English abstract).

National Institute of Technology (KOSEN), Tomakomai College (2019). *Guide Book of National Institute of Technology (KOSEN), Tomakomai College 2019*, pp. 25.

Developing Cross-Cultural Awareness in Provincial Hokkaido by Connecting Exchange Students and Kosen Japanese Students

D.Taquet[*a], M. Ono[b], M. Krause-Ono[b], and M. Kuriyama[c]

[a] National Institute of Technology Hakodate College, Department of General Education, Japan
[b] Muroran Institute of Technology, College of Liberal Arts, Faculty of Engineering, Japan
[c] National Institute of Technology Tomakomai College, Department of Engineering for Innovation, Japan

* dtaquet@hakodate.kosen-ac.jp

Abstract

Japan has been able to greatly increase the number exchange students in higher education, as a way to improve its global ranking and competitiveness on the international scene. As of May 2018, there were 298,980 international students in Japanese higher education and language institutes. Through various coordinated efforts, the government has so far been successful in reaching a steady increase of 12% each year since 2015, based on the JASSO (Japan Services Student Organization) survey.

However, not all regions or prefectures are equal in this effort. Indeed, data show a great discrepancy between urban areas, and provincial Japan, the Kanto region, and unsurprisingly the greater Tokyo metropolitan area, concentrating close to half the total population of international students.

As teachers in the Hokkaido area, that only hosts 1.7% of those students, our goal with this practical research is to provide more opportunities for local students to interact with their international counterparts. As cross-cultural understanding, and development of autonomous communication methods, English is a tool, not a finality.

The three-step approach, spread over 3 years, consists first in 2-day seminars, then written communication using Moodle chatrooms, and finally group videolink discussions with Skype or GInet.

In this presentation, we will focus on the rationale behind the project, the challenges we have encountered and how the use of technologies have provided some answers for the development of a better, and more effective framework.

The authors of this study believe it will provide valuable data and a solid framework that could be applied in other technical institutes all through Japan.

Keywords: *international exchange, intercultural communication, global studies in provincial areas, collaborative learning between Japanese and foreign students*

Introduction

Globalization of technical education and cross-cultural communication have been bustling concepts in the technical programs all over the world for the past few years. However, in order to develop such skills, and ambitions, Japanese students must first be accustomed to communicating with foreigners, to apply their classroom knowledge to practical communicative situations. This opportunity is readily available in large Japanese cities, or large universities which have a large foreign exchange student body, but what can be done for smaller cities and universities? The goals of the present educational research were to provide Japanese students with opportunities to get engaged into multicultural, multiracial, and multi-lingual environment. Furthermore, for the purpose of this study English is not considered an objective, but a tool among others to successfully achieve cross-cultural understanding. Finally, in a globalized, ultra-connected world, the constant flow of information and news makes it hard, and sometimes impossible to identify, and retain important world events, and cross-cultural affairs. This project also put the emphasis on urbanism, environmental issues, and disaster preventions in several countries.

Objectives

This research group was formed through a clear objective: analyse, encourage, and develop best practices for cross-cultural communication through a variety of methods. We based our methods and efforts on an approach that was previously conducted by Ishikawa, Matsuda, and Ono (2009) to ensure access to direct intercultural exchange for students located in regional areas.

The area we are focusing on in this research is located between the southern and central parts of Hokkaido, where are based the three higher education institutions our team members work at: NIT Hakodate College, Muroran Institute of Technology, and NIT Tomakomai College (Figure 1).

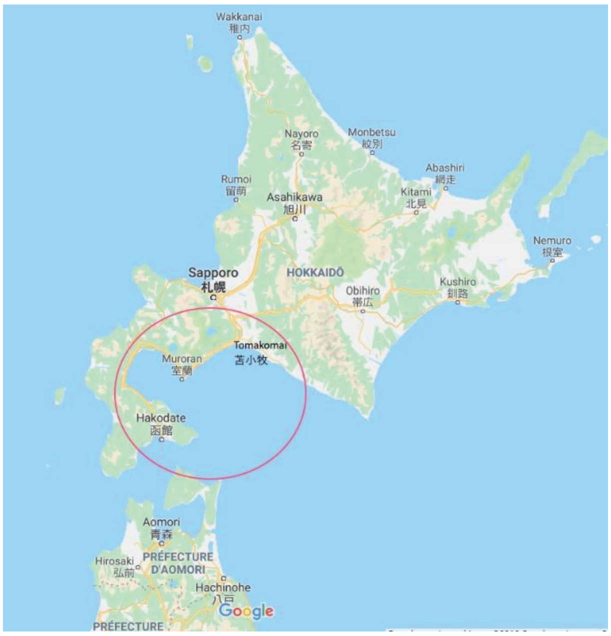


Figure 1. Location of the research team members.

Hokkaido, the northernmost island of Japan, and by far the largest prefecture, is only home to 5.4 million people, for a density of 64.5 people per inhabitable km2. As point of reference, Tokyo's density is 6168, Osaka is 4639.

With only 1.7% of Japan's total number of exchange students, and a density just 1% percent of that of Tokyo, we can understand that the chances of interactions are few and far between. Even then, most of Hokkaido exchange students are centralized at Hokkaido University in Sapporo, which gathers 2349 of the 3614 foreign students in the prefecture.

As such, we can see the importance of developing such opportunities for communication in rural areas such as ours. The timeframe of this research was divided into 3 distinct parts.

Educational Practices Step 1: On-Site Seminars

First, and what we felt what the most important, were the camp training lessons. There, Japanese students were invited along their international counterparts to two on-site educational gatherings.

The first seminar was held in the sounthernmost city of the group, Hakodate.

The seventeen participants, who had been recruited from each of the institutes, represented five countries: China, Cambodia, Japan, Malysia, and Mongolia. The engineering field were also varied: chemistry, production systems, mechanical, civil, electrical, and information science. (Figure 2).

Held during students' free-time in early December 2017, the main theme of the seminar was the introduction to cross-cultural communication, along with with a lecture comparing urbanism and city development between the three research cities (Hakodate, Muroran, and Tomakomai). This lecture was given in Japanese by M. Kuriyama, professor of civil engineering in the deprtament for engineering innovation at NIT Tomakomai. The students, divided into groups, also had an opportuinity to reflect upon stereotypes, and how they influence communication.

Figure 2. Students presenting some aspects of their cultural background in Hakodate.

The second on-site seminar took place during a 3-day weekend in October 2018 in Otaki seminar, Date city, west of Tomakomai. The theme of that seminar was one that echoed with all students-Japanese and foreign-Disasters; their prevention, human causes, and effect they have on city planning and environment. 19 students from the following areas were represented: India, Indonesia, Japan, Malaysia, Mongolia, Thailand, Vietnam, each group being led by a PhD student from that country, who were studying at MIT. Although group discussions were conducted in Japanese and English, students had to focus on creating a presentation in English. The educational practice was two-fold: visiting a location that had been hit by a disaster near Toya Lake, and for students to use their engineering skills to discuss and reflect upon disaster prevention methods in the four countries (Figure 3).

Figure 3. One of the groups brainstorming ideas for their poster session. 3 countries were represented in that group (Japan, Thailand, and Mongolia).

The discussions had all the more impact that it took place a few weeks after the large 6.6 magnitude hokkaido earthquake on September 6th 2018. Most students, both Japanese and international, were in Hokkaido during the disaster and were able to share their impressions, memories, and fears about the earthquake.

Students were also taken to lake Toya, famous for its beautiful scenery but also for bearing the marks of a recent volcanic erruption. Indeed, Mount Usu errupted in

2000 spewing burning gases and mud. It was the mud slides that had the most impact on local towns, destroying whole roads and buildings on their path (Nakano). Although no one died, the damage incurred was estimated to be 10.3 billion yen (approx, 92 million US dollars), and 4700 inhabitant of nearby municipalities had to be evacuated (Figure 4).

Figure 4. A residential building, swept by a mudslide near Toya Lake.

Students participating in the research groups were able to see first-hand the immense power and potential for destruction that such disaster could bring to nearby locations. It also motivated them to create posters describing environmental issues in the 4 countries of the PhD students, who led each group (Figure 5).

Figure 5. Group picture with students holding their posters.

Educational Practices Step 2: Moodle Communication

Once the on-site camps have been completed, our next task was to set up a moodle-like textchat system for students to participate. Indeed, creating a balance between teacher control and student autonomy, a moodle-like system will not only help them improve student's comprehensive language ability, but also their autonomy, a key-component in learners' motivation, through peer communication (Ma, 2016). Unfortunately, and quite ironically, while setting the communication modules was systematic, the authors did not anticipate that motivating the foreign students to join, and participate would be much more challenging a task. Some reasons include, but may not be limited to: school/university calendar differences, different approach to digital literacy, lack of motivation, different culture.

Future Practices

At the time of this paper's submission, the authors are planning another on-site training that will also include digital literacy reinforcement. Indeed, a group of Italian students from a technical high-School coming to NIT Hakodate College in early September of 2019, will participate in a seminar in Otaki.

Furthermore, the final stage in our three-step objective will be to create video-links using BlueJeans or Skype, giving more autonomy to students, reinforcing their motivation, and thus creating a long-lasting communication line between the Japanese and foreign students. As Information and Communication Technologies (ICT) are used and developed differently in Italy and Japan, putting these protocols in place will require precise communication, and dedication between the teachers and students of the various schools and countries.

We are hoping to gather empirical data on students' motivations through questionnaire, thus leaving the possibility for further improvement in a follow-up research.

Conclusions

The objectives of this research were quite ambitious to begin with. We wanted to offer Japanese students from provincial areas an opportunity, a gateway to cross-cultural understanding, while expanding their horizons concerning issues that future technicians and engineers will need to focus on and solve: environmental changes, and disaster preventions. The first part of the project was succesful, but a lack of coordination between group members, and difference in school calendars made participation to digital communication harder to set up and enact. Further reflection is needed to analyze, and overcome the logistical challenges.

Acknowledgements

This research has been funded through the JSPS KAKENHI program, Grant Number JP17K02921

References

Ishikawa, N., Matsuda, K. and Ono, M., 2009, International Video Conferencing Classes with Communication-Based Activities (Japanese). *The Council of College English Teachers Research Reports*, 28, 25-34.

Japan Student Services Organization, 2018, *The Current Situation of Accepting International Students in Higher Education Institutions.* Retrieved from: https://www.jasso.go.jp/en/about/statistics/intl_student_e/2018/ref18_03.html#no6

Ma, J, 2016, The Application of Moodle-Based Platform in College English Learning. *Sino-US English Teaching,* 13, 332-337

Nakano, M., 2002, Eruption of Mount Usu. March 31, 2000 at Mt. Usu in Hokkaido. Retrieved from http://www.sozogaku.com/fkd/en/hfen/HA1000619.pdf

DEVELOPMENT OF THE CAPSTONE INNOVATION PROJECT COURSE - ANALYSIS OF PROJECT ASSIGNMENTS AND STAKEHOLDERS

J. Roslöf

Faculty of Engineering and Business, Turku University of Applied Sciences, Turku, Finland

janne.roslof@turkuamk.fi

Abstract

Capstone Innovation Project is a course at Turku University of Applied Sciences (TUAS) that many Bachelor's students complete during their second or third year. The projects are based on assignments given by external stakeholders, typically local companies or other organizations. Most of the assignments are multidisciplinary and, accordingly, the project teams consist of students from different subject fields and programs. Initially, the course was introduced into certain TUAS's curricula inspired by the CDIO Initiative (www.cdio.org) and its goals to include different design-implement experiences to the engineering programs. In addition to the aim of providing interesting and state-of-the-art applied topics for the students and facilitate their learning, the goal of the course was from the beginning to improve the collaboration with the local companies and organizations as well as to benefit regional development. The course concept has been developed during several cycles based on the experiences and feedback from faculty members, students, and project customers. In this paper, the course concept and its different development phases are shortly described. Special focus is set to illustrate and analyze the topics of the project assignments and their development during the course cycles. The first pilot implementation contained only two projects and a handful of students in 2012. In 2018-2019, the course was participated by a significant number of students and there were 34 different projects running simultaneously. That is, it is interesting to study the types and domains of the project assignments and the backgrounds of the project owners. Which type of topics are given to the student groups? Have the profiles changed during the years, as the concept has been expanded and improved? The analysis is based on the public project descriptions from seven academic years between 2012-2019.

Keywords: *Collaborative Learning, Learning Outcomes, Project-Based Learning, Regional Development, University-Industry Collaboration*

Introduction

In autumn 2012, a new Capstone Innovation Project course based on the inspiration of the CDIO Initiative (www.cdio.org) was piloted at Turku University of Applied Sciences. According to the CDIO standard number five (CDIO, 2010), a CDIO program curriculum should include two or more design-implement experiences, including one at a basic level and one at an advanced level. Although different student projects had been a part of the studies for a long time, there was no systematically coordinated course framework to enable advanced multidisciplinary project participation for the students at TUAS. The development need concerning this advanced-level Capstone project, in particular, was identified as a part of the stepwise CDIO adaptation process self-evaluation of our degree program curricula.

Encouraged by the positive experience from the pilot projects, the course was extended in autumn 2013 to cover a larger group of the students; first the Bachelor's programs in Information Technology, Electronics, Business and Library and Information Services, and later several other degree programs and disciplines. Today, the Innovation Project is included in most of the Bachelor's Programs of the Faculty of Engineering and Business at TUAS. Yet the concept has been further developed during each iteration, the pedagogical and implementation model still follows rather closely the one documented by Kulmala, Luimula and Roslöf (2014).

The innovation project is implemented in multidisciplinary teams of 6-10 mainly 3rd-year students. The course allows students to develop a prototype solution to a problem or need of a real client. The project covers the whole life cycle of a product development process from an initial idea phase to the closing of the project. The pedagogical framework of the course includes innovation pedagogy (the general pedagogical model of TUAS; see e.g. Lehto, Kairisto-Mertanen and Penttilä (2011)), problem-based learning and project-based learning. User-centered methods are applied in the planning phase of the project, and agile methods are used in project implementation.

Today, there have been seven academic years of Capstone Innovation Project rounds at TUAS. This paper focuses on describing the project assignment topics and

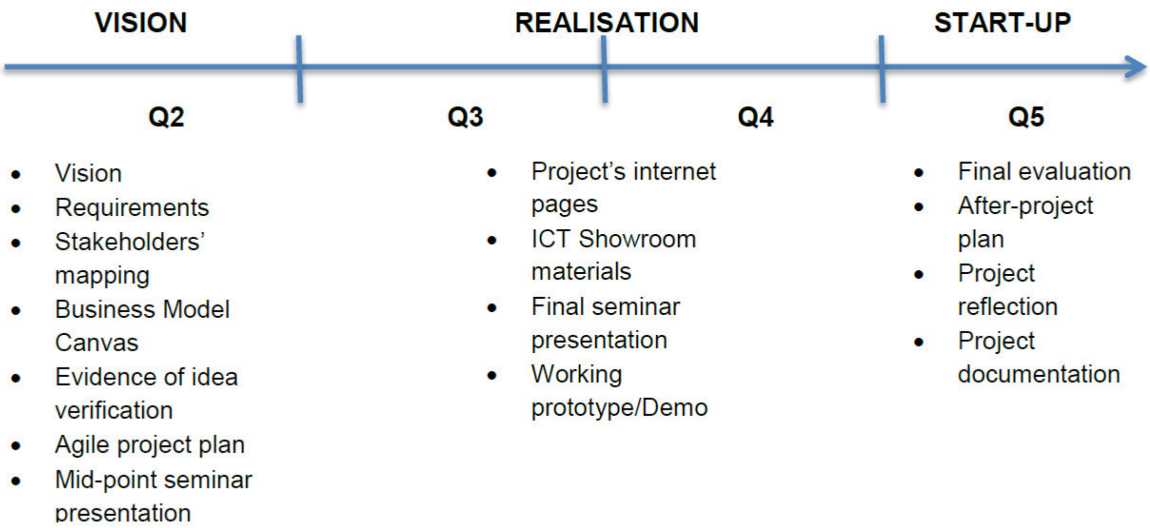


Figure 1. Original TUAS Capstone Innovation Project course structure and outcomes (Kulmala, Luimula & Roslöf (2014)). The parts of the course timeline refer to TUAS five teaching periods (Q1-Q5); the course starts mid-October (beginning of Q2) and ends by the end of May (end of Q5).

types as well as analyzing how the project portfolio has developed throughout the years.

Method and Data

The project assignments were analysed based on the descriptions documented on the general website of the course (http://capstone.dc.turkuamk.fi). The project description of each assignment provides a short description of the goals and contents as well as, in most of the cases, a reference to the project owner or customer.

The projects were categorized based on the following factors: 1) Academic year, 2) Domain, 3) Field of Application, 4) Technology area (if applicable), and 5) Type of the Project Owner/Customer.

The range of academic years covers seven cohorts starting from the pilot year 2012-2013 to the most recent academic year 2018-2019. The timeline of all the projects follows mainly the same flow. The new project assignments are negotiated by the coordinating teachers in August-October, the projects are started in late October and run until April-May next year. The rough timeline of a typical innovation project is illustrated in Figure 1.

The Domain category refers to the TUAS Bachelor's Degree Programs that are participating in the course. Yet many projects have a multidisciplinary nature, they are usually connected to one of the disciplines and the project owners are often members of the programs' collaborator networks. There has been a growing number of degree programs joining the course. The current selection has been as follows:

1) Business Administration
2) Chemical Engineering
3) Electronics
4) Information Technology
5) Library and Information Services

However, a small number of students from other programs (such as Mechanical Engineering) have also participated in the course. A set of structural changes has taken place in the degree programs during these years. For example, the program in Electronics has been merged into the program of Information Technology. These changes have not been fully reflected in the data collection and analysis but, instead, the domain of the project has been determined based on the topic of the assignment to maintain the same logic throughout the period of the study.

The Field of Application indicates the project owner's field of business or the operative environment in which the project results are planned to be utilized. Only one main field of application is determined for each project yet some of the projects could have been connected to several different areas. In some cases, it was difficult to place the project to a specific field in the first place. The following fifteen categories were used:

1) Business Marketing
2) Chemistry and Chemical Engineering
3) Civil Engineering
4) Culture and Arts
5) Education and Social Services
6) Entertainment and Media
7) Facility Management
8) Food Industry and Agriculture
9) Healthcare and Wellbeing
10) ICT, Electronics and Telecommunications
11) Manufacturing Industry
12) Service Business Design
13) Sustainability and Recycling
14) Tourism and Sports
15) Transportation and Logistics

Most of the projects are aimed to utilize certain technologies and/or engineering competences to reach their intended outcomes. Thus, it is interesting to categorize the projects also concerning this aspect. Again, each project was allocated to one technological area only even in the case of some projects several different areas could have been applicable. The used technological fields were:

1) N/A (Not Applicable)
2) AVR, Game, and UI/UX Design
3) Chemical Engineering
4) Cybersecurity
5) Electronics Design
6) Mobile Application Development
7) Software Design and IoT
8) Technical Concept Design
9) Website Design

Finally, the type of the project owner was listed in three different categories: 1) Private companies, 2) Public organizations (including universities and TUAS itself), and 3) Third sector non-governmental organizations.

Results and Discussion

In total, 154 projects have been implemented during 2012-2019. The annual number of projects has grown from the two pilot projects to a level of 30-40 annual assignments. This can be described as a significant impact both in terms of students' learning activity and regional development. Each project team has typically eight members which means that approximately 300 students participate in these projects every year.

The development of the annual number of the projects and their distribution between the different domains (degree program areas) are illustrated in Table 1 as well as in Figures 2 and 3.

Table 1. Development of the number of projects per domain (degree program) during the years 2012-2019.

Domain / Degree Program	*2012-2013*	*2013-2014*	*2014-2015*	*2015-2016*	*2016-2017*	*2017-2018*	*2018-2019*	*Total*
Business Administration	0	2	4	3	9	6	4	*28*
Chemical Engineering	0	0	0	0	3	9	6	*18*
Electronics	0	1	1	2	5	3	5	*17*
Information Technology	1	9	10	12	9	25	18	*84*
Library and Information Service	1	3	1	1	0	0	1	*7*
Total	*2*	*15*	*16*	*18*	*26*	*43*	*34*	*154*

The majority of the projects have been connected to the topics in Information Technology. Also, projects dealing with Electronics and different Business Administration assignments have been present almost every year. Chemical Engineering projects have emerged since 2016. Besides, a small number of assignments in the domain of Library and Information Services has been completed as well.

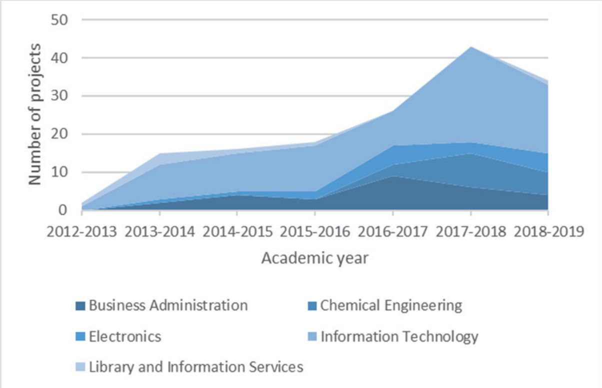


Figure 2. Development of the number of projects and the distribution between the domains (degree programs).

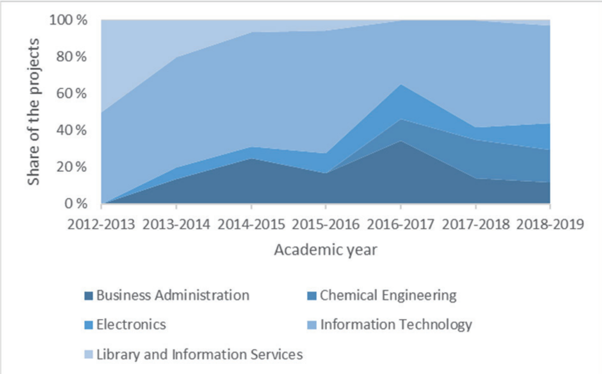


Figure 3. The relative share of the projects between the different domains (degree programs) each academic year.

Table 2 presents the Fields of Application of the project assignments. Although the selection of the originating domains is rather limited and heavily ICT-focused, the areas of application are significantly more diverse.

Table 2. Fields of Application of the projects.

Field of Application	*2012-2013*	*2013-2014*	*2014-2015*	*2015-2016*	*2016-2017*	*2017-2018*	*2018-2019*	*Total*
Business Marketing	0	1	3	1	1	0	2	*8*
Chemistry and Chem. Eng.	0	0	0	0	3	5	2	*10*
Civil Engineering	0	0	0	0	0	2	0	*2*
Culture and Arts	0	0	0	2	1	1	1	*5*
Education and Social Services	0	3	3	5	0	2	2	*15*
Entertainment and Media	0	3	0	0	0	2	1	*6*
Facility management	1	1	0	1	1	0	0	*4*
Food Industry and Agriculture	0	0	1	1	6	3	4	*15*
Healthcare and Wellbeing	1	2	6	2	0	6	1	*18*
ICT, Electronics & Telecom	0	1	0	1	4	10	9	*25*
Manufacturing Industry	0	0	0	0	0	1	1	*2*
Service Business Design	0	2	2	1	4	5	2	*16*
Sustainability and Recycling	0	0	0	0	0	4	3	*7*
Tourism & Sports	0	2	1	3	6	1	2	*15*
Transportation and Logistics	0	0	0	1	0	1	4	*6*
Total	*2*	*15*	*16*	*18*	*26*	*43*	*34*	*154*

For example, several projects have dealt with applications in healthcare and wellbeing as well as tourism and sports. Yet, it should be noted that not all the classifications are very clear. For example, some of the project descriptions did not indicate the intended application at all (many of these projects have been listed as ICT applications).

Analysis of the technology applied in the different projects was not very straightforward either. Also in this perspective, some of the projects had a multidisciplinary character whereas others focused to utilize very specific technological tools to address the assignment. Yet, all the projects were placed to only one category that was considered to reflect the central field of tools utilized. Table 3 presents the resolution of the applied technologies.

Table 3. Technologies applied to address the project assignments.

Applied Technology	*2012-2013*	*2013-2014*	*2014-2015*	*2015-2016*	*2016-2017*	*2017-2018*	*2018-2019*	*Total*
N/A	1	5	5	5	5	6	3	*30*
AVR, Game and UI/UX Design	1	5	3	4	4	4	5	*26*
Chemical Engineering	0	0	0	0	2	4	4	*10*
Cybersecurity	0	0	0	0	0	3	0	*3*
Electronics Design	0	1	0	1	4	4	4	*14*
Mobile Application Developmen	0	1	2	3	3	4	6	*19*
Software Design & IoT	0	0	1	3	2	5	5	*16*
Technical Concept Design	0	1	0	1	3	7	4	*16*
Website Design	0	2	5	1	3	6	3	*20*
Total	*2*	*15*	*16*	*18*	*26*	*43*	*34*	*154*

The category N/A (Not Applicable) denotes the projects that did not use any specific technologies in the engineering context (business development projects etc.). Accordingly, the category Technical Concept Design refers to projects that included engineering research and development activities but were not bound to specific technological domains.

Even though the categorization task was not self-evident, it is easy to see that the majority of the projects have applied ICT-based tools even in those cases in which the actual field of application has been something else. Only 16 % of the projects dealt directly with the field of ICT, Electronics and Telecommunications (see Table 2) but 64 % of the project assignments were addressed using ICT-based tools. This development is further illustrated in Table 4 and Figures 4 and 5.

Table 4. Technologies applied to address the project assignments; ICT-connected categories merged.

Applied Technology	*2012-2013*	*2013-2014*	*2014-2015*	*2015-2016*	*2016-2017*	*2017-2018*	*2018-2019*	*Total*
N/A	1	5	5	5	5	6	3	*30*
Chemical Engineering	0	0	0	0	2	4	4	*10*
ICT and Electronics	1	9	11	12	16	26	23	*98*
Technical Concept Design	0	1	0	1	3	7	4	*16*
Total	*2*	*15*	*16*	*18*	*26*	*43*	*34*	*154*

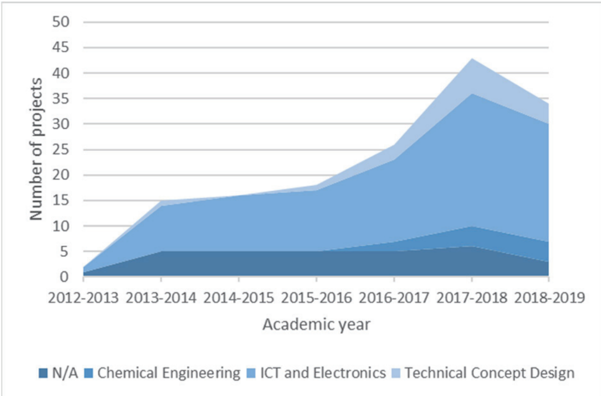


Figure 3. Development of the number of projects applying different technologies (ICT fields merged).

Capstone Innovation Project – Example (http://capstone.dc.turkuamk.fi):

BUSTER PROJECT

Active Noise Cancelling of engine noise in motorboats via speakers. Speaker emits the same sound as the unwanted source but in a different phase. Generally, this antiphase sound wave combined with the original sound wave form a new wave and therefore effectively cancel each other out.

This is achieved using digital signal processing and analog circuits.

Expected Outcomes: Reduced motor noise, ANC-system integrated with already existing sound systems, other possible applications in eg. office environments

Benefits/Impacts: More enjoyable boat trips and office environments, less unwanted noise

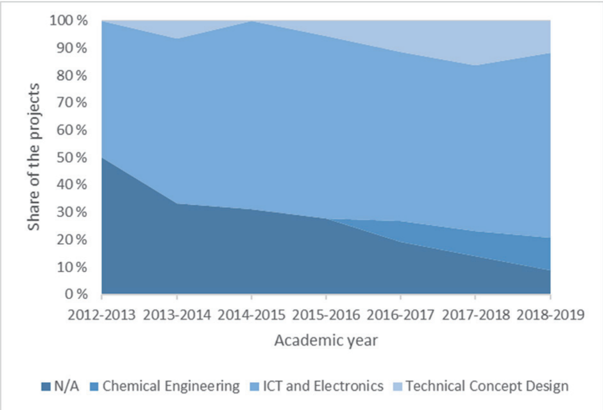


Figure 4. The relative share of the projects applying different technologies (ICT fields merged).

The project stakeholders and customers – or project owners as they are called in the TUAS Capstone terminology – were not easy to map using the public project descriptions either. The project owner was mentioned only in some of the descriptions. The other categorizations were made based on assumptions and information from other TUAS internal sources. However, the profiling of the project owners can be considered reliable enough for this overview analysis. The distribution of the project owners is presented in Table 5 and further illustrated in Figures 5 and 6. Please note that the category public includes also the projects assigned by TUAS internal research groups.

Table 5. Project owners.

Project Owner	*2012-2013*	*2013-2014*	*2014-2015*	*2015-2016*	*2016-2017*	*2017-2018*	*2018-2019*	*Total*
Private	0	8	8	7	16	32	23	*94*
Public (incl. university)	2	7	6	9	9	11	11	*55*
Third sector	0	0	2	2	1	0	0	*5*
Total	*2*	*15*	*16*	*18*	*26*	*43*	*34*	*154*

Figure 5. Development of the number of different types of the project owners.

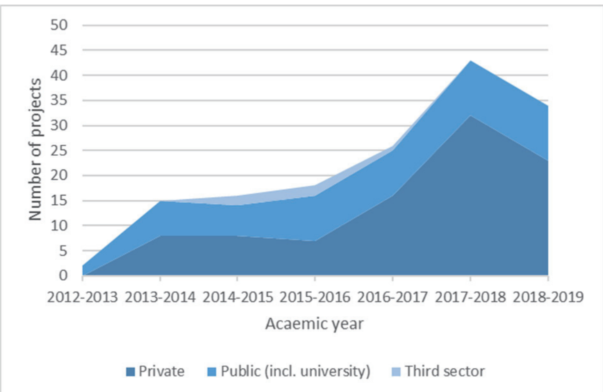
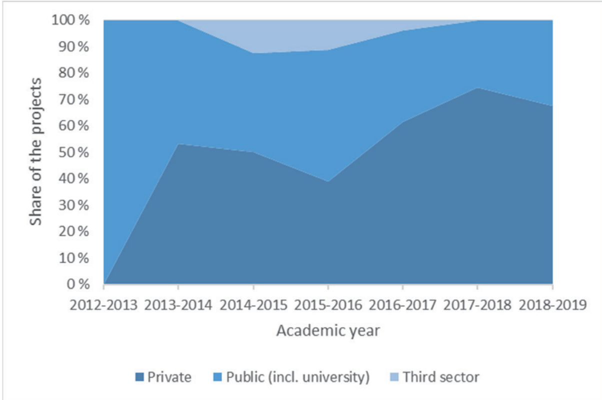


Figure 6. Relative share of the different types of the project owners.



The number of project owners representing the public sector play an important role especially during the first implementation rounds. After that, the number of public assignments has remained rather stable. The growth of the project portfolio has come from the private sector. That is, it has become easier to attract private companies to assign projects as the concept has become more mature. An interesting detail in this context (yet not visible in the project descriptions data) is that a project fee has been applied during the past three years and more focus has been put on the project agreements and IPR issues. This seems to have had a positive impact on the interest of companies. The third sector (different non-governmental institutions, associations and sports clubs for example) seem not to represent a major role as project owners. This sector could have the potential to generate interesting project assignments but it is possible that the introduced project fees are not feasible for them.

Conclusions

In this paper, the project assignments of the TUAS Capstone Innovation Project course during the past seven academic years were presented and analyzed. The number of projects has increased from the first two pilot cases to a level of 30-40 assignments a year.

Despite the multidisciplinary objectives of the course and the complex nature of the real-world assignments, the domains of the projects reflect the disciplines that have been most active to participate in and send students to join the projects. The projects represent a wide range of application areas indicating that TUAS has been able to attract project owners operating in many different fields fo business. Also, the number of private companies as project owners has grown steadily over the years.

ICT-connected technologies seem to dominate the tools using which thew assignments are solved. This is probably caused partly by the background of the TUAS staff members who are active in recruiting new projects to the course. Yet, this finding can also reflect the nature of the development needs of the project owners (often local SMEs) and, on the other hand, indicate that there is potential to find additional assignments and growth from other fields of business and engineering.

The innovation project course has also become a significant platform of both the learning of applied competences and a tool for university-industry collaboration. Today, hundreds of students work closely with tens of project owners who present real-world challenges for them to solve.

Acknowledgments

The contribution of all the TUAS staff members who have participated in the different development and implementation phases of the Capstone Innovation Project course is gratefully acknowledged. Besides, the inspiration of the CDIO Initiative and its contributors has significantly facilitated the work.

References

CDIO Initiative (2010). *The CDIO Standards v 2.0*, www.cdio.org.

Kulmala, R., Luimula M., & Roslöf, J. (2014). Capstone Innovation Project – Pedagogical Model and Methods. *Proceedings of the 10th International CDIO Conference*, Barcelona, Spain.

Lehto, A., Kairisto-Mertanen, L., & Penttilä, T. (eds.) (2011): Towards Innovation Pedagogy – A New approach to teaching and Learning for Universities of Applied Sciences. *Reports from Turku University of Applied Sciences*, 100.

Turku University of Applied Sciences (2019). *The Capstone Innovation Project Website*. Available at: http://capstone.dc.turkuamk.fi. Accessed on July 4, 2019.

PARTNERSHIP BETWEEN VOCATIONAL TRAINING COUNCIL AND OVERSEAS UNIVERSITIES IN OFFERING TOP-UP ENGINEERING DEGREES IN HONG KONG

K. M. WONG*

School for Higher and Professional Education, Vocational Training Council, Hong Kong

* km_wong@vtc.edu.hk

Abstract

Engineering education for undergraduates is crucial in nurturing young professionals for sustainable development of every city in the world. Being the largest vocational and professional education and training provider in Hong Kong, Vocational Training Council (VTC) provides a wide range of engineering programmes with internationally recognized qualifications. Among the 13 member institutions of VTC, School for Higher and Professional Education (SHAPE) aims to provide further articulation pathways to professional degrees in multiple disciplines for VTC's Higher Diploma graduates.

This paper presents an overview of SHAPE's top-up engineering degrees in partnership with overseas universities. Key areas in the partnership between SHAPE and overseas universities are discussed, such as programme design for student-centred learning, quality assurance, and external recognition. Examples will be drawn from the Bachelor of Engineering (Civil and Infrastructure) (Honours), or BEng(CI) in short. The programme is the long-term collaboration between SHAPE and RMIT (Royal Melbourne Institute of Technology) University. The programme was first launched in 2011 and showed an increasing trend of admission numbers over the years. Good practices in the collaboration between SHAPE and RMIT University are presented.

Keywords: *Overseas partnership, engineering education, top-up degree, vocational education, Vocational Training Council, Hong Kong*

Introduction

According to a report from United Nations Educational, Scientific and Cultural Organization (UNESCO, 2010), "engineering education seeks to develop a logical, practical, problem-solving methodology and approach that includes soft social as well as technical skills… Engineers use both scientific knowledge and mathematics on the one hand to create technologies and infrastructure to address human, social and economic issues, and challenges on the other." In this 21st century, every city in the world is striving for sustainable development, hence engineering degree education for nurturing future engineers plays an increasingly important role in any education system.

To facilitate better understanding of the Hong Kong Education System, the background of Hong Kong's secondary education is first given, the Higher Education is then discussed with a focus of the role of VTC, which is the largest vocational and professional education and training provider in Hong Kong. This paper focuses on the articulation pathway of SHAPE's top-up engineering degrees. Key areas in the partnership between SHAPE and overseas universities are discussed, such as programme design for student-centred learning, quality assurance, and external recognition. Examples will be drawn from the Bachelor of Engineering (Civil and Infrastructure) (Honours), or BEng(CI) in short, which is the long-term collaboration between SHAPE and RMIT University.

The BEng(CI) programme was indeed a successful showcase of the overseas partnership between SHAPE and RMIT University. The BEng(CI) was first launched in 2011 for a part-time intake of one class of around 40 students. With a strong demand, an increasing trend of admission numbers was observed over the years. The part-time (PT) intake in 2018 was increased to four classes of over 120 students. The full-time (FT) mode of the programme was also launched in the same year. The author is currently the SHAPE Programme Coordinator of the programme and be responsible for coordinating with the RMIT academics and for overseeing the delivery and operation of both the FT and PT modes of the top-up programme.

Overview of Hong Kong Secondary and Higher Education

Since Hong Kong Education Reform for secondary education and higher education was first proposed by Education and Manpower Bureau, now known as Education Bureau, of Hong Kong Special and Administrative Region (HKSAR) Government in 2000, the academic structure was changed to 3-3-4 in 2009, which means three years of junior secondary school, three years of senior secondary school, and four years of university education. The 3-3-4 scheme replaced the traditional 3-2-2-3 structure (three years of junior secondary school, two years of senior secondary school, two years of matriculation course and three years of university education). The Hong Kong Diploma of Secondary Education (HKDSE) is conducted annually for all students who have completed the 6-year secondary curriculum. The HKDSE replaced the traditional Hong Kong Certificate of Education Examination for Secondary Form 5 students and Hong Kong Advanced Level Examination and for Secondary Form 7 students.

VTC Articulation Pathways

The main articulation pathways to bachelor's degrees for senior secondary school graduates in Hong Kong are four-year bachelor's degrees, sub-degrees and top-up degrees. The most common forms of sub-degrees are higher diplomas (HDs) and associate degrees. Being the largest vocational and professional education and training provider in Hong Kong, VTC provides a range of alternative articulation pathways in eight academic disciplines for senior secondary school graduates. The eight academic disciplines of VTC are as follows:

1. Applied Science
2. Business Administration
3. Childcare, Elderly and Community Services
4. Design
5. Engineering
6. Hospitality
7. Information Technology
8. Interdisciplinary Programmes

Figure 1 shows the VTC articulation pathways for senior secondary school graduates, who achieve five HKDSE subjects at Level 2 or above, including English Language and Chinese Language. Five of the VTC's 13

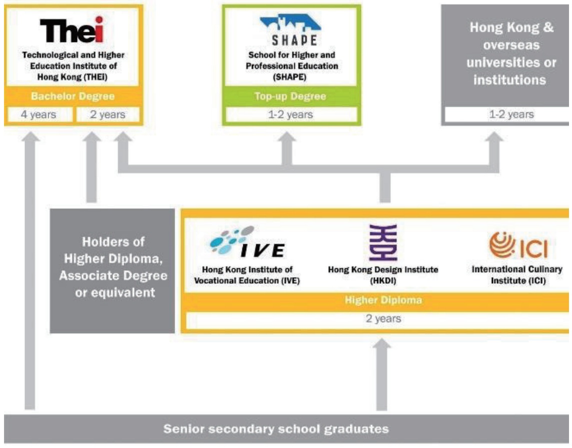


Figure 1 VTC Progression Pathways for Senior Secondary School Graduates in Hong Kong

member institutions are shown in Figure 1, namely, Hong Kong Institute of Vocational Education (IVE), Hong Kong Design Institute (HKDI), International Culinary Institute (ICI), Technological and Higher Education Institute of Hong Kong (THEi) and SHAPE. As indicated in Figure 1, DSE graduates fulfilling the minimum university entry requirements (note 1) can take the path through THEi and complete 4-year full-time bachelor's degrees. Alternatively, they can also take the path through IVE, HKDI and ICI and complete full-time HD curriculums in two years. If the HD graduates decide to pursue a bachelor's degree, they can apply for 3rd year entry to THEi and complete the degree in two years. Alternatively, if they choose to enrol top-up degrees offered by SHAPE in collaboration with overseas universities, they can achieve degrees in one to two-year study. The minimum time needed to complete a bachelor's degree in SHAPE is three to four years, which is comparable to that in other local or overseas institutions. The discussion is then focused on SHAPE's

Table 1 SHAPE top-up programmes in collaboration with partner universities

Country	University	SHAPE top-up engineering programme [Mode of Study: FT & PT]
UK	Coventry University	Bachelor of Science (Hons) Construction Management [PT]
Australia	RMIT University	Bachelor of Applied Science (Construction Management) (Honours) [FT&PT]
		Bachelor of Applied Science (Aviation) [FT&PT]
		Bachelor of Engineering (Civil and Infrastructure) (Honours) [FT&PT]
		Bachelor of Engineering (Electrical Engineering) (Honours) [FT&PT]
		Bachelor of Engineering (Mechanical Engineering) (Honours) [FT&PT]
UK	Solent University	Bachelor of Applied Science (Hons) Marine Operations Management [PT]
UK	University of Central Lancashire	Bachelor of Engineering (Hons) Building Services and Sustainable Engineering [PT]
		Bachelor of Science (Hons) Architectural Studies [PT]
		Bachelor of Science (Hons) Building Surveying [PT]
		Bachelor of Science (Hons) Quantity Surveying [PT]
UK	University of the West of England, Bristol	Bachelor of Engineering (Hons) Electronic and Computer Engineering [FT&PT]
		Bachelor of Science (Hons) Architectural Technology and Design [FT&PT]
		Bachelor of Engineering (Hons) Building Services Engineering [FT&PT]

top-up collaborative degree programmes with partner universities.

SHAPE: Partnership between VTC and Overseas Universities

Established in 2003, SHAPE is a self-financed arm of VTC and aims to offer a myriad of opportunities to prospective students with HD and degree qualifications to pursue a higher qualification. SHAPE has 13 partner universities in Australia, United Kingdom and China. It offers over 50 bachelor's and master's degrees across the eight academic disciplines of VTC. SHAPE nurtured more than 22,000 graduates so far.

In engineering discipline, SHAPE offers 14 top-up engineering degree programmes in partnership with five internationally renowned universities in the academic year of 2019/20 as shown in Table 1. Depending on the student demands, part-time and full-time modes of study are provided for the programmes. The duration of full-time study ranges from 12 to 24 months, while that of the part-time study ranges from 14 to 36 months. Intakes of approximately 1000 students to all the engineering programmes in both FT and PT modes are observed per academic year in recent years.

External recognition is important in promoting the social image as well as increasing the quality of top-up degrees in Hong Kong (Agbola and Cheng 2017). 13 of the 14 engineering programmes in Table 1 are accredited by Hong Kong Council for Accreditation of Academic and Vocational Qualifications (HKCAAVQ) and recognised under the Hong Kong Qualifications Frameworks (QF, see note 2) at Level 5, which is the level commonly pitched for bachelor's degree award titles (HKQF, 2018). In other words, the QF level of the engineering programmes accredited by the HKCAAVQ is the same as that of locally-accredited bachelor's degree programmes.

Collaboration for Student-Centred Learning

The oversea partner universities as the award-granting institutions are responsible for assuring and approving the academic standard of the awards. For example, moderating sample assessments, approving assessment results and progression, and conducting part of the teaching activities. Programme Manager or Programme Leader is appointed by the universities to be responsible for all academic matters of the top-up programmes.

SHAPE as the local operator of the university programmes is responsible for ensuring the local operation and delivery are conducted in accordance with relevant university regulations as well as relevant Hong Kong regulations. For example, marketing, recruiting students and teaching staff, providing learning and teaching facilities, conducting part of the teaching activities, and submitting documents required by the HKSAR government. Programme Coordinator is appointed by SHAPE to be responsible for liaising with the corresponding Programme Manager and handling SHAPE responsibilities for the programme.

An outcome-based learning approach is adopted for the design of the engineering programmes in Hong Kong (Kerry, 2011) and in developed countries. A set of programme learning outcomes are devised, so that each student should have achieved the programme learning outcomes by the time of graduation. The programme learning outcomes are then supported by the course learning outcomes. The contents and assessments of individual courses are hence designed centred around their course learning outcomes. This outcome-based design process hence naturally follows a student-centred learning approach. For example, the programme learning outcomes statement of BEng (CI) are "The Civil and Infrastructure Engineering programme is designed to ensure that, when you graduate, you will be able to perform professionally and effectively in civil engineering and related fields, and demonstrate that you have acquired the associated capabilities and skills as defined by the national accreditation body, Engineers Australia." (RMIT University, 2019).

The collaborative degree programmes delivered at SHAPE have many advantages for the students. As a result of the collaboration, the students can enrol the top-up degrees delivered offshore in Hong Kong without travel to the oversea universities. The top-up degrees provide a cost-effective alternative to going abroad for an oversea degree study with a relatively high tuition fee plus living cost. In addition, the part-time mode of study also allows students to work full-time locally and acquire industry experience for career advancement.

The top-up degrees are awarded by the partner universities. In other words, the top-up degrees delivered at SHAPE in Hong Kong are the same academic qualifications as the onshore degrees at the overseas partner universities. As a matter of fact, RMIT University provides an option for the top-up offshore degree graduates to attend either the onshore graduation ceremony in Melbourne or the offshore ceremony in Hong Kong.

The SHAPE top-up degrees are taught by experienced teaching staff from the partner universities as well as local SHAPE lecturers. This teaching arrangement provides students with global and local perspectives of their disciplines. For example, when the BEng(CI) students learn the structural engineering design practices, they will not only learn the Australia design standards, but also local Hong Kong design standards. The learning experience will help students to develop an international perspective and be able to compare and analyse the commonality and differences between local and overseas practices.

SHAPE students can gain access to a wide array of campus facilities of VTC in Hong Kong as well as the online resources and support provided by the overseas universities. Each SHAPE student is given a VTC student card and a partner university student card. The students can get access to the learning resources and support in both VTC library and the partner university library. With the SHAPE student card, the students can access to campus facilities of nine IVE campuses and HKDI across Hong Kong. The SHAPE classes are normally conducted in IVE campuses and their laboratory sessions are conducted by the hands-on learning activities using the IVE engineering facilities.

Collaboration for Quality Assurance

Quality assurance of the collaborative engineering programmes is a joint responsibility for partner universities and SHAPE. Both parties often maintain their own robust quality assurance systems. On the SHAPE side, Academic Committee for the Collaborative Degree Programmes (CDP AC) formulates strategies for the development of collaborative degree programmes and to consider any matters related to the academic quality of these programmes. The CDP AC is supported by the Quality Assurance Committee for Collaborative Degree Programmes (CDP QAC) and the Discipline Academic & Quality Assurance Committees for Collaborative Degree Programmes (DAQACs). The CDP QAC oversees and guides quality assurance policies and activities for collaborative degree programmes operated by SHAPE. The DAQACs oversee, review and make recommendations on the academic management and operation of the collaborative degree programmes under the respective disciplines. At the local operational level, there are Programme Boards for Collaborative Degree Programmes (CDP PBs) under each discipline to monitor the implementation of the academic policies, regulations, and procedures stipulated by the partner universities.

While the RMIT University quality assurance system is beyond the scope of this paper, a brief description of the SHAPE and RMIT operational committees for programme delivery is given below. The RMIT Programme Managers convene Programme Liaison Committee Meetings with SHAPE Programme Coordinators when they travel to Hong Kong to discuss academic matters, feedback from SHAPE teaching staff on aspects of the courses and programmes, and any student concerns. When RMIT teaching staff visit Hong Kong and conduct teaching for SHAPE students, they convene Course Coordination Meetings with SHAPE teaching staff to discuss all issues relating to the courses. By end of each teaching semester, the Couse Assessment Committees (CACs) review the assessment results of each individual course to ensure that results are valid and complete, whereas Programme Assessment Boards (PABs) monitor the students' academic progress throughout the programme and audit the course grades. The teaching staff of RMIT and SHAPE are members of the CACs and PABs.

Collaboration for Professional Recognition

Recognition by professional engineering bodies in their trades is important to graduates' career prospect. The recognition allows the top-up degree graduates to take graduate training schemes to professional chartership. For example, same as the onshore programme in Melbourne, the offshore BEng(CI) programme gained full accreditation from Engineers Australia (EA). In addition, the part-time offshore BEng(CI) programme also gained full accreditation from and the Hong Kong Institution of Engineers (HKIE) (Civil Engineering Discipline). Both EA and HKIE are signatories (note 3) of the Washington Accord, which is an international agreement between bodies responsible for accrediting engineering degree programmes (International Engineering Alliance, 2014). As engineering degree programmes normally seek recognition from the local signatory only, engineering degrees recognized by two signatories at the same time are uncommon. However, the dual recognition status can double the benefits of the students from the two professional bodies. The degree graduates can have the freedom to choose to practise locally in Hong Kong using the HKIE recognition or practise abroad using the EA recognition. Furthermore, the students can participate as student members in the professional development events organized by both professional bodies. As a result, they can develop their professional knowledge and networks more rapidly, which are extremely helpful to the students particularly at the early stage of their career.

Other Forms of Collaboration

With the strong partnership developed in collaborative degree programmes, VTC and RMIT also developed other forms of collaboration. For example, VTC and RMIT organized a one-day Civil Engineering and Construction Forum in Hong Kong Science Park on 12 October 2018. The forum invited government officials, industry professionals and academics to give presentations on the following topics: 1) infrastructure development policy; 2) innovation in materials, structures and construction technology; 3) advanced manufacturing and industrialization in civil and construction; 4) Infrastructure Management and Forensics. The forum was received very well by the participants.

In addition, RMIT University also provided various staff development activities for VTC's staff, such as providing training on moderating students' research projects to SHAPE project supervisors, discussions to help SHAPE staff to understand the academic standards of the BEng programmes. Furthermore, VTC also provides support for staff of IVE Engineering Discipline to pursue part-time Doctor of Philosophy degrees on their areas of interest in RMIT University.

Conclusions

This paper presents the close partnership between VTC and overseas universities in delivering top-up engineering degrees through SHAPE. The flourishing partnership benefits not only both parties, but also the numerous students of the top-up degree programmes. Key areas of collaboration are discussed with examples from the RMIT-SHAPE BEng(CI) programme. Good practices in the collaboration between SHAPE and RMIT University are presented for experience sharing with institutions having or in consideration of starting similar collaborative engineering degrees.

Notes

1) The minimum entry requirement for university admission is the achievement of Level 3 or above in the HKDSE English Language and Chinese Language and Level 2 or above in the HKDSE Mathematics, Liberal Studies and one Elective Subject.
2) The QF in Hong Kong is a 7-level hierarchy. Each qualification is assigned a level to indicate its position in the hierarchy relative to others. The level of a qualification is determined in accordance with a set of Generic Level Descriptors which specifies, in four domains, the outcome standards expected of the qualifications at each level. The four domains are:

    (a) Knowledge and Intellectual Skills;
    (b) Processes;
    (c) Application, Autonomy and Accountability; and
    (d) Communications, IT and Numeracy.

3) The Washington Accord is a self-governing, autonomous agreement between national organisations (signatories) that provide external accreditation to tertiary educational programmes that qualify their graduates for entry into professional engineering practice. In 2014, there was 15 signatories to the Washington Accord that together deliver over 7,000 programmes producing graduates that are significantly similar in competencies. (International Engineering Alliance, 2014)

References

Agbola, F. W., & Cheng, C. (2017). Student's local top-up higher education choices. *Studies in Continuing Education*, 39(3), 333-356.

International Engineering Alliance (2014). 25 years of Washington Accord, Retrieved from http://www.ieagreements.org/assets/Uploads/Documents/History/25YearsWashingtonAccord-A5booklet-FINAL.pdf

Hong Kong Qualifications Frameworks (HKQF). (2018). The revised GLD and the Explanatory Notes, Retrieved from https://www.hkqf.gov.hk/en/KeyFeatures/levels/index.html

Kerry, K.J. (2011). Conceptualising quality improvement in higher education: policy, theory and practice for outcomes based learning in Hong Kong. *Journal of Higher Education Policy & Management*, 33 (3), 205–218.

UNESCO (2010). Engineering: Issues, Challenges and Opportunities for Development. *UNESCO Report*.

RMIT University (2019). Programme Guide of Bachelor of Engineering (Civil and Infrastructure) (Honours), Retrieved from http://www.rmit.edu.au/handbook/bh077hkghkgvt

A Recurrent Education for a Graduate from the Technical College through a Collaborative Research

Ritsuo SAKIMURA[*,a], Issei HAN-YA[b]

[a] Department of Civil Engineering, National Institute of Technology, Gunma College, Maebashi, JAPAN
[b] President's office , CleanData Ltd., Ebetsu, JAPAN

* rsakimura@cvl.gunma-ct.ac.jp

Abstract

Provided a recurrent education program for a graduate (3 years after his graduation from the technical college to gain an ability to develop a measuring system by herself, through a collaboration with a company, whose main business fields are surveying and measurement.
The graduate wanted to develop the system what she needs for his tasks, however, she did not know where/what to start. To help her, we have provided the following education program.
Development program: Develop a measuring system using, Single FRQ GNSS receiver, Raspberry Pi with HAT and data communication network.
Testing program: Test and evaluate the developed system at an actual work site.
Writing a paper program: Write a technical paper concluding the development and testing of the measuring system and submit it to Japan Society of Civil Engineers
We could recognize following effect through this recurrent education.
She(the graduate) could understood basic of the development method of the measuring system.
She, started from a beginner in programming, could improve his programming ability so that she can make a small function software only in about one year,
She got an unexperienced sense of achievement since the developed measuring system was sold to the end user company and was useful in their work at sites.
She contributed to raise presence of the company, to which the graduate belongs, by presenting a technical paper,
She could get, through above experiences, she could get a self-confidence to develop measuring system with functions necessary for her main tasks.

Keywords: *Recurrent education, Education Program, Measuring System, Programming, Single FRQ GNSS, Raspberry Pi*

Introduction

From a company (surveying and consulting firm) to which one of our female graduate joined, we have got a request to provide a programme to improve her career further.
In this paper, we report around the recurrent education program which aim to provide possibility for her to expand her career.

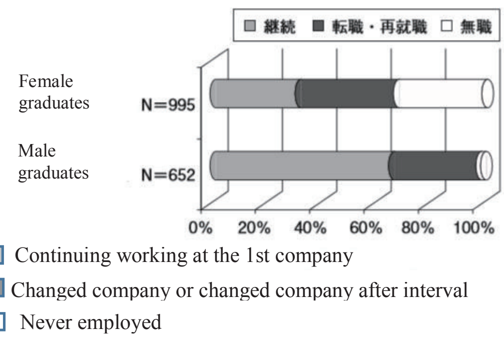
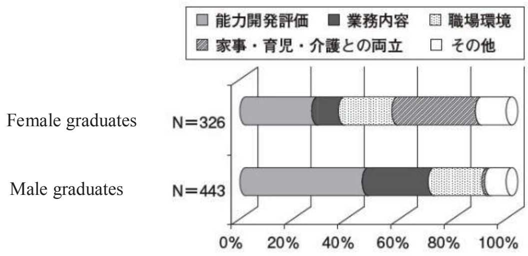


Figure.1 Employment Status of Technological College's graduates

Figure.1 shows, the employment status of the technological college's graduates (Twenty years after graduates), surveyed during 2003 through 2005.

- As in illustrated in the Figure.1, employment retention rate of female graduates (995 samples) of Technical Universities' is obviously lower than one of male graduates (652 samples)
  88.4% of 331 graduates who continue working at the first company are in 20s and 30s, and there are high potential to change the company or loose the job.
- Female graduates who changed the company or changed after interval (363 persons) and is engaged in technical jobs are 46.1% which is less than half.
- 32.3% of female graduates has not got a job.

The reason why person quits the job are checked and sorted as in Figure.2.



Not Adapted to job

Not suited job environment not Manageable both job and housework, childcare and nursing

Other reasons

Figure.2 The reason to quit the job (female employee)

- Mismatch in Job assignment
  Job assignment is decided with person's school career rather than personal ability/suitability or wish. (e.g. Doctor/Master degree or bachelor degree holder may be assigned to R&D or engineering design jobs. Technological college graduates may be to technical or quality management jobs)
- As shown in Figure. 2, a large part of reason to change job is not possible to manage both company job and family life. In the referred survey, it analyses that there are no definite way to let the female graduates to continue her career improvement longer, however, the survey pointed out following factors are important
- Let the female graduates to understand the situation to continue career improvement typical for woman along with their life stage
- By introducing role models, teach wisdom and ingenious to make career improvement possible.

From above observation of the survey, the purpose of the recurrent education is set as follows.

- By providing the recurrent education, reduce the possibility for 32.3% of female graduates from the Technological college who may not be able to get a job in the later time and give their technical ability back to society.
- Considering above purpose, we as a particular case, we choose one of female graduate, and set a recurrent program with following directions considering her particular interest and situation.
- For 3 years after graduate she has been working at the first company she joined. However, the survey indicates female employee may leave the company at 70% probability in the later time.
  Therefore, to prepare such situation, the recurrent education is important.
- Choose a recurrent education subject which is easy to understand and effective related to current work, since time allowed for education to be found Among her main job.
- Choose a subject not to enforce her ability for current job, but technical subject which support to proceed the job or one which may lead an idea to replace existing job works with other technique.
- After providing the recurrent education, there should be some synergy effect on to the current job.

To further decide education programme (including education level) more in details, we have made an interview with her.

Through actual work experience after her graduation, she became able to carry series of work process, from field measurement using Total station, GNSS and 3D laser scanner instruments through post processing of data. Also, for the ordering body, she could explain about applied surveying method and its result. (Figure. 3) We judged she has gained sufficient ability to continue as surveying engineer.

Figure.3 Field measuring work

Next, we questioned if she has any problems or difficulties. To proceed her job tasks and replied as follows,

- She could not find the measuring instrument or system completely satisfy her work.
- She requested to manufacturer to modify functions, however, such request was never accepted.
- She considered if she can develop by herself, however, did not know how/where to start.
- It may need technically high level knowledge to develop something and she thought is it not possible for her.

She is capable satisfactorily to use the measuring system as a user. However, not at all capable to develop some measuring system. Engineer to develop/design measuring system and surveying engineer are somehow connected through measuring instrument or system products. However, communication opportunity between those engineers to exchange their opinion are very limited and there is very few engineers having both knowledge and experience in both field.

If she acquire career around development design, she will be able to become an engineer who can understand standpoints both surveying engineer and development engineer which may give wider choices when she needs re-employment or change her job.

Methods

Based on these consideration, we have chosen a recurrent education program with a target to develop a newly configured system, titled as "Surveying system applicable for start-up construction surveying using single FRQ GNSS" (using existing hardware devices combined with newly developed control software) This study was proceeded in cooperation with a surveying company. (in order to evaluate its efficiency at the field) Figure. 4 shows overview configuration of the target system.

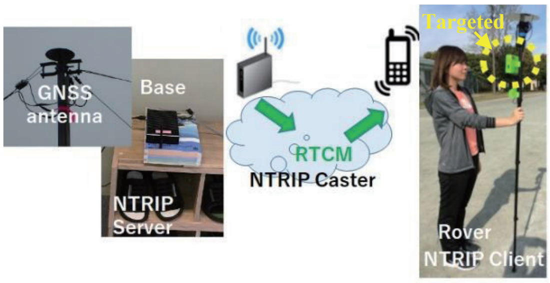


Figure.4 Overview configuration of targeted development system

In this recurrent education program, the development is focussed on the display of controller (yellow circled on the Figure. 4.) In this education program, we aim that the developed output is in the practically applicable evel for the actual work of the user. Also, through the explanation that she should provide as a developer to end user, she should be able to experience different standpoint which may give her feeling of career up. With such considerations, we have divided program into 3 programs,

Development program: to develop the measuring system based on defined specifications

Testing program: to check and verify the system's functionality

Paper writing program: to introduce the system to society and industry.

Followings are the details of each step.

Development program:

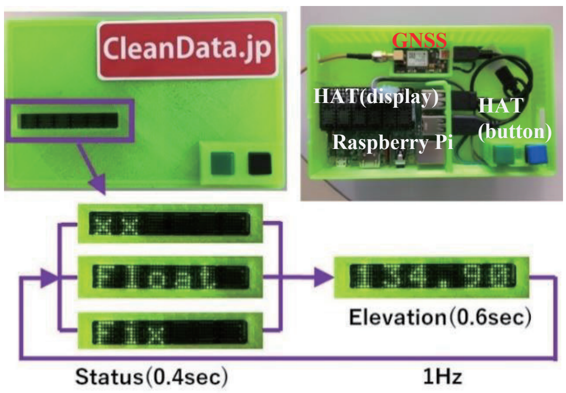


Figure.5 shows more details of developing area shown in Figure.4

On RaspberryPi3 (in Figure.5), "Raspbian" is used as OS, and "Python" development environment is installed in it. Figue.4 shows GNSS measuring system using network connection. GNSS data received antenna at the Base receiver is processed to generate correction data which to be sent to Rover receiver through network using NTRIP protocol. In the Rover receiver, Rover's 3D coordinates are calculated using GNSS data received at Rover and correction data from the Base receiver.

GNSS measurement is not always possible, depending on the GNSS satellites constellation, open sky over the measuring point, etc. "NMEA GGA" format information output from the receiver can tell following status of GNSS measurement.

No Data/Single/DGNSS/ →RTK processing is not possible →display "xx"
RTK-Float→RTK under processing→display "Float"
RTK-Fix→RTK solution obtained→display "Fix"

From this measuring sequence, we have defined functions to be developed as follows,

- Display status of GNSS measurement on 6 digits display (HAT) connected to RaspberryPi3.
- The status of GNSS measurement can be drawn from GNSS data received by GNSS receiver.
- GNSS data received by GNSS receiver is updated at 1Hz (every 1 second).
- On the display, GNSS measurement status and measured height to be displayed.
- GNSS measurement status should be updated in every 0.4sec and measured height (elevation) to be updated in every 0.6sec.
- 3D position coordinates to be recorded by pushing the Rec button.
- Above functions to be programmed using Python.

Before starting actual development, we have instructed followings.

- Understand development environment(scripter)
- Control method of HAT (display and buttons) connected to RaspberyPi3.
- Data format of GNSS receiver output.
- Understand Multi-Process mechanism.
- Understand Python language and how to make CLASS definition.
- How to use debugger.

The said function could be realized within about 1 year time. According to her, programming is interesting and suited her characteristic.

Testing Program:

Normally, just developed system does not function properly, and need verification tests to find problem to be corrected. This work is called "debugging" and repeated until the problems are all solved.

Then, the system should be checked by user in actual work condition. The debug verification was performed at schoolyard (Figure. 6)

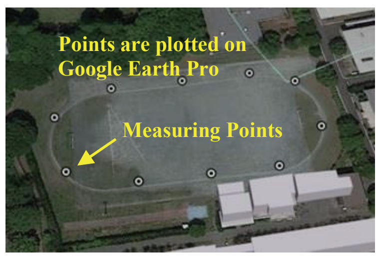


Figure.6 debugging using schoolyard

- As in Figure.6, position measurement is done at about every 30m along with the athletic track
- At each point, measurement to be initiated when the GNSS status (see Figure. 5) is shown as “Fix”.
- The measured and recorded 3D coordinates (latitude, longitude, elevation) is overlaid on Google Earth Pro display.
- If the plotted positions are matched along with the track, then debugging is completed.
  Move to the measurement in an actual measuring site.

Figure.7 Test using actual measuring site

She could recognize the developed software function as specifications through this debugging process. Also, she could understand the debugging process is important to verify and determine the quality of the Developed system. After accomplishing the debugging, move further to user verification to check if the system fulfil the use in the actual work field.
The work filed is to excavate sand deposit at a river before starting excavation, surveying to be performed to estimate volume of sand deposit. Also, after the excavation is done, surveying to check excavated shape to be performed. The performance of the developed system is checked for these surveying works.
The graduate has explained about the system to the field representative person, from developer’s stand point. Also, her explanation included user’s stand point, therefore, it was smoothly understood by the representative and he could start measurement 15 minutes after the explanation. She, herself tried to use the system in the field to check if the realized function satisfies the intended specifications and also if the specification itself is adequate to use. When she found problem, she seems to be able to estimate where the cause exists in the software, and therefore the debugging process could accomplish in a short time without many iterations.

Paper writing Program:

The program to write and submit a paper around the development of the measuring system and also include to present the activity in sessions in order to get evaluations from the related society. These activities were included in the program since we believe getting experiences repeatedly to write papers and get other’s evaluations will improve her ability to define the design specifications in the future. Figure. 8 shows she is explaining to members of measuring system manufacturer, functions and difference of the developed system.

Figure.8 Explanation to specialists

Fig. 9 shows she is explaining about the developed system at a seminar organized by The Associated General Contractors of Gunma. She functioned as a lecturer and facilitator in the seminar. In the middle of her presentation, at a moment she stuck in the presentation. Even she understood well about the contents of explanation, this might be happened due to lack of experience to speak in front of many audience. Repeated experiences would be necessary to get used to.

Figure.9 Lecture and facilitator in seminar

At the 74th Annual Seminar of Japan Society of Civil Engineers (JSCE), she submitted as a first author and made an oral presentation titled, “Development of the rapid editing system for laser scanner point cloud using Raspberry Pi”. Also, at the 75th Annual Seminar, she submitted a paper on her subsequent study titled, “Measurement of As-built survey using single FRQ GNSS receiver using correction data via NTRIP protocol” as the first author. (It is being printed as of June/2019) She could accomplish all 3 programs, Development program, Testing program and Paper writing program in about 2 years period, by finding time among her main tasks.

Results and Discussion

Followings are results obtained through recurrent program. The developed system was accepted by and sold to the end user company. The contractor company (shown in Figure. 7), who cooperated to evaluate the developed system, acknowledged that work efficiency improvement using the developed system, compared with the conventional measuring method and started to use in their surveying work before start up construction. (Figure.10)

Figure.10 The end user is surveying the developed system

The graduate only took a part of development of system function this time, however, she could get an experience that the system has been purchased by the end user and used in actual site. She could feel happy on this since it was not possible if she stayed at user's stand point.

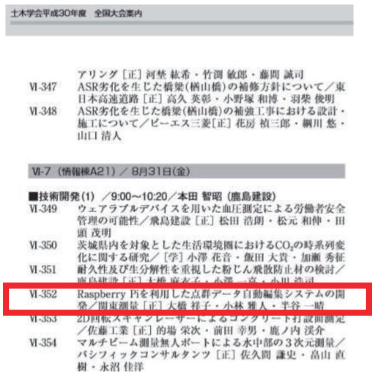
Programming:

She has never experienced programming work during 3 years after joining to the first company, however, through this education program, she became able to make a small functional level using Python.
Just an example of her achievement.
Figure.11 shows program to check if a USB memory is inserted to the USB port of RaspeberryPi3.

```python
# try USB Mount
subprocess.call(['sudo','umount','/media/pi/Data'])
try:
    subprocess.check_call(['sudo','mount','/dev/sda1','/media/pi/Data'])
    USBpath = '/media/pi/Data/'
except subprocess.CalledProcessError:
    ShowClosing(menu,"USB!!!")
    time.sleep(0.5)
    import os
    os.system("sudo shutdown -h now")
    #USBpath = '/home/pi/Data/'
```

Figure.11 Script for USB is either enable or not

The USB memory is to properly record the measured 3D coordinate data. When program is executed, at first, the program will check availability of the USB memory and indicate a alert "USB !!!" on HAT display for a short period, then automatically end program execution. With this function, the user recognizes that he forgot to set the USB memory. This is realized only in about 10 programming steps, however, she programmed efficiently control of OS and HAT display.
In the beginning of education, it was not expected that She could reach such level of programming.
Programming main area of system function is difficult and yet not possible for her, however, she could gain the programming ability to make sub functions which is Based on very clear specifications. Improve presence of the company to which the graduate belongs. Figure. 12 is the program of the 74th Annual Seminar of Japan Society of Civil Engineers. The name of company she belongs to is listed in the seminar program and state the company name in her oral session, therefore, presence of the company could be improved.



土木学会平成30年度　全国大会案内

アリング［正］河埜 紘希・竹渕 敏郎・藤間 誠司
Ⅵ-347 ASR劣化を生じた橋梁(楢山橋)の補修方針について／東日本高速道路［正］高久 英彰・小野塚 和博・羽柴 俊明
Ⅵ-348 ASR劣化を生じた橋梁(楢山橋)の補強工事における設計・施工について／ピーエス三菱［正］花房 禎三郎・綱川 悠・山口 清人

Ⅵ-7（情報棟A21）／8月31日(金)

■技術開発(1)／9:00～10:20／本田 智昭（鹿島建設）
Ⅵ-349 ウェアラブルデバイスを用いた血圧測定による労働者安全管理の可能性／飛島建設［正］松田 浩朗・松元 和伸・田頭 茂明
Ⅵ-350 茨城県内を対象とした生活環境圏におけるCO_2の時系列変化に関する研究／［学］小澤 花音・飯田 大貴・加瀬 秀征
Ⅵ-351 耐久性及び生分解性を重視した粉じん飛散防止材の検討／[illegible]
Ⅵ-352 Raspberry Piを利用した点群データ自動編集システムの開発／関東測量［正］大橋 祥子・小林 雅人・半谷 一晴
Ⅵ-353 2D回転スキャンレーザーによるコンクリート打設面測定／佐藤工業［正］的場 栄次・前田 幸男・鹿ノ内 渓介
Ⅵ-354 マルチビーム測量無人ボートによる水中部の３次元測量／パシフィックコンサルタンツ［正］佐久間 謙史・畠山 直樹・永沼 佳洋

Figure.12 List in the JSCE program

Sudden change of company.
The graduate, due to planned marriage, had to move to other city and leave the first company, as one of the case of changing job as described in the survey as in Figure.1. Since she wants to continue working, she tried to find a job at the moved place and could get a job at consulting firm who provides recurrent education for engineers in the construction industries. Probably this was not possible if she has only job career as surveying engineer and the provided recurrent education might helped.
On the other hand, there are contradictions.
For the fist company who asked to provide a recurrent education to her, has lost the employee from who they expected from her to contribute to the company from improved ability gained from the recurrent education. However, the company had to accept for the reason of marriage. For the female graduates, the recurrent education should be considered by expecting 70% of them may have to leave a company or re-join to a new company. For entire society, it may be important that the recurrent education system should be based on consideration and understanding on these situation, also the result of survey (as in Figure. 1)

Conclusions

The female graduate, after getting the recurrent education, is not yet in the level she can stand on the engineering job, however, she could get a new career. As her case, in occasion or changing job, added experiences may widen the job search area and may lead a higher possibility to find a new job.
Approach of the recurrent education program proved, with a couple of good conditions, was practically applicable.
However, it is also obvious that the same recurrent program would not applicable to any graduates and succeed to improve their ability and career.
Her success achieved in 2 years was due to her interests on development process and curiosity to challenge to a new subject. Also, helped by her colleagues in good relationship and tolerant understanding of her boss in the company.

As the last point, good timing of providing the recurrent education, 3 years after her graduation.
In this period she could gain fundamental skills as a surveying engineer (which is end user of the measuring system) and in the following years, if she continue to work at the same company, she might continue the same task as routine works or her task might be shifted to function mainly interfacing with ordering bodies of surveying work, therefore, acquiring new technical skills would be difficult.
She got a recurrent education at such timing which helped her to gain the different experience smoothly.
In other industries other than surveying industry, providing recurrent education at about 3 years after graduation may be applicable if fundamental career skills can be obtained in the same period.

For such analysis, however, much more verifications for different cases would be required.

Acknowledgements

This work was supported by JSPS KAKENHI Grant Number JP18K02970.

References

Career Building of the Technical College Female Graduates, Yukio UCHIDA (2011), *Journal of JSEE*, 59-3, 2011

Development of Automatic Point Cloud editing system using Raspberry Pi, Shoko OHASHI et al., *The 70th Annual Academic Seminar*, VI division, Japan Society of Civil Engineers

Measuring construction finished shape using single FRQ GNSS receiver with NTRIP, Shoko OHASHI et al., *The 71st Annual Academic Seminar*, VI division, Japan Society of Civil Engineers (now printing)

Development of Application System using single Frequency GNSS and the verification, Ritsuo SAKIMURA et al., *J. of Applied Survey Technology*,vol30,(now printing)

Nurturing 'global engineers' through international exchange activities: An attempt by NIT Nara College with the GECEP program

Kazuhiro Itakura[*a], Naoshi Kanazawa[b] and Shinji Uchida[c]

[a] Department of Liberal Studies, National Institute of Technology, Nara College, Japan
[b] Department of Liberal Studies, National Institute of Technology, Nara College, Japan
[c] Department of Information Engineering, National Institute of Technology, Nara College, Japan

*kitakura@libe.nara-k.ac.jp

Abstract

The National Institute of Technology, Nara College, launched its Global Education Centre (GEC) in April 2017. This organizational reform was part of an effort to respond to the growing local demand for 'global engineers'. In 21st-century society, concepts such as 'diversity' and 'inclusion' have important implications amidst increasing social mobility. The work environment is undergoing extensive changes across the world. Modern workplaces encourage an environment that fosters diversity and inclusion and enables individuals from various backgrounds to collaborate in the creation of innovative ideas and solutions. In this context, the GEC was inaugurated as a central body to promote global education and initiate the expansion of a global network in Nara College. In addition, the GEC developed the Global Engineering Cooperative Education Program (GECEP) in order to nurture engineers with a global perspective. The GECEP started in April 2018, offering courses to selected students to help them acquire the fundamental skills required for working in a global environment. Additionally, some subjects are open to all students; thus, we are making it possible for more students to participate in our global education program. The program sets down three basic skills for a global engineer: good English communication skills, cross-cultural understanding, and global communication skills in a specialized field. The GEC provides students with opportunities to acquire the above-mentioned skills, by enabling them to socialize with foreign students from diverse cultural backgrounds and to experience collaborative project work with them through international exchange programs. We intend to give a presentation on our efforts towards promoting global education, achievements, challenges, and prospects for the development of an intercultural training program for an engineering college. In this paper, the authors will examine the relationship between students' active participation in the international exchange program and its educational impact, analysing data collected by observations of and interviews with students who have participated in past programs.

Keywords: *global education, global engineer, cross-cultural understanding, student exchange, active learning*

1. Introduction

The National Institute of Technology, Nara College, launched its Global Education Centre (GEC) in April 2017. This organizational reform was part of an effort to respond to the growing local demand for 'global engineers'. In 21st century society, concepts such as 'diversity' and 'inclusion' have become more important due to the increasing social expectations that have resulted from globalization. The work environment is undergoing extensive changes across the world. Modern workplaces encourage an environment that fosters diversity and inclusion, which enables individuals from various backgrounds to collaborate and develop innovative ideas, products, and solutions. Engineers in the globalized world are expected to freely communicate with people from various cultural backgrounds and build relationships that are based on mutual trust. With this in mind, the GEC was put forth as a central body to promote global education and initiate the expansion of a global network in Nara College. Its steering committee consists of faculties elected by each of the five departments. Currently, under the initiative of the GEC, Nara College is collaborating with overseas institutes, especially in the Asian region, to promote and expand overseas student dispatch as well as the overseas student acceptance program. Additionally, the GEC developed the Global Engineering Cooperative Education Program (GECEP) in April 2018 in order to nurture engineers with a global perspective. The GECEP offers courses to selected students to help them acquire the fundamental skills required for working successfully in a global environment. With the aim of fostering these 'global engineers' the GECEP provides students with opportunities to socialize with students from diverse cultural backgrounds and to work with them through international exchange programs. It has been a year since the GECEP started. This paper primarily aims at evaluating the program's current educational impact on participating students. In the following sections the authors will first explain the contents of the GECEP and its goals. Then, its educational impact will be examined by analysing data collected from the observation of students as well as a questionnaire that was administered to students who have participated in past programs.

2. Achievement Goals of the GECEP and Subjects Provided

The GECEP is a special extracurricular education program conducted by the GEC. This program was developed for nurturing 'global engineers' and has established the cultivation of 'global professional leaders' as an educational goal. We set down three basic skills necessary for global engineers: (A) good English communication skills, (B) cross-cultural understanding, and (C) global communication skills in a specialized field. The GECEP offers two courses: the Basic Course for the five-year basic course students and the Advanced Course for the advanced course students. In both courses, students must participate in exchange programs with overseas institutions (e.g. participation in overseas training programs). The program started in April 2018, and currently 39 students are registered in the Basic Course and 15 are registered in the Advanced Course.

I would like to explain the achievement goals of the Basic Course.

First, with regard to 'good English communication skills', we aim for students to achieve the following Basic Course achievement goals by the time they complete the program.

A-a: Basic comprehension of the flow of speech and discussion about familiar topics.
A-b: The ability to read and understand English sentences about familiar topics without using a dictionary.
A-c: The ability to actively participate in conversations about familiar topics and to express ideas based on one's interests and experiences.
A-d: Acquire enough skill to give an English presentation while referring to prepared documents in advance.

Next, with regard to 'cross-cultural understanding', we assume that attitude, knowledge, and skills are three key components that are implemented in order to cultivate an understanding of different cultures (For these three components we refer to Byram's model on 'Intercultural Communicative Competence'). Students are required to achieve the following goals.

B-a: Attitudes: Acquired attitudes such as 'susceptibility towards cultures', 'tolerance of ambiguity', 'respect for different things'.
B-b: Knowledge: You can understand and explain the basic aspects of 'social product and lifestyle', 'religious beliefs', 'sense of values', and 'attitude' in Japan and foreign countries.
B-c: Skills: You can interpret different cultures in relation to your culture, analyse the values of unknown cultures, and have the ability to accept them.

Finally, with regard to 'global communication skills in a specialized field', we aim for students to achieve the following goals at the end of the course.

C-a: A basic knowledge on mathematics and the natural sciences, and the ability to apply them in solving problems in your specialty fields.
C-b: In order to solve the problem of your specialized engineering field, you can use the knowledge of the specialized field. It is important to develop the ability to solve a problem related to multiple technical fields by understanding the principles in your own field of specialization and applying them to the resolution of these problems.
C-c: To use English technical terms, mathematical formulas, units, etc. to freely conduct basic communication in English while working in your specialized field.
C-d: Give oral presentations in English as well as provide a summary of conducted research in English. This summary should consist of hundreds of words.
C-e: You can understand the importance of subjective actions and actively exert your own ability to improve the situation in your surroundings.

In order to achieve the above goals, the Basic Course provides the following extracurricular subjects; below are the subject names, their contents, the year they can be taken, and relevant goals to each subject.

- English Active Learning I: Self-learning through e-learning (1st year-) (Relevant goals: A-a,-b,-c,-d)
- English Active Learning II: Self-learning through e-learning (2nd year-) (A-a,-b,-c,-d)
- Global Communication: Project-type learning, presentations, and discussion in English (3rd year-) (A-a,-b,-c,-d)
- Cross-Cultural Exchange: Participation in short-term overseas students' acceptance program (1st year-) (B-a,-b,-c)
- Overseas Training: Participation in overseas dispatch programs (1st year-) (B-a,-b,-c, C-e)
 *Length must exceed five days.
- Global Challenge: Participation in the Centre's organized events or seminars (1st year-) (A-a,-b,-c, B-b,-c, C-b)
- Global Engineer Skills: Lectures and exercises for developing English proficiency in specialized fields (3rd year-) (C-c,-d)

Since the GECEP is a program for nurturing global professional leaders, students are required to participate in exchange programs with overseas institutions (e.g. participation in 'Cross-Cultural Exchange' or 'Overseas Training'). Also, students must take special subjects to improve skills needed in a global work environment. For course completion, students must get all credits of subjects provided in the program within the five years of study in the basic course. Other than getting all the credits, their average value of GPA from first through fifth grade must be 2.3 or higher for regular curriculum.

There is also a condition for continuation of the program. In the Basic Course, students must ensure that the total average score of their grades from the regular curriculum—including elective subjects—is 70 points or more at the end of a year. Therefore, if their total average points at the end of the grade are less than 70 points, they will not be able to enrol in the following year. However, if the total average of their grade results is 70 points or higher in the following year or after, these students can resume their participation in the program in the following year. Students who complete the Course and meet the GPA standard requirement will be awarded a certificate of completion from the GEC.

3. Students' Activities in Their First Year

It has been a year since the GECEP started. The first-year GECEP Basic Course students have participated in three subjects. Since 'English Active Learning' is a self-learning subject, major activities in the first year were in the 'Global Challenge' and the 'Cross-Cultural Exchange'. 'Global Challenge' is a series of seminars conducted by the GEC. In 2018, the GEC organized a variety of events such as a report meeting run by the students who joined the 'Overseas Training'; final presentations by overseas students who studied at the Nara College for internship; seminars with guests from outside as well as 'Intensive English Communication Skills Training' with a guest Native English-speaking lecturer. The goals for the students were to get used to listening to English presentations in order to motivate them to become more interested in learning about foreign cultures.

Students were required to actively participate in 'Cross-Cultural Exchange'. This subject includes a variety of activities related to the short-term overseas students' acceptance program. Nara College accepts short-term visits from overseas institutions. In the past few years, we have accepted student visits from Hong Kong IVE (Sha Tin) during the summer school break and visits from two polytechnics from Singapore during the spring school break. We incorporated exchange activities with overseas students into the GECEP as one of subjects. This program is now offered as an elective subject at Nara College. Therefore, the subject is open to all regular course students who are not registered in the GECEP. They are also eligible to be given a credit for the activities.

I would like to introduce the contents of the activities; in particular, the international exchange activities of the Singaporean students conducted every March since 2009.

Usually 20 to 30 students participate each year in the acceptance program, and 28 students participated in the activities in March of this year. The following is a brief course schedule of various activities related to international exchange conducted in March 2019.

Lesson 1: Course Guidance
Lesson 2-4: Special Seminars
Lesson 5-9: Preparation Activities
Lesson 10-13: Acceptance Activities
Lesson 14: Preparation for Report Meeting
Lesson 15: Presentation at Report Meeting

Participating students began preparing the activities two months before the arrival of the Singaporean students. In the first meeting, we created three groups to introduce Japanese culture, the school profile, campus life, and ice-breaking games. We conducted rehearsals and exchanged opinions with the students for improving the contents. An English teacher also participated in this rehearsal. This teacher provided opportunities for students to receive guidance and advice on technical aspects, such as whether words are correctly pronounced and whether speakers are aware of audiences' attention.

As the activities became an elective subject called 'Cross-Cultural Exchange', we held a 'cross-cultural understanding seminar' as a part of the lecture on the subject. In the seminars held last December and January, one guest speaker from Canada who has been working as a CIR (Coordinator for International Relations) in Nara and a student from Malaysia studying in the five-year regular course in Nara College gave presentations about their country. A teacher in charge of the course also lectured on his specialized area (India). They were held with the aim of learning about foreign cultures and societies and providing students with the opportunity to acquire a wide range of cultural knowledge that we believe is necessary for success in global engineering. Also, we intended to provide an opportunity to students to make friends with international students.

The exchange activities at Nara College included a campus tour. On the tour, visiting students go to each department and its facilities to learn more about the characteristics of education. Along with these activities, the program includes company and factory tours in Nara and neighbouring prefectures as well as visits to cultural heritage sites. These activities are aimed at giving overseas students the opportunity to learn about Japan's technical capabilities, skilled technologies, and the temperament of Japanese engineers. Meanwhile, we expect that Japanese students will also be able to rediscover their own cultures and traditions, and that should give them a sense of pride when conducting cultural visits with overseas students. The activities do not end with the exchange with overseas students. Students are then required to give a presentation on their activities in a report meeting, and earn a credit for the same. The presentation is important for them to reflect on their activities and to remind them of the lessons learnt. It also motivates other students to get involved in the next round of activities.

With the exchange activities for Singaporean students that we have had so far, an understanding of different cultures and intercultural exchange have been central to the program. Project work is a part of the Hong Kong IVE student acceptance program that started in 2016; this is not a part of the spring program. This is a new initiative to encourage Japanese and overseas students to acquire practical English communication skills through collaborative work. In the past two programs, we held a workshop on 'Robotics and Disaster' and 'How to Take Action for Environmental Conservation'.

4. Program Evaluation

It has been a year since the GECEP started. To evaluate the effectiveness of the program, we presented a survey to 19 students who participated in the GECEP Basic Course. We asked them to answer the nine items below, rating them on a scale of 1-5 to each question.

-Items
1. By participating in the GECEP, you were able to overcome your aversion to English.
2. By participating in the GECEP, your motivation for learning English has improved.
3. The program has helped you to maintain the motivation for learning English.
4. By participating in the GECEP, you were able to communicate actively with foreign students.
5. By participating in the GECEP, you became interested in foreign cultures and history.
6. By participating in the GECEP, interest in your own culture and history has become stronger.
7. The GECEP helped you learn that there are values and ways of thinking that are different from your own.
8. You were able to develop an attitude to understand and accept cultural differences.
9. Your motivation for studying abroad and internship abroad has increased.

-Rating Scale
1. I strongly think so.
2. I think so.
3. Somewhat.
4. Undecided.
5. No.

The results were gathered and reviewed.

Table1: The results of the survey

Items	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Rating 1	3	4	7	6	5	2	3	5	10
2	7	11	9	5	4	5	10	9	5
3	6	3	2	4	8	4	4	5	4
4	2	0	0	4	1	7	2	0	0
5	1	1	1	0	1	1	0	0	0

On items 2 and 3, the GECEP seems to have had a certain effect on students' motivation for learning English and also helped students maintain their motivation for learning English. In particular, items 8 and 9 were rated highly by the students. The GECEP seems to have had some effect as a training tool to develop an understanding and acceptance of different cultures. The results of item 9 shows that participation in the GECEP has led to an improvement in the students' desire to go abroad. On the other hand, items 5 and 6 are not evaluated well enough as compared to the other items. With these answers, we also analysed the correlation between answers to each item. The results of calculated polychoric correlation coefficient showed that this correlation is high in between items 1-3, 2-3, 2-5, 5-6, and 5-7. First, the results implied that students who thought their motivation for learning English had improved also became interested in foreign cultures and history. Second, students who became interested in foreign cultures and history became interested in their own culture and history. Third, students who became interested in foreign cultures and history were also able to learn that there are values and ways of thinking that is different from their own.

It has been a year since the start of the program, so it is too early to conclude the outcome of the effectiveness of the GECEP. However, from the results shown in the survey and the observation of students' activities, we got an impression that students' active participation in the GECEP—in particular, the acceptance activities—has enabled them to overcome their sense of resistance to communication in English. Acceptance activities are unique opportunities for students to practice their English communication skills actively. Through the activities, students are made aware that there is a problem with their lack of English vocabulary and listening skills. This results in the improvement of motivation for learning English. Although problems were observed in terms of English proficiency, students also developed the ability to actively communicate in English using gestures, facial expressions, or other techniques that help convey their message to the another person. We also found that many students who participated in these activities are considering studying abroad or participating in overseas internships.

The GECEP puts forth cross-cultural understanding—the skill to understand, accept and adapt to different cultures—as one of the basic skills necessary for global engineers. This comes from our belief that this ability is as important as English communication skills in building relationships that are based on trust with people from different cultures. While responding to the students' desire to learn English practically, the GECEP is expected to offer intercultural training to help these students to adjust and adapt to a changing global work environment.

References

Byram, Michael. (1997). *Teaching and Assessing Intercultural Communicative Competence*. Clevedon: Multilingual Matters Ltd.

JOINT ENGLISH TRAINING PROGRAM IN THE PHILIPPINES

Kangbin Lei[*, a], Osami Yanagisawa[b], Jongdoc Park[c], Kenichi Fukudome[d], Katsuhiro Narikiyo[a] and Hiroshi Ohyama[a]

[a] National Institute of Technology (KOSEN), Hiroshima College, Japan
[b] National Institute of Technology (KOSEN), Yuge College, Japan
[c] National Institute of Technology (KOSEN), Oshima College, Japan
[d] National Institute of Technology (KOSEN), Toyama College, Japan

*Corresponding author E-Mail: lei@hiroshima-cmt.ac.jp

Abstract

With the progress of globalization of industry, not only technical ability but also high communication ability in English is required. Therefore, in order to foster students as global engineers who can play an active role in the world, many technical colleges including KOSEN colleges send their students to overseas to learn English and to improve their international communication skills.

There are five colleges which have departments of maritime technology in National Institute of Technology (KOSEN) in Japan. The joint English training program for the five college students, which is one of the wide range programs named "NYK mirai project", were performed at NYK-TDG Maritime Academy (NTMA) in the Philippines from 2015. This program has a buddy system which makes a pair between KOSEN and NTMA students. It is employed to take care each other. KOSEN students participated in specialized maritime lessons and also basic subjects at regular classes with NTMA students. And special English seminar only for KOSEN students were provided in every evening at NTMA.

On the other hand, Hiroshima College launched its own overseas English training program at Emilio Aguinaldo College (EAC) in the Philippines from 2009. In every summer vacation (August or September), a few or dozen of students visit the Manila of the Philippines, and take two-week English training lessons that is a one-on-one (man to man) English conversation training program at Aguinaldo International Language Institute in central Manila.

In this paper, the details of the above two English training program will be reported, including the concrete situation, for example, the daily schedule, the lesson contents, the implementation results, the cost and performance of overseas English training in the Philippines and the issues that still exist in those program, finally some remedies are also proposed.

Keywords: *English training, joint program, KOSEN, the Philippines, NTMA, EAC*

Introduction

The maritime technology departments in the five colleges (Hiroshima, Yuge, Oshima, Toyama and Toba) of KOSEN in Japan have challenges to improve from the classical maritime English education which focus on reading and writing typically in Japan to modern to enhance motivation and ability of students to be ship officer and manager at oversea. The projects of Japanese government were named as "Maritime human resources developing project" (2012~2017), "Next generation maritime human resources developing project" (2017~2019) and "Mirai Project NTMA" (2015~2019).

Various international internships and English training programs are developed and carried out among the 5 colleges of KOSEN as shown in Table 1. Same of them are suit for other department like information science. Program at NTMA (NYK-TDG Maritime Academy) have a best cost performance among these programs. MAAP English seminars give a chance to many students to study English without any extra personal cost. In this paper we focus on "The English training and international internship programs in NTMA".

Table 1 English Training Programs for 5 Colleges

Name	Place	Days	Price UD$	Program
NTMA	Philippines	11	700	Special seminar, Regular lesson
KCC	Hawaii	21	5000	English seminar, Camp activity
SMA	Singapore	14	3000	English seminar, On board training
AMA	Philippines	14	1200	English seminar
MAAP	Japan	14	0	Professional Maritime seminar

Name	Number of participant				
	2014	2015	2016	2017	2018
NTMA		4	9	10	23
KCC	10	16	12	11	
SMA	16	13	8		
AMA	8				
MAAP	840	630			

On the other hand, Hiroshima College of KOSEN has conducted overseas English training in the Philippines since 2006 as shown in Table 2. Although many colleges of KOSEN offer English language training in English-speaking countries such as the United Kingdom, the United States and Australia, Hiroshima College has begun to offer English language training in the Philippines instead of such countries. This is because of the following reasons.

Firstly, Hiroshima College has three academic exchange partner colleges in Manila, and these colleges have prepared a program to learn English in one week until 2008 and in two weeks thereafter.

Secondly, Although English is not a native language, it is an official language in the Philippines, and English education have been developed since elementary school. Therefore, most people of the Filipino can speak English, and even when it is necessary to talk with local people in everyday life such as shopping and eating etc., the conversation can be conducted in English, in other words, it can be expected to have the same learning effect as a country whose native language is English.

Thirdly, Prices in the Philippines are cheap, and tuition, accommodation and airline fares can be researched for less than 200,000 Japanese yen.

Fourthly, There is only one hour of time difference between the Philippines and Japan, and if you leave in the morning from the nearest Hiroshima Airport from Hiroshima college, you will be able to arrive in the evening on that day, so you can start English training lesson from the next morning without jet lag.

Fifthly, As in Japan's summer, August and September in the Philippines is hot and humid, and there is little change in physical condition due to climate change, but other English-speaking countries are different from Japan at the same time, so it is prone to losing health or get sick.

Table 2 English training program by Hiroshima College

Time	Date	Participant	Days	Host*
1	2006/3	1	9	UP, AMA
2	2006/7	2	9	UP, AMA
3	2007/3	5	9	AMA
4	2008/3	2	9	AMA
5	2009/9	6	16	EAC, (AMA)
6	2010/9	6	16	EAC, (AMA)
7	2011/9	8	16	EAC, (AMA)
8	2012/9	8	16	EAC, (AMA)
9	2013/9	15	16	EAC
10	2014/9	8	16	EAC
11	2015/9	10	16	EAC
12	2016/9	16	16	EAC
13	2017/9	15	16	EAC
14	2018/8	26	16	EAC
15	2019/8	22	14	EAC

*Abbreviation of Organizations
NTMA: NYK-TDG Maritime Academy
KCC: Kauai Community College
SMA: Singapore Maritimes Academy
AMA: AMA Computer University
MAAP: Maritime Academy of Asia and the Pacific
UP: University of the Philippines
EAC: Emilio Aguinaldo College

Class of Joint NTMA Program

The English training and international internship programs were performed at NYK-TDG Maritime Academy (NTMA) in the Philippines as "NYK mirai project". An official agreement between KOSEN and NYK for this program entered into force in November 2017. Number of participant of students and schools for this program were remarkably increased in 2018 as shown in Table 3.

Table 3 Number of participant of students and colleges

Year		2015	2016	2017	2018
Student	Hiroshima	3	3	6	7
	Yuge	1	3	4	7
	Oshima	0	3	0	7
	Toyama	0	0	0	2
	Toba	0	0	0	0
Instructor	Hiroshima	1	1	1	1
	Yuge	0	1	1	1
	Oshima	0	1	0	1
	Toyama	0	0	1	1
	Toba	0	1	0	0

Buddy system which makes a pair between KOSEN and NTMA student was employed to take care these students. They set together at classroom, eat together at canteen, sleep together at quadruple room at dormitory, and join together morning exercise. They did exactly same thing with the buddy as shown in Table4 and Table5.

Table 4 Day schedule of the program in NTMA

Date	Activity
1	Arrival
2	Attend regular classes, Welcome party
3	Attend regular classes, special English seminar
4	Trip to Manila old down town
5	Trip to Coconut plantation
6-9	Attend regular classes, special English seminar
10	Attend regular classes, Farewell party
11	Departure

Table 5 Time schedule of the program in NTMA

0500H	Reveille (fellow Cadet's daily) Routine
0800H	Attend classes of 3rd year cadets
1200H	Lunch with NTMA Cadets at Cafeteria
1300H	Attend classes of 3rd year cadets
1700H	Attend English oral communication activities
2100H	Administrative time
2200H	TAPS (sleeping time)

The students of KOSEN performed introduction presentation of themselves, school, training ship, club activities and town in English for all NTMA students. They participated in specialized maritime and also basic subject regular classes, ship manoeuvre simulator and engine trouble simulator training and so on taught in English with their buddy.

Special English seminar for KOSEN students were provided at every evening after dinner. Seminar was carry out by active learning style included games, pair work, and group work with their buddy. The seminar cover self- introduction, Phonetic alphabet, and Maritime vocabulary.

One day trip to Manila old down town and Coconut plantation on Saturday and Sunday were provided. Students had very good communication in English. KOSEN students could understand Philippines culture and geography very well.

Evaluation of Joint NTMA Program

Questionnaire survey for KOSEN students for "English training and internship program" in NTAM in 2018 was performed to evaluate enhancement of student motivation to study English and be seaman as shown in Table 6.

<u>Table 6 Questionnaire for KOSEN students in 2018</u>
Just choose one number from listed below for each question.
1. Very false 2.False 3.Neither true & false 4.True 5.Very true
<u>About buddy</u>
Q. 1.1 Can you understand your buddy's English?
Q. 1.2 Can you ask a question to your buddy in English?
Q. 1.3 Can you perform the program in harmony with buddy?
Q. 1.4 Can you enhance your understanding for your buddy?
Q. 1.5 what kind of topic is easy to communicate?
1:Hobby 2:Dayly dormitory routine 3:Maritime technical 4:General subject 5:Social system 6:Culture
Q. 1.6 what kind of topic is difficult to communicate?
1:Hobby 2:Dayly dormitory routine 3:Maritime technical 4:General subject 5:Social system 6:Culture
<u>About class</u>
Q. 2.1 Do you understand teacher's instruction in English?
Q. 2.2 Do you like this class style (presentation, roll play, work shop and etc.)?
Q. 2.3 Can you join the class proactively?
<u>Educational effect for the program</u>
Q. 3.1 Can you enhance your understanding for Filipino [Japanese] through the program?
Q. 3.2 Can you enhance your motivation to communicate with foreigner?
Q. 3.3 Can you enhance your motivation to study maritime English?
Q. 3.4 Can you enhance your motivation to be international ship officer and ship manager at oversea?

<u>Table 7 Questionnaire for NTAM students in 2018</u>
Q. 1.1-1.6 = Q. 1.1-1.6 in Table 6
Q. 2.1-2.4 = Q. 3.1-3.4 in Table 6

Result and discussion for Joint NTMA Program

Fig.1-1, Fig.1-2 and Fig.1-3 show statistical results in percentage of the questionnaire survey for KOSEN students for the program at NTMA in 2018. KOSEN students can communicate with NTMA buddy even though their poor English. KOSEN students have difficulty to understand English at the class. But new teaching style help to understand English thought giving additional environmental information. All sector shows remarkable motivation enhancement. They already have high motivation to join the program with some cost. They are already 4th and 3rd grade who are close to period of job hunting.

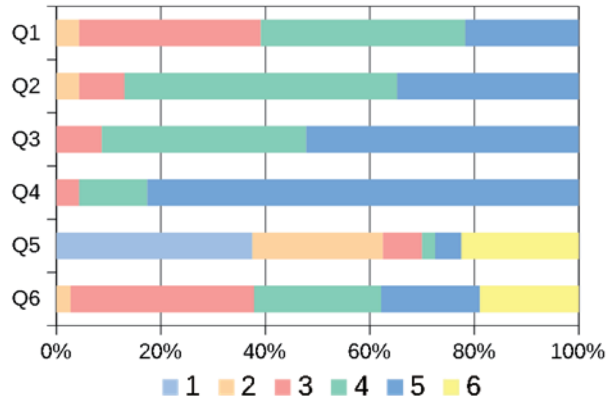


Fig.1-1 Statistical results about buddy system in percentage of the questionnaire survey by KOSEN students for the program at NTMA in 2018

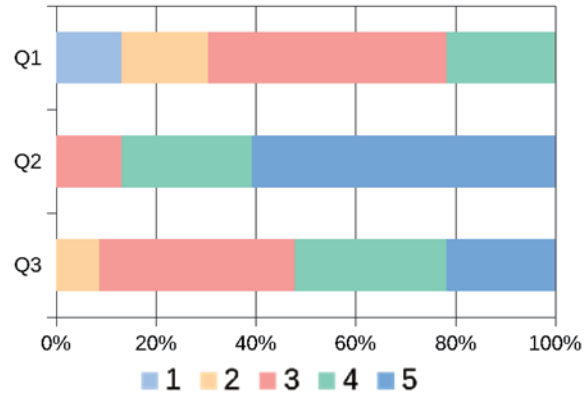


Fig.1-2 Statistical results for class in percentage of the questionnaire survey by KOSEN students for the program at NTMA in 2018

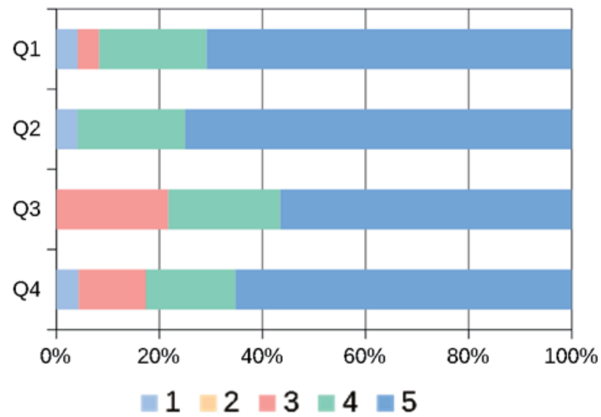


Fig.1-3 Statistical results for educational effect in percentage of the questionnaire survey by KOSEN students for the program at NTMA in 2018

Fig.2-1 and Fig.2-2 show statistical results in percentage of the questionnaire survey for NTMA students for the program at NTMA in 2018. NTMA students can communicate with KOSEN buddy since they are native English speaker and have excellent hospitality. All sector shows remarkable motivation enhancement.

The buddy system works very well to have a lot of English conversation and understanding between KOSEN and NTMA students. It is very important not to Japanese student stick each other in this program. Otherwise they do not learn English and speak in Japanese.

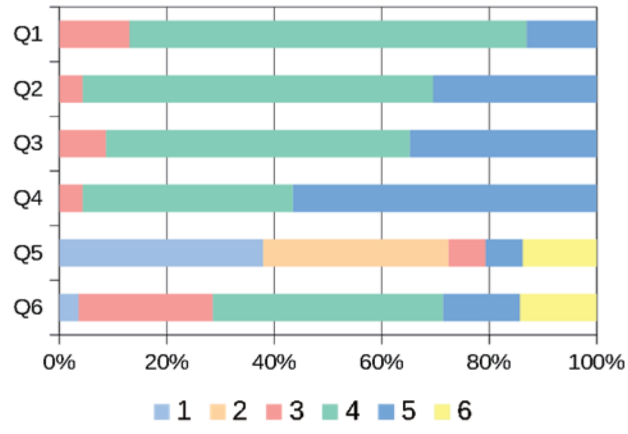


Fig. 2-1 Statistical results for buddy system in percentage of the questionnaire survey for NTMA students for the program at NTMA in 2018

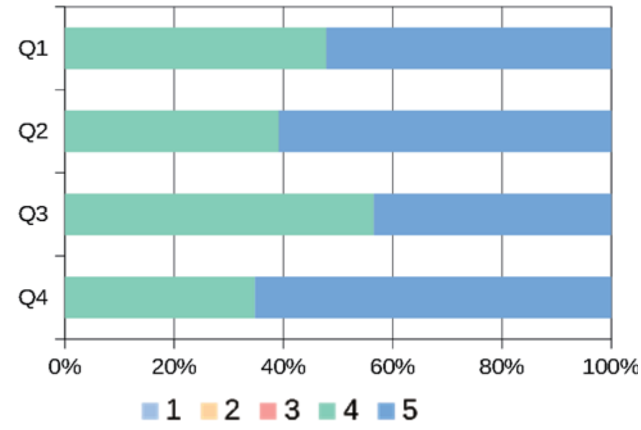


Fig. 2-2 Statistical results for educational effect in percentage of the questionnaire survey for NTMA students for the program at NTMA in 2018

Summary on Joint NTMA Program

English training and internship program in NTMA in the Philippines which is affordable for all students was developed. Host NTMA give a chance to many KOSEN students to study English without any extra personal cost. It is very important to learn maritime English and also to understand inter-cultural background to be able to communicate with international colleagues in future work on ships. Maritime English classes on board the training ships are very effective. We conclude the program is successful to enhance student's motivation to be seaman.

Class of English training program at EAC

In 2018, twenty six students participated in the overseas English training program held by Hiroshima College, including thirteen students from the Hiroshima College, four from the Kure College, and eight from the Yonago College and one from the Kochi College.

Emilio Aguinaldo College (hereinafter referred to as EAC) is one of the three partner colleges of Hiroshima College in the Philippines, EAC started to provide English language training for Hiroshima College since 2011. The English training program (10-Day EFL Program) prepared by the EAC was organized at the times as shown in Table 8 and Table 9.

Table 8 Weekday schedule for 10-Day EFL Program

Time	Contents
9:00-11:00	Speaking, grammar (one-on-one)
11:00-12:00	Reading, group activity
12:00-13:00	lunch break
13:00-15:00	Writing, vocabulary (one-on-one)
15:00-16:00	Conversation, game, group activity

Table 9 Day schedule of the 10-Day EFL Program

Date	Activity/Lesson
Day1	Orientation, pre-test, self-introduction, noun
Day2	Verb, spatial order, physical description
Day3	Adjective, portraying a person, biography
Day4	WHO question, adverb, inform & request
Day5	WHY question, preposition, antonyms
Day6	HOW question, conjunction, synonyms
Day7	WHERE question, determiners, arguing
Day8	WHAT question, describing characteristics
Day9	HOW TO question, process description
Day10	Idioms, defining, post-test, graduation

1. Expanding English Grammar

At Expanding English Grammar, which took place from 9 am to 11 am, an EAC teacher came to a class and gave a lecture on the subject of the day. Although the contents are simple as shown in Table 9, many of the students at first had difficulty understanding because they were explained in English.

2. Reading and Group Activity

The reading and group activity, which took place from 11 am to 12 am, was to check the content of grammar on that day with reading comprehension and vocabulary reinforcement.

3. Writing and Vocabulary Enhancement

The Writing and vocabulary enhancement lesson, which took place from 1:00 pm to 3:00 pm, was to check the content of Grammar on that day with appropriate word supplementation and free composition that decided the theme.

4. Conversation Exercises

In the afternoon Conversation Exercises and group game were took place with student tutors. The contents of the activity were suitable to the young people such as "self-introduction", "game" and "activity such as dance" Most of the students could act together and said that they enjoyed this activities.

5. Real Life Experience

In Real Life Experience, Students went to the EAC cafeteria and one interviewed five local students, and recorded the interviews that is reported to their teachers. Mostly students were actively working to achieve their goals. On the other hand, another Real Life Experience went to a nearby shopping mall and was looking for ten stores. At that time, they had to ask the local people for the location of the store, and the answers would be the contents that they learned in the morning.

6. Closing Ceremony

The Closing Ceremony was taken place on the last day. Both the moderator and the words of gratitude were also given by our students. The moderator's words were prepared by the EAC teachers, but the words of gratitude were presented by the students' own thought in the manuscript. Although there were minor mistakes, it was a well-informed speech.

Result and discussion for EFL program at EAC

Table 10 shows the Performance report for 10-Day EFL (English as a Foreign Language) Program at EAC, which are the records and comparison of scores between pre-test and post-test on written exam and oral exam for twenty six participants, of course, we deleted the personal information of names.

Table 10 Performance report for 10-Day Program at EAC

National Institute of Technology, Hiroshima College

Performance Report

Pretest					Posttest				
Written Exam		Oral Exam			Written Exam		Oral Exam		
Score	Description	Score	Description	Overall Score	Score	Description	Score	Description	Overall Score
39	Pre-Intermediate	2	Beginner	Elementary	39	Pre-Intermediate	4.5	Elementary	Pre-Intermediate
35	Pre-Intermediate	2	Beginner	Elementary	55	Intermediate	4.5	Elementary	Pre-Intermediate
46	Intermediate	2	Beginner	Elementary	71	Upper Intermediate	5.0	Pre-Intermediate	Intermediate
49	Intermediate	2	Beginner	Pre-Intermediate	61	Intermediate	4.0	Elementary	Pre-Intermediate
38	Pre-Intermediate	4	Elementary	Elementary	51	Intermediate	5.0	Pre-Intermediate	Intermediate
39	Pre-Intermediate	2	Beginner	Elementary	69	Upper Intermediate	4.5	Elementary	Intermediate
41	Pre-Intermediate	2	Beginner	Elementary	45	Pre-Intermediate	6.0	Pre-Intermediate	Pre-Intermediate
27	Pre-Intermediate	2	Beginner	Elementary	34	Pre-Intermediate	5.0	Pre-Intermediate	Pre-Intermediate
34	Pre-Intermediate	4	Elementary	Elementary	30	Pre-Intermediate	4.0	Elementary	Pre-Intermediate
62	Intermediate	4	Elementary	Pre-Intermediate	79	Upper Intermediate	5.0	Pre-Intermediate	Intermediate
42	Pre-Intermediate	2	Beginner	Elementary	61	Intermediate	5.0	Pre-Intermediate	Intermediate
49	Intermediate	2	Beginner	Pre-Intermediate	75	Upper Intermediate	5.0	Pre-Intermediate	Intermediate
53	Intermediate	3	Elementary	Pre-Intermediate	79	Upper Intermediate	5.0	Pre-Intermediate	Intermediate
51	Intermediate	2	Beginner	Pre-Intermediate	57	Intermediate	4.5	Elementary	Pre-Intermediate
40	Pre-Intermediate	2	Beginner	Elementary	54	Intermediate	4.5	Elementary	Pre-Intermediate
43	Pre-Intermediate	2	Beginner	Elementary	68	Upper Intermediate	5.0	Pre-Intermediate	Intermediate
35	Pre-Intermediate	4	Elementary	Elementary	57	Intermediate	4.0	Elementary	Pre-Intermediate
31	Pre-Intermediate	2	Beginner	Elementary	43	Pre-Intermediate	5.0	Pre-Intermediate	Pre-Intermediate
49	Intermediate	3	Elementary	Pre-Intermediate	61	Intermediate	5.0	Pre-Intermediate	Intermediate
57	Intermediate	3	Elementary	Pre-Intermediate	61	Intermediate	5.0	Pre-Intermediate	Intermediate
44	Pre-Intermediate	3	Elementary	Elementary	62	Intermediate	4.5	Elementary	Pre-Intermediate
38	Pre-Intermediate	2	Beginner	Elementary	61	Intermediate	4.5	Elementary	Pre-Intermediate
57	Intermediate	3	Elementary	Pre-Intermediate	62	Intermediate	5.0	Pre-Intermediate	Intermediate
35	Pre-Intermediate	3	Elementary	Elementary	50	Intermediate	5.0	Pre-Intermediate	Pre-Intermediate
33	Pre-Intermediate	2	Beginner	Elementary	54	Intermediate	5.0	Pre-Intermediate	Pre-Intermediate
49	Intermediate	2	Beginner	Pre-Intermediate	44	Pre-Intermediate	4.5	Elementary	Pre-Intermediate

On the pre-test performance, the average score of written exam is 42.9, and the average score of oral exam is 2.5 for twenty six participants, the overall description are seventeen students for elementary level and nine students for pre-intermediate level.

However, after the just 10-days EFL Program at EAC, On the post-test performance, the average score of written exam is 57.0, and the average score of oral exam is 4.8 for twenty six participants, the overall description are fifteen students for pre-intermediate level and eleven students for intermediate level.

From the above results, it can be seen that although the individual scores of individual students show a drop, their overall ability has improved. In particular, it is clear that conversational ability has greatly improved.

Achievements and Issues

As the above results and discussion on the questionnaire survey and examinations of English proficiency before and after the English training programs at EAC in the Philippines, the English level of most students was rising. In particular, the scores for oral exams, which lead to communication skills, were almost clearly increased. From this result, it is thought that the English training program at EAC in the Philippines had a great effect.

As good points and future issues for this English training programs at EAC, The student's impression and comments are shown below.

Good points (Participant's comments)

1. I wanted to improve my English skills so that I could follow daily conversations, but I joined this English training program, then I greatly exceeded my expectations and I was very satisfied.

2. English skills improved a bit by talking with the teachers and local students. It turned out that words and gestures can be transmitted even outside the school.

3. I know that even simple English words can be understood somehow. When I heard a word at a key point, I came to understand it somehow.

4. I heard a little English and I can understand it as it is. It became possible to connect this words and that words and communicate them to each other.

5. I was nervous at first. It became possible to do shopping as usual. The conversation with the local students was fun.

6. There was a big shopping mall nearby and it was convenient.

7. There was a difference in culture with Japan, and I studied a lot.

8. It was good to be able to experience the first time overseas. I was surprised at the large number of Filipino people. The prices in Manila were cheap.

Future issues (Need to take measures)

1. Manila City in the Philippines is a Level one area indicated on the Ministry of Foreign Affairs Overseas Security Website, and there is also a report that Japanese people were damaged every year, So it is necessary to decide whether to carry out or continue this English training program based on careful consultation considering the world situation every year.

2. Almost every year there were students who are taken to hospital for illnesses etc. such as diarrhoea. For example, in 2016, five of eight male students were taken to the hospital, in 2017, one female student was taken to hospital with fever, in 2018, and two male students were taken to the hospital by Taxi. So in order to prevent unforeseen accidents and diseases etc. in advance, we refrain from eating and drinking of unsanitary food and make sure to join overseas travel insurance.

3. Because security in Philippines was not as good as in Japan, there were losses of valuables. For example, smartphone was lost in a taxi, and smartphone was dropped to a bike seat with a sidecar, etc. So when a student goes out, he or she must inform the instructor as much as possible, and always act with two or more people.

Some remedies

We address the above isuues that exist in the English training program for KOSEN students in Philippines by taking the following measures or remedies.

1. An emergency communication network was created to deal with the emergency events that maybe take place in English training program in Philippines.

2. Regardless of the number of participated students, two teachers or more must be dispatched to lead the students every times.

3. The staff and instructors of KOSEN colleges in charge of overseas English training program keep close contact with the local person in charge of this program.

4. At the training destination, the students always act with two or more people, and the students should always be in contact with the teacher, when they are going out, be sure to notify the schedule to the leading teachers.

5. The leading teacher send daily report to the Student Affairs Division of Hiroshima college every day, and always pay attention to collect information about local safety and inform it to the students.

Conclusions

Both joint NTMA program and EAC English training program clearly showed improvement in both of students' English proficiency and communication skills in English. Especially, comparing with other English speaking countries, the overseas English training in the Philippines has a very good ratio of performance to price, so that the number of participants of students will be thought to increase in the future.

However, in the Philippines, there are issues such as food hygiene and security situation, so it is necessary to take sufficient care and measures to make the overseas English training program successful.

References

Hiroshi OHYAMA and et al., (2018). Development of Essential Personalities for Future Maritime Professionals -International Internships Programs Developing Global Adaptability-, NAVIGATION, 203, 20-24.

Acknowledgements

This Joint NTMA Program is sponsored by “NYK mirai project” from NYK Corporation. The English training program at EAC is sported by Emilio Aguinaldo College. The authors would like to express gratitude to instructors and staff of NTMA and EAC to perform the joint English training programs.

INTERACTIVE EDUCATIONAL EXCHANGES BETWEEN NAGAOKA KOSEN AND ADTEC MELAKA BASED ON PROJECT-BASED LEARNING

Susumu Nakamura*[a], Takahiro Yamamoto [b], Hisako Okumura [c], Mohd Fadzly bin Othman [d], Rezawati binti Ismail [e], Normazlinda binti Che Mahmood [f] and Mohd Zabidin bin Abd Samad [g]

[a] Department of Electrical and Electronics Systems Engineering, NIT (KOSEN), Nagaoka College, Japan
[b] Department of Civil Engineering, NIT (KOSEN), Nagaoka College, Japan
[c] Department of Materials Engineering, NIT (KOSEN), Nagaoka College, Japan
[d] Assistant Director of Student Affairs, ADTEC Melaka, Malaysia
[e] Division of Mechatronic, ADTEC Melaka, Malaysia
[f] Department of Human Resource, ADTEC Melaka, Malaysia
[g] Director, ADTEC Melaka, Malaysia

* Email: snaka@nagaoka-ct.ac.jp

Abstract

National Institute of Technology (KOSEN), Nagaoka College (hereinafter called "Nagaoka KOSEN") and Advanced Technology Training Center (ADTEC) Melaka signed an academic exchange program on November 6th, 2014. Then, both institutes signed the second-term academic exchange program on February 26th, 2019. ADTEC Melaka was erected under the 7th Malaysia Plan and commenced operations in 2001. ADTEC is fully-governed by the Department of Manpower under the Ministry of Human Resources, Malaysia. ADTEC Melaka is one of eight ADTECs in Malaysia which run technical courses in Diploma level. We reported on the exchange programs between Nagaoka KOSEN and ADTEC Melaka at ISATE2015, ISATE2016, and ISATE2017. This paper reports interactive exchange programs between Nagaoka KOSEN and ADTEC Melaka based on project-based learning from 2017 to 2018. The aim of the exchange programs was to upgrade the technical skills of ADTEC Melaka's teachers and students and vice versa. The interactive exchange programs were conducted at both institutes. Making an autonomous sumo robot, a wind generator and an I-attendance tracker were conducted at Nagaoka KOSEN in 2017. By using the budget of the Sakura Science Exchange Program, Nagaoka KOSEN invited ADTEC Melaka students in the Japanese academic year 2017, and 2018. ADTEC Melaka also accepted Nagaoka KOSEN's students in 2017 and 2018 to do the interactive exchange programs.

Keywords: *Interactive exchange program, Design, Prototyping, SolidWorks, 3D printer, Project-based learning*

1. Introduction

Nagaoka KOSEN was established in 1961 under the Ministry of Education of those days. Based on the Japanese Government's policy, all 55 National KOSENs, including Nagaoka KOSEN, were incorporated as a new single legal entity in 2004 and are now under the umbrella of the National Institute of Technology, Japan. However, each KOSEN maintains its independent authority.

Nagaoka KOSEN has five departments which strive to produce young practical engineers in a five-year higher education system along with two more years advanced courses to meet the strong demand from industry. The five departments are as follows:

Mechanical Engineering
Electrical and Electronic Systems Engineering
Electronic Control Engineering
Materials Engineering
Civil Engineering

The Manpower Department is one of 13 departments in the Ministry of Human Resources, Malaysia. The responsibilities of the Manpower Department are to provide skills and educational training for secondary school graduates and industrial workers, maintaining a good relationship with the industry to ensure employability of its graduates, and to improve the quality of its instructors/lecturers.

The Manpower Department Training Institution or Institusi Latihan Jabatan Tenaga Manusia (ILJTM) was established to carry out pre-employment skills training programs in order to fulfill the nation's industrial sector needs. At present, there are 32 technical institutes consisting of 23 Industrial Training Institutes (ITI), eight Advanced Technology Training Centers (ADTEC) and one Japan-Malaysia Training Institute (JMTI).

ADTEC Melaka was erected under the 7th Malaysia Plan and commenced operations in 2001. It is one of eight ADTECs in Malaysia. The first students' intake was in January 2002 with 88 students as the pioneer batch. ADTEC Melaka offers technology programs at Diploma levels. The curriculum for all programs is designed to have 60% practical and 40% theory. There are five full-time courses offered to students which are as below:

Diploma in Production Technology
Diploma in Mechatronics Technology
Diploma in Telecommunications Technology
Diploma in Computer (Systems) Technology
Diploma in Automotive Technology

Nagaoka KOSEN and ADTEC Melaka have signed an academic exchange program on November 6th, 2014. The first collaborative training program between Nagaoka KOSEN and ADTEC Melaka was conducted from May 11th to June 5th, 2015. The aim of this program was to assist ADTEC Melaka teachers in developing the robot using current technology. This training program actively engaged the participants in design using SolidWorks, prototyping with ink-jet and FDM type 3D printers, programming and controlling LEGO and TETRIX Robotics. The second collaborative training program between Nagaoka KOSEN and ADTEC Melaka in practical design and manufacturing was conducted from August 21st to September 1st, 2015. Fifteen students and two professors from Nagaoka KOSEN visited ADTEC Melaka to attend the collaborative training program. The aims of the collaborative training program were to give Japanese and Malaysian youth students the opportunity to know each other and to gain learning experience through the project-based learning approach. Nakamura et al. (2015, 2016, 2017) reported on these collaborating training programs at ISATE2015, ISATE2016, and ISATE2017.

2. Incoming Program

2.1 Program from September 19th to October 18th, 2017

In order to take the project-based learning, four teachers and eight students from ADTEC Melaka visited Nagaoka KOSEN from September 19th to October 18th, 2017. The aim of the training program was to upgrade the technical skills of ADTEC Melaka's teachers and students. For the project-based learning, they were divided into three groups and each group has different projects; an autonomous sumo robot, a wind generator, and an I-attendance tracker. For each project, one teacher from Nagaoka KOSEN was assigned to be a supervisor.

・Autonomous sumo robot

The first group designed and created an autonomous sumo robot. Generally, the autonomous robot is a robot that performs tasks and actions with high autonomy. It is highly needed in several areas, such as floor cleaning, drainage treatment, delivery, space exploration, and self-service. It requires several sensors, to ensure the robot can perform a few tasks and a camera to detect or locate the specific object. This project was assigned to build a robot that plays sumo game autonomously using the below strategies:

(i) Search and Attack
Locate, navigate and push an opponent
(ii) Search and Run
Locate, run away and sustain in the field
(iii) Random Movement
Move forward, detect line and sustain in the field

The scope of the project are as follows:

(i) To build a sensory system to able sumo robot using IR and Ultrasonic sensors
(ii) To use CMUcam5 Pixy to replace ultrasonic sensors
(iii) To develop the programming structure for the robot movement

Japanese and Malaysian students were working together to build the robot as shown in Figure 1.

Figure 1 Discussion between Japanese and Malaysian students about the robot.

・Wind Generator

The second group has designed and created a wind generator. The wind generator or wind turbine is a device that converts the kinetic energy of wind into electrical power. The smallest turbine is used to charge the battery which supplies auxiliary power for boat or power traffic warning. A wide range of vertical and horizontal axis type is manufactured. Figure 2 shows a wing made with a 3D printer. The objectives of the project are as follows:

(i) To develop a gear transmission system with a ratio of 1: 3 using a wind source from the outdoor unit of air conditioning to turn DC power generator (DC motor generator).
(ii) To produce a gear transmission system with a ratio of 1: 3 using a wind source from the outdoor unit of an air conditioner to twist the DC electric generator (DC motor generator).
(iii) To develop an electronic circuit to step up a circuit to increase the voltage from 3v to 5v.

Figure 2 A wing made with the 3D printer

・**I-attendance tracker**

The third group has developed the I-attendance tracker. The I-attendance tracker is system recording student attendance using thumbprint or RFID card as an input. The teacher can access the system using the mobile phone through shortcut apps. The objectives of the project are as follows:

(iv) To develop a system, switching from manual to a system connected to Wi-Fi networks
(v) To design to facilitate the lecturer to know the presence of students
(vi) To develop the system to cope with tardy students

All projects started with a discussion within the group members about basic concepts of the target object. After that, they designed the equipment with SolidWorks, cut out parts fabricated all parts, and finally assembled them as shown in Figure 3.

Figure 3 Assembling I-attendance tracker.

2.2 SAKURA Exchange Program in Science

Nagaoka KOSEN invited ten students and one teacher from ADTEC Melaka in the Japanese academic year 2017 and 2018 by using a budget of Japan-Asia Youth Exchange Program in Science (SAKURA Exchange Program in Science) which is supported by Japan Science and Technology Agency. There are two sessions which were from February 20th to March 1st, 2018 (Grant Number S2017F0421188) and from October 8th to October 17th, 2018 (Grant Number S2018F0531400).

The main activity of SAKURA Exchange Program in Science was a group work to participate in a line tracer competition. Ten Malaysian students from ADTEC Melaka and almost the same number of Nagaoka KOSEN's students were divided into five teams. Each team consisted of Japanese and Malaysian students.

The competitions of line tracer robot were conducted using mBot on February and LEGO robot EV3 in October in 2018 as shown in Figure 4. In the line tracer competition, each team had two chances to try the race and the ranking was determined by the total points of two races.

The impressions of the students and teacher who visited Nagaoka KOSEN by the SAKURA Exchange Program in Science are shown below. The English sentences of the impressions are original except for the spelling errors.

"It was an amazing experience. I got to see and experience the culture that made Japan the great country it is today. I hope this country will continue to thrive in the near future."

"Need a more day visit with industry. Need to go to visit industry that related to a course of the student. Happy with sensei, culture and more. Want to go to Japan again."

"I am very satisfied with all the programs you held. I am happy 10 days in Japan. All sensei kind to me. I hope we can meet again another day. I like all about Japan. All Japanese students are polite and kawaii."

"It was very enjoyed and many things that I learned from this program such as Lego robotics, mBot robot and eat Japan food. The environment of Japan is very fresh and the culture is good. All the students, teacher and staff are friendly and give us pieces of information about the research that they have done."

"First in really impress with discipline in Japan, harmony place, peaceful. Learning new things about Japanese culture. I very impress with Nakamura sensei with, friendly father ability, good in time and keep strong for making a group complete. All the programs are working properly."

"This program very interesting, get new friends, get new learning, can learn Japanese culture, add the day of the program and I am very happy."

"I wish an exchange program can be held for two weeks or more. I am very happy because I can make new friends here and I can learn English, Japanese culture and Japanese food. Thank you very much Nagaoka College for inviting me and ADTEC Melaka."

"I hope that one day NIT, Nagaoka College or Japanese Government will offer further study in Nagaoka for ADTEC students or even practical."

"This program gives more experience and knowledge to students. Japan country is so clean place, like no rubbish everywhere and has a smoking area place. This program gives more information about new technologies in Japan country."

"I am satisfied with this program and improve myself to succeed. I hope the program will link the ADTEC students and NIT, Nagaoka College students. I am very happy to be here because Japan is a safe country and fresh air. I hope to come again on the day. Nakamura Sensei is very nice and very good. Happy to meet you Sensei."

"This program gives me experience about Japanese technology, science and culture. I think Japanese science, technology and culture one stage ahead and can inspire me to give the best effort to my country. Thank you very much because give me the golden chance to come to Japan. I hope can come again near future."

Figure 4 Programming of LEGO robot EV3.

3. Outgoing Program

Sixteen students and one teacher from Nagaoka KOSEN visited ADTEC Melaka to attend the collaborative training program from August 30th to September 9th, 2017. In 2018, Nineteen students, three teachers and one administrator from Nagaoka KOSEN visited there from August 31st to September 10th.

The aims of the outgoing program are to give Japanese and Malaysian youth students the opportunity to know each other and to gain learning experience through a problem-based learning approach. To foster originality and ingenuity of students, Nagaoka KOSEN and ADTEC Melaka students worked together to participate in the robot competition. The major activity of the collaborative training program was group work to build the robot using LEGO robot EV3 and mBot as shown in Figure 5. During the group work, Japanese students and Malaysian students were divided into five teams. Each team consisted of Japanese and Malaysian students.

Besides that, there were a factory tour at Yakult Malaysia and sightseeing in Kuala Lumpur city to enlarge students' knowledge or information about Malaysia.

After returning to Japan, Japanese students made presentations about outgoing programs during the school festival. The students shared their experience with Nagaoka KOSEN's students, parents and the college's staff who did not participate in the interactive educational exchanges.

Figure 5 Competition of line tracer using mBot.

4. Conclusions

In order to conduct the interactive educational exchanges between Nagaoka KOSEN and ADTEC Melaka, ADTEC Melaka's students and teachers visited Nagaoka KOSEN and vice versa. Students' feedback mentioned that the collaborative training program gave them a rare opportunity on interaction with foreign students and they had very significant educational benefits, such as improving communications skills and stimulating motivation for learning foreign languages. All students who participated in the programs think that they would like to visit each other again if the chance arises.

Nagaoka KOSEN and ADTEC Melaka have signed the second-term academic exchange program on February 26th, 2019. There are also plans to have mutual exchange programs between both institutes this year.

Acknowledgements

We sincerely appreciate Ms. Chin Phaik Yoong, former Director General, and Mr. Datuk Muhd Khair Razman Bin Mohamed Annuar, current Director General of the Manpower Department of the Ministry of Human Resources, Malaysia, giving us the opportunity to do the collaborative training programs.

Japan-Asia Youth Exchange Program in Science (SAKURA Exchange Program in Science, Grant Number S2017F0421188 and S2018F0531400) was financially supported by the Japan Science and Technology Agency.

References

Nakamura, S., Iyama, T., Tokoi, Y., Kaneko, K., Aoyagi, N., Yamazaki, M., Ismail, R., Mahmood, N., and Samad, M. (2015). Collaborative Training Programme Between Nagaoka College and ADTEC Melaka Based on the Solidworks and Tetrix Robotics. Transactions of ISATE 2015, pp.556-560.

Nakamura, S., Togawa, K., Ismail, R., Mahmood, N., and Samad, M. (2016). The Second Collaborative Training Programme Between NIT, Nagaoka College and ADTEC Melaka in Practical Design and Manufacturing. Transactions of ISATE 2016, pp.711-715.

Nakamura, S. Iyama, T., K., Ismail, R., Mahmood, N., and Samad, M. (2017). Global Engineering Education Between NIT, Nagaoka College and ADTEC Melaka Based on Project-Based Learning. Transactions of ISATE 2017, pp.436-441.

URL: Japan-Asia Youth Exchange Program in Science, http://www.ssp.jst.go.jp/EN/outline/index.html

EXPLORING THE RELATIONS BETWEEN THE INTERNATIONAL EXCHANGE EVENTS AND THE ENHANCEMENT OF STUDENTS' MOTIVATION

Yuko UESUGI

National Institute of Technology, Kure College, Japan
uesugi@kure-nct.ac.jp

Abstract

This paper aims to prove a close relation between the international exchange events which are held in Japan and the enhancement of students' motivation toward the acquisition of languages and the cross-cultural understanding. The research question is how closely they are related to each other.

In order to find an answer to this question, the effects of the international exchange events between National Institute of Technology, Kure College, NIT Kure, and Radford College in Australia are analyzed. Some cases are introduced such as the Skype-used communication classes and the homestay programs. Thus, this paper provides the report on how effective the international exchange events between these two colleges are.

In the Skype sessions, where both sets of the students exchange their cross-cultural information with each other both in English and Japanese, we try to achieve the tandem education. The tandem education is an education system where both sides aim to develop their different target languages; in this case, English for the NIT Kure students and Japanese for the Radford College students. By conducting Skype sessions along with the exchange programs, both sides of the students can have an effective reunion which leads to a firmer and longer friendship.

Having a sister school where we can exchange our different languages has been an interesting journey, bringing about new learning opportunities for students in Australia and our sister students in Japan. The sister-relationship has been conducted for seven years. We regularly send our students on the homestay programs with the purpose of the international exchange.

There are two main resources to be analyzed as follows: the questionnaires from the students, the interviews to the students and the transitional scores of English tests.

As a result, the correlation was found between them. We will continue to explore every opportunity in the future to have cross collaboration, Skype sessions, and exchanges. Consequently, these events will give you some unique educational insights from different cultural perspectives. It will continue to help students to cross cultural barriers, think globally and build human understanding rather than just cross-cultural understanding.

Keywords: *sister-relationship, homestay program, international exchange, tandem education, cross-cultural understanding*

1. Introduction

Since March 25, 2015, Radford College in Australia and NIT, Kure have been collaborating international exchange programs as the sister-relationship. Since then, we've been sharing the common goals to achieve: the Skype-used tandem education where both sides aim to develop their different target languages, English for the students in NIT, Kure and Japanese for those in Radford College; the enhancement of cross-cultural understanding among both sets of the students; and the increase of the students' motivation toward learning. We send our students each year regularly and occasionally irregularly on the homestay programs for the purpose of the international exchange between our schools.

Among many different kinds of international exchange events, this paper especially focuses on the international exchange events such as short-stay international students' visiting occasions.

This paper explores the relation between these international exchange events which are held in Japan and the students' motivation toward their English acquisition and cross-cultural understanding.

2. Materials and Method

Two main resources as materials to support this paper are as follows: first, the interview to the student who experienced hosting an international student; second, the questionnaires to the students at NIT, Kure, in regard to the exchange events. They shared their own views after they had spent time with an international students not only in classes but also in the extra curriculum after school or off campus. These points of view from the students' angle give us insight to reach the clues about how effective international exchange events are for the enhancement of their motivation to learn English.

The English study motivation enhanced by exchange programs which include study tours abroad has been discussed by many researchers. As one example among many, Okada (2016) reported various exchange programs in the past several years and related students' motivation for English to them. Yamazaki (2011) discussed English teaching for intercultural understanding with broad analysis with English educational date of Asian and European countries.

This paper uniquely focuses on the international exchange events held in Japan. As a host college, short-stay international students study in our college with our students. Any student in our college can participate in these planned events with international students, unconcerned about their family or financial issues.

3. The Interview to the Host Student

The interview to the Host Student was conducted after he hosted one male student from Radford College between Dec, 2018 and Jan, 2019. And now he is planning to study in Australia and to be hosted by the same Radford college student for one month in Sep, 2019.

The outcomes of the interview are as follows:

Q1. What makes you decide to become a host family?

A. I have been interested in English and foreign countries. This chance would be a good one for me. My family has wanted me to study abroad.

Q2. What changes have you got from this experience?

A. I wanted to study English more. I focus on daily conversation and expressions rather than grammar. I used to regard the English language as grammar, but memorizing useful expressions is more important than learning grammar.

Q3. What was good about hosting a student?

A. It was good to spend a long time with one exchange student. I came to understand what to care about.

Q4. What was not good about hosting a student?

A. None.

Q5. What was difficult about hosting a student?

A. I couldn't express what I wanted to say in English.

Q6. What do you like to do when you study in Australia and stay with the same exchange student?

A. I want to make as many friends with different nationalities as possible.

Q7. Are you worried about your English ability?

A. A little. Even an easy sentence cannot be understood if the intonation isn't correct. I need to be careful about Japanese English.

Q8. What is your future dream?

A. I hope to work and live overseas.

This interview shows that this host student successfully built a relationship of trust with the exchange student. Although he had been motivated before he hosted the students, his world was broadened wider. It is amazing for both students to exchange hosting experiences with each other. Also, both colleges have sympathetic understanding to accept the student and supportively maintain the friendship between them.

4. The Results and Analysis of the Questionnaires

The questionnaires were given to the 2nd year students at NIT, Kure, after they experienced various international exchange events between our college and our sister school in Australia. The number of the students is 179. Since those students entered our college, we have conducted the exchange events three times: the homestay and school visit of 13 Radford College students and 2 teachers for one week; 13 students and 2 teachers' one-day visit from Australia as an irregular event supported by Hiroshima Pre. Board of Education; one Radford College student who had the irregular homestay with NIT, Kure student. How have the students' views changed since they experienced these international exchange events? Was the students' motivation enhanced due to these events?

In the questionnaires, 10 questions were asked to the students as follows:

Q1. The international exchange events can improve English.

Q2. The international exchange events increased my interest in foreign cultures.

Q3. The motivation toward learning English was enhanced thanks to the international exchange events.

Q4. I communicated positively with the foreign students.

Q5. My English ability was improved due to the international exchange events.

Q6. I'd like to accept more foreign students to my classes.

Q7. I feel some changes in myself through the international exchange events.

Q8. The international exchange events made me feel like going abroad to study.

Q9. I hope we'll have more international exchange events in the future.

Q10. I'd like to participate in the international exchange events positively in the future.

For these questions, the answer options were five: 1. Yes, very much. ; 2. Yes. ; 3. So, so. ; 4. Not very. ; 5. Not at all.

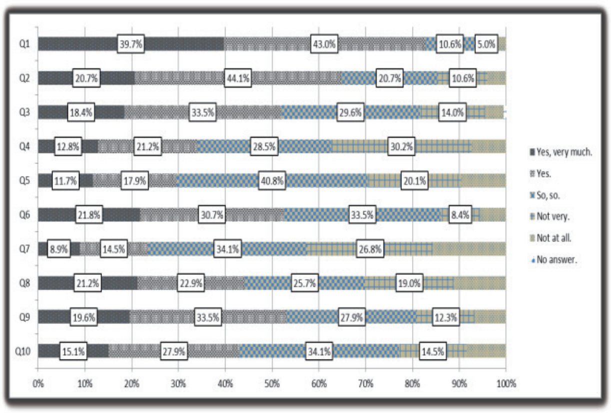


Figure 1: The Results of the Questionnaires

Analyzing the questionnaires, 82.7% students think the international exchange events can improve English and 64.8% of them think they got interested in foreign cultures. 51.9% of them were motivated by the international exchange events, although the questions to ask their own attitudes in the events have different results. For Q.4 only 34% of them positively communicated with foreign students, which was assumedly caused by their shyness. Only 29.6% think their English was improved due to the events and 40.8% answered "So, so." The time and number of these events were limited, so it is quite natural for them to answer this way which shows the lack of confidence.

52.5% wanted to accept more foreign students to their classes, although the negative reactions are clear in admitting their own changes in themselves. About half of them were motivated to study abroad thanks to these events but the other half weren't.

53.4% want to have more future events and 43% positively want to participate in these events.

Figure 1: The interactions when Radford College students visited us for one week in 2019

As for the free comments, some characteristic comments are picked up as follows.
The picked up free comments from the 2nd year students:

・It was good that I came to know how important communication skills were.

・It was interesting to know the cultural differences.

・I got interested in foreign countries and cultures. I started to hope to visit them.

・I wanted to have more individual activities rather than one exchange student to the all the students.

・I wish I could have more international exchange events.

・Reading and writing English is important but in fact it is meaningless if we cannot speak English. Therefore, I want to have more chances to speak English.

・I noticed that we Japanese are luck of communication skills when I saw the exchange students' attitudes.

・I've already kept in touch with one exchange student since we met in our class. I am amazed to know how different our cultures are.

・Communicating with foreigners makes us interested in foreign cultures and improves our English ability.

・I hope we can have online English conversation classes with sister schools overseas.

・I found it difficult but great to have a chance to listen to the native speakers' English.

・The interactions with exchange students makes me feel like studying abroad, discovering the new world and developing my English ability.

Figure 2: The interactions when Australian students visited us for one day in 2019

The picked up free comments from the 1st year students of the advanced course are as follows:

・The number of the chances to use English is very small, so I tried to speak to the exchange students at the cafeteria and so on by myself. In the designated seats in class, it was difficult for me to speak to them. Mingling both sets of the students is desirable.

・The more chances to speak English, the better our speaking abilities can be. I hope to learn daily English expressions in class.

・I enjoyed the presentation about Australian cultures by the exchange students. I cannot speak English and I'm still afraid of speaking. So I strongly hope to get used to English from now.

・More exchange events can lead to enhance the students' motivation.

・Before the exchange events, I thought I needed to have basic English learning in class. I hope to have more exchange students in class to interact more closely. Also, listening to the native speakers' English for such a short time doesn't improve English, although it can enhance our motivation.

・We need to have some measures toward the situation when the exchange students come to study Japanese. Since our target languages are different, it is hard to meet our needs with each other.

・It's good to exchange the cultural presentations on both sides.

・We need to have closer interactions to have more effective international exchange events.

・I hope we can have more sister schools abroad to create more chances to study abroad. It's also good to have an event where we can share the information with the students who have experienced the study abroad. We need to create the situations where we must speak English.

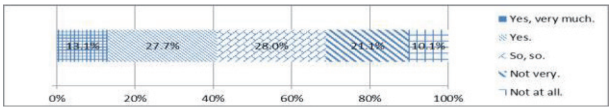
・I hope to have more chances to speak with each other than those to listen to their presentations. Small group talk is necessary. As a result, the dialog is a significant key for the international exchange events.

・If we cannot speak English, nothing matters in our daily life. However, English is essential for us future engineers to have interactions with people around the world when we obtain various knowledge and technology using English.

According to the free comments above, it can be said that the international exchange events have surely great effects on the enhancement of motivation to learn English. They hope to have closer interactions such as small-group discussions. The English speaking environment is significant for learners to utilize English in reality.

Additionally, the International Exchange Office at NIT, Kure conducted a questionnaire to all the students in July 2019 in order to survey what can be problems

when they go abroad to study or participate in the intercultural events. 8 questions were asked to 465 respondents in total. Among these questions, one question is related to this paper. The question is as follows:
Q. Do you like to participate in the international exchange events held at or around school?



About 40% students like to participate in the international exchange events held at or around school. Also, it is worth solving the problem that there are about 30 % students who said not very or not at all. In the future, we need to open up those negative answered students' mind by improving intriguing and attractive events.

5. Finding and Discussion

Not all the students can study abroad for family matters or financial reasons. Therefore, these international events held in Japan where any student with various English levels can participate play a significant role and have great effects on the enhancement of their motivation toward language acquisition.

Students are daily told to study English hard with lots of explanations about its importance by their teachers or parents, but in reality it's hard for them to come to the realization. Participating these events by themselves can strike home. It's important to involve the students to their unknown world by incubating the international exchange events.

The creation of the English speaking environment is the key for the Japanese students to improve English. They first realize not only their own lack of English ability but also the importance and necessity of English. This is a starting point to broaden their own views toward the acquisition of English. They face some difficulty to conquer. And then they realize that as long as they are too shy to speak out and afraid of making grammar mistakes in English, their English will not be improved. This notion changes their attitudes toward English.

Once they are motivated, they search the ways to achieve their goals. We need to keep incubating these international exchange events as their incentives.

6. Conclusions and Future Perspectives

According to the questionnaires and free comments, it is necessary to set up small groups where they can mingle easily, considering the allocation such as one foreign student to 2 or 3 Japanese students. The more different people they have interactions, the more effective these exchange events can be.

Creating these authentic cross-cultural events is surely effective when we devise the ways to involve the students who cannot study abroad due to their financial matters as well as the students who are not interested in intercultural events.

References

Okada, Akira. (2016). "English Study Motivation Cultivated by Exchange Programs" Journal of NIT, Koyama College: 49, 5-8.

Yamazaki, Yusuke. (2011). "English Teaching for Intercultural Understanding" *Journal of Contemporary Social Studies*: 9, 1, 41-48.

Developing Resilient Mindsets in Students for Natural Disasters by Engaging them in the Development of Pocket Maps and Guides

Yoshiko ASAMI & Tomek ZIEMBA

National Institute of Technology, Oita College, JAPAN

* y-asami@oita-ct.ac.jp

Abstract

In recent years, more large-scale natural disasters have been happening across Japan, including the Kumamoto and Hokkaido earthquakes. In those times, it is often found later that many non-Japanese residents and visitors did not have the appropriate information provided or know the basics of survival in these extreme incidences. With the assistance of local governments, the researchers have begun a program in which students are made responsible to make these emergency information materials to be provided to foreign visitors and residents. Students worked in groups to create one-page, foldable maps that can be distributed to visitors to the city throughout the period of the Rugby World Cup (RWC). Groups were first instructed to go out to scout locations of emergency sites and supplies around the downtown area to get other necessary emergency evacuation site and supplies information, and then decide what is the most important details to be included in the limited space of their pocket maps. The final pocket maps and guide pamphlets made by the student groups will be submitted to city hall officials for approval this summer, and then distributed freely to visitors of the RWC starting this fall. This research has still not yet concluded, so the details of the review and selection process of city hall officials, as well as feedback from visitors using the maps will be surveyed from now on.

Keywords: *language education, natural disasters, resilient learning, earthquakes, tsunami*

Introduction

In recent years, there is a growing increase of floods, heavy rain and earthquakes all over Japan. Especially when earthquakes make tsunami which have in previous occurrences killed thousands of people. As the Japanese faced these natural disasters, it is essential to think about how to survive in future instances. Many students themselves have experienced these natural disasters before, as most recently as the Kumamoto earthquakes that are still suffering with recovery efforts, and thus understand just how truly dangerous disasters may be.

When this study began, it was announced that one of the locations for the Rugby World Cup would be in Oita prefecture, which lead to this college to focus on resilient mind education. There will be a previously unimaginable amount of people, including foreigners, visiting our prefecture at that time, and in the worst case scenario if some kind of natural disaster happens, it is essential for its residents to be able to help or support foreigners in particular (who may not be familiar with these natural disasters) to stay calm and lead the evacuation areas. Furthermore, with the 2020 Tokyo Olympic and Paralympic Games will be held, these preparations are not limited to just rural areas involved in the RWC.

There are a lot of existing disaster maps in each prefecture already, but after contacting the city office and asking how much the disaster map is ready for practical use, the answer was “It is capable of helping; however, it is a little bit vague. If possible, could students focused on resilient mind education incorporate more practical details and improve the existing maps?” This request lead to the start of this research activity.

The main idea was to let students collaborate with each other in groups during English classes to debate, suggest and create actual improvements to these seemingly outdated and potentially impractical materials. It would also be seen as an ideal opportunity to develop a student-centred activity which incorporates their specialized fields of education in various engineering fields while improving and using their English abilities as well.

Many research articles have been published in relation to resilience education and communication. Pfefferbaum et al (2012) mentions: “Education and training recommendations, which also advanced an integrated approach, were addressed to leaders, responders, medical providers, mental health professionals, schools, and the general public. Training and education were seen as key to promoting the identification, development, and dissemination of (1) existing best-practice educational materials in the areas of disaster mental health; (2) materials for all hazards and public health emergencies; (3) information addressing the needs of individuals with pre-existing mental health problems; and (4) guidance on bereavement support.” This supports the necessity for students in particular to learn and put into practice their education in relation to emergencies and reinforces its uniqueness as an opportune learning experience.

However, in recent publications on resilience education by Japanese ministries, specialized lesson times have not been set aside for these materials, and are often used in generalized times, such as homerooms. In most cases, there are no specialists on the subject among the teachers responsible for educating on the matter, and its incorporation across Japan is bleak at best. It can be said that only be the repeated occurrences of these tragic natural disasters can people be truly educated on the importance of this matter. Shinoda & Kawada (2007) had mentioned in their work that since the Hanshin-Awaji Great Disaster, residents are losing their sense of importance and preparation for these potential events.

With the upcoming RWC and Tokyo 2020 Games, it is hoped that no natural disasters would occur during these events, but in the case that they do and help is needed, students would be educated, ready, and prepared to help themselves, other residents and even visitors from other countries to their town to stay safe and alive. By emphasizing the importance of communicative competence in these times of need, it was thought that incorporating English language education would be a unique and practical experience for the students.

Materials for teachers

Given that the researchers involved in this project were not specialists in the field of resilience education, it was first necessary to become educated in the specifics of the topic before being able to educate on it to our students.

The first step in preparing ourselves was to visit the Great Hanshin-Awaji Earthquake Disaster Reduction and Human Renovation Institute in Kobe City. Despite most Japanese likely having experienced many earthquakes in their lives, one on a scale comparable to that in 1995 is not very common. With the support and permission of the institute, materials were also brought back to use and provide further realistic detail to the students at hand.

Following this fundamental base step, the researchers participated in an opinion exchange between those who actually survived the disaster (both Japanese and foreign residents). This unique experience, named Popoki's Peace Project, brought forward what people would think of and react initially when a natural disaster hits, and not reflect solely on objective hindsight.

Furthermore, a unique disaster risk communication game, called "Crossroad: Kobe" had been created and test played by those involved. By incorporating the crossroad game in group discussions at the college in question, students would be able to discuss with each other in details about what is truly essential at the current stage of preparation in Oita prefecture. The results of these discussions lead to each group deciding on a specific type of disaster preparation aspect to focus on and describe in detail on their specified group maps.

Materials for students

Oita Kosen students have experienced recently the Kumamoto and Oita earthquakes, which was one of if not the biggest natural disasters in Kyushu experienced in recent years. However, their recollections of these incidences, let alone information on previous similar disasters like in Kobe and even Eastern Japan a few years ago, they admit to having been educated on what to do in times of emergency, yet also to not remember most of it or having been able to put any of it into practice.

Due to this, the researchers decided to invite specialists from Oita City Hall to give lectures to our students on disaster prevention and preparedness. The content of these lectures included details about the expected foreign and domestic audiences expected to come to Oita during the RWC by a specialist in the tourism board. The information provided also discussed how most visitors from abroad are of a higher income range and will spend usually between two to three weeks in the area, not just watching the matches, but also visiting local and rural sightseeing spots in between these main events. Another city hall specialist on disaster prevention educated the students on the scale and severity of previous natural disasters, such as Hanshin-Awaji and Eastern Japan by going into detail about the size and severity of the tsunamis and showing actual footage of the aftermath. This had shown the greatest impact on the students.

Finally, a tourism specialist went into detail on what Oita residents should focus on in promoting their rural cultures, including actual existing PR maps that are distributed to visitors to educate them on local specialties. During the lecture, it was made known that the number of foreign residents is one of the highest in Japan, and that students have a multitude of opportunities to meet and communicate with non-Japanese people right in the comfort of their own home prefecture and city.

One of the researchers being a foreign resident of Japan went into detail on what they learned on disaster preparedness in their time spent here. Even if there are plenty of foreign residents already living around town, having a foreigner close to them share their experiences was a very unique learning experience for the students. Coming from a country with very little natural disasters, the commonality of earthquakes, floods, and tsunamis was also not something to quickly get used to, but given the severity (most recently) of the Kumamoto earthquake, being prepared at any moment for a potentially worst case scenario is engrained into the brain as a response. What most Japanese students brush off as just another tremor can be felt as a serious event to those unfamiliar.

To further reinforce these situations hitting home with the students, another researcher described their experiences as a Japanese visitor abroad, in where sometimes non-English speaking countries it can be difficult to simply find the appropriate bathroom, let alone ask locals for advice or help in times of need. Seeing as most students have not been overseas, let alone outside of their own hometowns or Oita prefecture at all, the concept of Japanese not working as a communication tool is foreign to them. It is thus important to share these kinds of experiences with them so that they can be at least mentally prepared and maybe even foresee upcoming trials and tribulations that may arise given the situations detailed by the project. What they would do with non-Japanese fluent visitors in times of disaster and need is a valid reality that students need to consider with great concern, as it is very likely for another tremendous natural disaster to occur at any moment in time.

Figure 1 Oita City’s multilingual disaster guide

The final goals for the student groups are to create a specialized map to be distributed, so Oita City hall was generous enough to provide students with a copy of the existing multilingual disaster guide (shown in Figure 1). Reinforcing that there are various languages foreign residents of Oita use, students were reassured that their existing knowledge of English would be enough to help contribute positively to the improvement of this project.

Methods (4th year students)

For the purposes of this study, fourth year students (equivalent to first year university) were the target grade for resilience education. First, students experienced the Crossroads game in class, which was based on the 1995 Hanshin-Awaji earthquake. It is a card game in which actual situations from that time are brought up once again and students must decide the best course of action. For example, one card states “You are a city hall worker in charge of distributing rations. There are 3000 people in your evacuation site but only 2000 rations in stock. Do you distribute them?” Students, in groups of about five, would then pick a YES or NO card, and further discuss and debate why they chose that card.

They are also reminded that there is no correct answer, a minority answer wins them more points, and regardless of the answers of their peers, to understand their opinion and where their sources of concern are coming from. Most students have trouble stating their own opinions to begin with, as Japanese tend to stick with the silent majority, so it is also a good experience in getting students to actually think outside the box and voice rarely expressed opinions for the sake of obtaining points and winning the game at the end of class.

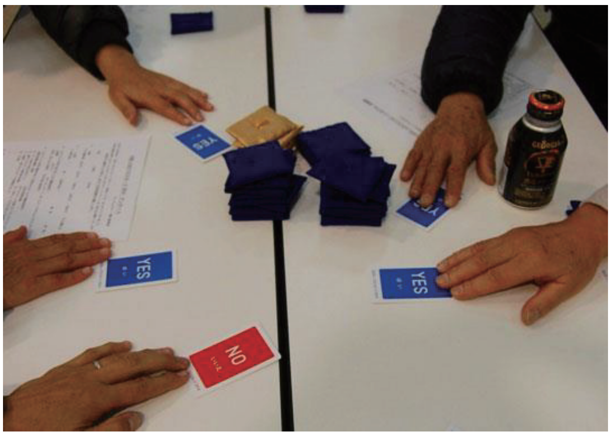


Figure 2 Image of the Crossroad game being played

Points are tallied in a very unique way – minority opinionated cards obtain one point for each player, and in the rare opportunity that there is only one person against all the other team members, that individual gets 3 points.

Fundamentally it is to get the students to think of which answers will be less common, and thus get them more points, which leads them to thinking outside of social norms and also potentially against their usual trains of thought. Although the activity was done in an English classroom, the detailed discussions on why each person chose which card was initially permitted to be done in the native tongue of Japanese.

Once the students became familiar with explaining their positions in detail in Japanese, students were then required to do the same in English from then on, especially for fifth grade students.

Students initially displayed great struggles in expressing themselves in detail in English, but given that there are exchange students in each grade in the college observed, students gradually became more comfortable in talking about why they chose their ways of thinking. Students that previously would refrain from speaking in class became vocal and took the activity very seriously. When asked why caused the change of heart, the students simply replied, “Because I want to win.” The gamification of education showed off its fullest potential.

This Crossroads game is also a potential good example as an entry-level activity in debate education, which will be further observed in upcoming research efforts.

Figure 3 Oita City’s currently used sightseeing map

Group Activity – Original Maps

After the City Hall worker lectures and experiencing the Crossroads game, students began to work in groups on the project at hand. With the upcoming RWC and previous knowledge and experience of natural disasters and what comes with them, student groups were responsible for creating their own emergency maps in groups of around six to seven students.

Given that local governments have made their own official materials that are already in circulation (as seen in Figure 3), students were tasked with creating their own original, specified map based on their group discussions and fields of interest.

Students would first discuss what kinds of specialized maps would be necessary, such as evacuation sites, or emergency supply purchasing locations and so on. Some examples brought forward by the student groups were baby supply maps, Japanese-English emergency phrase 'yubisashi' maps (sample seen in Figure 4), magnitude scale maps, hospital maps, halal friendly maps, and so on.

Figure 4 Image of a 'yubisashi'-styled layout

Given that local governments have made their own official materials that are already in circulation (as seen in Figure 3), students were tasked with creating their own original, specified map based on their group discussions and fields of interest. Currently the creation of maps is still being made but will be complete within a few weeks and those details described further in upcoming continued research on this topic.

The students were given complete creative freedom on their maps – including the size, colours and designs. Many students also asked if a computer-based design and not hand drawn would be acceptable, and some groups even went as far as suggesting including QR codes in which further details which would not fit on the limited map space would be accessible by using a smartphone.

Other considerations groups suggested were kid-friendly maps that would be easy to read and find in real life, which in turn lead the instructors to leave the creative process to the students as their passion and motivation to create these maps did not seem fair to be limited by marks and regulations that could render the final product bland.

Most students opted for a 'yubisashi' style map based on specified situations. By simply pointing at illustrations and simplified words, communication is able to be achieved regardless of each participant knowing each other's language well enough to verbally communicate.

Yubisashi books are quite popular in Japan, and by incorporating their functions in a single-paged map, it is expected to increase the practicality and potential of getting across all the necessary information of the maps.

Group Activities for lower grade students

Thanks to the positive potential seen in this assignment and wanting to create a continuous environment for making resilience education a fundamental topic to be covered at the college, second grade students (high school level) were also tasked with making similar maps.

Students would undergo the same steps, but their maps were not based on resilient factors, as they have not yet learned much about the topic in their specialized fields of engineering yet as well. The lower grade students were thus directing into making specialized maps on a topic of their choice, such as sightseeing maps, souvenir shop maps, and a great variety of others in which the focus was more on being able to get their suggestions across in their group designed maps in English successfully or not.

The orientation sessions and preparation were similar to those of the fourth year students, but the students were encouraged more to share their own personal experience and suggestions on shops and other hidden treasures that only locals would know of in their map creation. One group went as far as making the theme of their map specifically for good places to go on a walk and have breakfast at. Other unique ideas included a free play space map, traditional foods map, and a cycling path map. The deadline for these to be submitted and then passed on to City Hall for approval and potential distribution is mid-August and the final results and reflection will be detailed in further research on this unique study.

Communication Skills

The fact that students have increased their communicative competence at least with each other is undeniable through this task. However it is a source of concern as to whether it is due to the Crossroads game experience leading them to turn over a new leaf, or if the simple knowledge of it being an evaluated assignment and students wanting to get good marks and make better maps than their peers (potentially seen as rivals at this point). Regardless of the source, at this time the communicative skills of the students have increased drastically compared to previous years in which group discussion activities had occurred but still did not lead to such heated and passionate discussions as seen through the groupwork necessary for this assignment to succeed.

It was also seen that, as previously mentioned, students that did not previously often make their voices heard began to fight for their rights, and students would more often than not ask for more time in class to discuss the matters at hand as opposed to working on it outside of class time because they were feeling pressured by the submission timeline. Although it may be seen as a negative aspect, it should be considered a positive as students rarely show such passion towards English.

Regardless of how much time is provided in class however, the deadlines and evaluations have been set, and the students are currently doing their best in and out of class time to make materials that they are already excited about being distributed to foreign visitors to our city. Just knowing that something they worked on so hard in their groups would be seen as a gift or souvenir to visitors makes them that more determined to succeed.

Evaluation

The evaluation methods are still a source of concern for the researchers involved in this study. Given that the maps assignment is already included in the syllabi as ten percent of their final marks, it is hard to fairly evaluate the final product without taking into consideration the time and efforts spend in class discussing and preparing for the creation of their maps. Peer evaluation is one option, in which students would rate their group members with the person who contributed the most getting a ten from their peers, and the average being balanced to a final mark out of ten. Some students who could not participate on some occasions due to unforeseen circumstances would still be recommended on a six or seven, to ensure a passing mark regardless of their efforts.

Although there are clear advantages and disadvantages to this evaluation method, teachers can take the peer feedback as a fair source of evaluation among group members to cover for times outside of class in which teachers cannot facilitate nor supervise the map production efforts, which are more likely to be done outside of class hours without any outside influence.

Another option would be to observe the reaction of the visitors using the maps. The numbers of maps distributed, feedback given by visitors who used the maps, and the necessity of the information provided on the maps can also be evaluated by those using them. Obviously to incorporate such information would need more time and feedback to create a fair evaluation, and marks for the assignment would have to be delayed until their finals.

Conclusions

Although the time and effort necessary to execute this kind of unique project is large, and upon reflection took significantly longer than originally projected and expected, with the start of the RWC looming in just a few months, the time line is significantly shorter than recommended. What would ideally be done over the span of an entire school year, students are expected to complete their original maps before the summer vacation in mid-August after being originally informed of the task in early April, at the beginning of the academic year.

Ideally, a detailed schedule spanning an entire school year made in advance with the approval and instruction of City Hall employees to meet their needs would be necessary. Furthermore, in respect to the deepening and necessity of regularized resilience education for Kosen students, these activities should not just be limited to two specific grades or levels and be incorporated in some way among all faculties and years of their education.

Regretfully, it seems unlikely to give a completely true and honest evaluation of each group's efforts on a scale of one to ten in the end. One potential option to ensure a fair evaluation would be to include peer evaluation and group satisfaction perceptions of their submitted maps.

All in all, the potential of this activity to not only allow students not comfortable in communicating in person to overcome their limitations and collaborate successfully in group discussion and project planning are already visible to the researcher teachers of the students at hand.

It is also a very unique opportunity and way to have students think outside the box and consider what might be of value and importance to visitors that are not from Japan and might not necessarily know English as well. Through the development of their maps in groups, they will also learn about other cultures and perspectives, and further their potential to act as bridges between their hometowns and people from all over the world.

Furthermore, by linking such global communicative activities with resilience education (a matter that hits close to home for most of the students involved), it creates a new field of education that will be in need of much further research and refinement in years to come.

Those involved in this project, in particular the researchers, will continue to observe and reflect on the future activities and improvements based on these efforts.

References

Drenan, H. (2017). *YUBISASHI mini Japan*. Tokyo: Johou-shuppan.

Enomoto, T. (2017). *The Original "POINT-AND-SPEAK" Phrasebook.* Tokyo: Joho Center Publishing.

Japanese Ministry of Land, Infrastructure, Transport and Tourism. (2013). *Saigai Shodouki Shidou Kokoroe*. Sendai: Tohoku Regional Bureau Ministry of Land, Infrastructure, Transport and Tourism.

Nagatomo, D. (2017). *Conversation Book for Everyday Japanese and English 4.* Tokyo: Joho Center Publishing.

Parry, R. L. (2018) *Ghosts of the Tsunami Death and Life in Japan's Disaster Zone.* Tokyo: Hayakawa Publishing.

Pfefferbaum, B., et al. (2012). The H1N1 Crisis: A Case Study of the Integration of Mental and Behavioural Health in Public Health Crises. *Disaster Medicine and Public Health Preparedness, 6*(1), 67-71.

Shiroshita, H. & Kawata, Y. (2007). Institutional Problems in Disaster Education in Compulsory Schooling Analyzed from the Historical Transition of the Course of Study (Japanese national curriculum). *J. J SNDS, 26*(2), 163-176.

Thayne, D. A. (2014). *Life-saving English Phrases in case of emergency.* Tokyo: ASK publishing.

Activity of scientific experiment club based on remote island engineering

T. Ito*, S. Ishida

General Education, National Institute of Technology (KOSEN), Yuge College, Japan

*t.ito@yuge.ac.jp

Abstract

NIT (KOSEN), Yuge College is located on Yuge Island in Kamijima town, and it is a complete remote island. This school cooperates with the local community to solve the problems of remote islands, and is working to solve them from an engineering viewpoint. We named this working "remote island engineering". For example, utilization of IOT technology, disaster prevention efforts, development of new technologies and products, and volunteering of local events utilizing our technology.

This school has no departments related to chemistry, biology and environment. Therefore, there are a few students who are interested in science. Even if they are interested in it, they have few opportunities to do scientific experiment. So, we launched a scientific experiment club 12 years ago. The first members were students interested in science and inactive students who did not belong to other clubs. At first, we had members conduct experiments close to our study, but there were a few participants.

Therefore, we proposed the members to do experiments and produce goods using the special products of Yuge Island. As a result, the members decided to produce soap and bath salt using algae salt, which is one of the special products of Yuge Island. Similarly, as a project of a TV program and an activity of the island, the members produced a curry as a new special product. This curry protect was led not only by club members but also by members of this school's student association, town office staff and residents, under the supervision of professional chefs. This curry was pouched and sold at the store.

Marche is held 2-3 times a year in Yuge Island, and a lot of residents enjoy the event. At the request of the organizer, this club has held working shop of children experiments. This club members thought about the contents of the experiments for children. The experiments which this club has done so far are making slimes, candles, lures, soap bubbles and aroma balls. These were easy to do and well received by the participants. This club sold *bekkoame* candy and *karumeyaki*, which are traditional Japanese sweets. Through activities in cooperation with kamijima town, club members have improved their proactiveness and communication skills.

Keywords: *science education, club activities, regional collaboration,*
remote island engineering, product development, scientific experiment

Introduction

Recently, a regional revitalization has been tackled by the national government as well, due to problems such as depopulation in local areas (Cabinet Secretariat Headquarter for Overcoming Population Decline and Vitalizing Local Economy in Japan). Universities are required to contribute to the region, such as revitalizing local industries, in cooperates with local public organizations and companies. Several successful cases have been reported, while these revitalizations are often reported in surrounding areas with large universities, industries, tourism resources, and there are few reported cases in remote areas such as remote islands. (T, Nabeyama, 2018; A, Kobayashi, 2015).

National Institute of Technology, Yuge College (NIT, Yuge College) is located on Yuge Island in Kamijima town. Kamijima Town consists of seven islands in Sashima, Ikina, Iwagi, Uoshima, Takaikamijima, Toyoshima, and Yuge Island. Whereas Iwagi Island has special products such as blue lemon and lemon pork, other islands do not have major industries except for seaweed farming and fishing. National Institute of Technology has been implemented “KOSEN 4.0” initiative for the purpose to expand the strengths and characteristics of each school. This has focused on the three directions of “human resource development to lead new industries,” “contribution to the region,” and “acceleration and promotion of internationalization.” The population of Yuge Island is about 3200, and 472 out of the 640 students who enrolled at NIT, Yuge College, are boarding students. Therefore, regional collaboration between NIT, Yuge College and Kamijima Town is essential, and as the town’s regional creation, the school occupies an important position

NIT, Yuge College cooperates with the local community to solve the problems of remote islands, and is working to solve them from an engineering viewpoint. We named this working “Rito Kogaku”, which means remote island engineering. It includes various activities, for example, utilization of IOT technology, disaster prevention efforts, development of new technologies and products, and volunteering of local events utilizing our technology. In 2018, NIT, Yuge College adopted the

“ KOSEN 4.0” initiative, “The IoT engineer development program familiar with disaster prevention and mitigation based on Rito Kogaku”, and we are also conducting studies as one of the members. We have studied based on the above thinking before the word “Rito Kogaku” was made. Science experiment club, which was established by us, contributes to the community and its activities are conducted mainly by students. In this paper, we intend to report the regional contribution of the science experiment club.

Establishment and activity of science experiment club

T This school has no departments related to chemistry, biology and environment. Therefore, there are a few students who are interested in science. Even if they are interested in it, they have few opportunities to do any scientific experiments. When we arrived, there was a robot club, a microcomputer club, and an astronomy club (now closure), but there were no club activities related to science. In addition, we belong to the general education department and could not have a graduation study. At that time, our studies were energy fermentation from waste. these studies need times and men. So, we launched a scientific experiment club 12 years ago. The first members were the students who were interested in science and the inactive students who did not belong to other clubs. Students who did not belong to other clubs were reluctant in their school life. Through club activities, one of the purposes was to foster positive attitudes and create a place to stay. At first, we had members in order to conduct experiments close to our study, but there were a few participants. It is considered that the motivation of the student did not occur because of the difficulty of the studies

Therefore, we proposed the members to do experiments and produce goods using the special products of Yuge Island. Yuge Island had a salt manor and its salt was offered to the emperor during the Heian period. Therefore, residents started producing algae salt as a new specialty product and started the company from

Figure 1. State of Club members helping open lecture "Handmade soap".

2009 (https://www.shimano-kaisha.co.jp/). Similarly, they launched the NPO "Shima University" for regional revitalization from 2010. We have given lectures on handmade soaps and bath additives in open school (T, Ito & M, Miyaoka, 2014; T, Ito, 2016), and students have been actively helping (Fig. 1). Under such a background, the club members decided to produce soap and bath salt with the algae salt. Members joined the NPO “Shima University” and worked with the residents to produce products (Fig. 2). The soap made by the members were developed until one step before the release. Members presented these studies at a conference for middle and high school students.

Figure 2. The soap devised by the members.

Produced original curry of Yuge Island

“Shimanowa 2014” was held to commemorate the 80th of a Setonaikai National Park designation and the 15th anniversary of the Setouchi Shimanami Kaido. “Shimanawa 2014” is a sightseeing promotion event held in cooperation between Hiroshima and Ehime on the islands and coasts parts. More than 400 events were held in 7 months.

Kamijima town was born when four municipalities merged in 2004, and it was the 10th anniversary in 2014. Therefore, as a big event of " Shimanowa 2014”, NIT, Yuge College had a request from media to create a new specialty product of Kamijima town. Its program was to make a new curry "Yuge no shosen curry". The reason is that there is an image of curry when it comes to maritime relations as represented by the Maritime Self-Defense Force. At first, it was recruited from all the students, but there was no one. So, when we talked to the club members, they showed us a motivation and they participated in the curry production. In addition, the student association and OB / OG of NIT, Yuge College also participated because there were few members at the club alone. Not only school officials but also our office staff and residents participated in the production. We scheduled the conference day with the TV station and a preparation day at school. The curry production was conducted after a total of three conferences and tastings for about three months. Before the conference day with the TV station, only student and OB / OG held twice product meetings. The conference was held in a workshop to discuss the image of Yuge Island (Kamijima Town), tourist attractions and local products. (Fig. 3) The supervision of professional chef put together these plans, repeated tastings and discussions, and finally the curry was completed. There is no fixed recipe for "yuge no shosen curry", but one that needs the following instructions. 1. As curry ingredients, use pork or lemon pork. And the color of roux should be lemon. 2. For toppings, use lemon and laver. 3. Use one or more of Kamijima town's special products. For example, Fig. 4 shows a recipe made by a professional chef.

On a TV program, the curry was announced at the summer festival of Kamijima town in live, and famous TV personality also appeared. The weather was rainy on the day, but 300 cups of sampling curry were sold out quickly (Fig. 5). Further, this curry was pouched and sold at the store (Fig.6).

Figure 3. State of the conference (workshop and tastings).

"*Yuge no shosen curry*" Recipe example

(ingredients)	(For four dinners)
pork (Lemon pork)	: 200 g
flour・salt・pepper	: appropriate amount
onion	: 1 piece
grated garlic	: 1 tablespoon
grated ginger	: 1 tablespoon
coconut milk	: 1 cup
granulated consomme	: 2.5 tablespoon
water	: 3 cup
lemon juice	: 1 tablespoon
(curry roux)	
curry powder	: 3 tablespoon
flour	: 5 tablespoon
butter	: 3 tablespoon

Figure 4. Recipe made by a professional chef.

Figure 5. A report on the PR brochure and state of the summer festival in Kamijima town.

Figure 6. Pouched curry

Marche of Yuge Island

Marche is held 2-3 times a year in Yuge Island, and a lot of residents enjoy the event. This Marche is called "*Kamijima teshigoto ichi*" and has been conducted 17 times so far. Foods, sundries and accessories sold are handmade by the exhibitors. There are also workshops unique to the island such as making sundries using seashells.

At the request of the organizer, the science experiment club held working shop of children experiments. The club members thought about the contents of the experiments for children (Fig.7). The experiments were making slimes, candles, fishing lures, soap bubbles and aroma balls.

Slime is made by mixing borax and laundry paste, and it is made harder than usual in consideration of outdoor events. The candles were colored and smelled, but making them outdoors was difficult. Therefore, its experiment is changed to putting a photograph and a picture on a candle now. The fishing lure was processed to make the fish look like a flat lead weight using tape or magic. The aroma balls were made from sodium alginate, calcium chloride and perfume. These experiments are well known to teachers and experts. The soap bubbles produced a good atmosphere by giving them to children. These were easy to do and well received by the participants. Especially slime was popular.

Figure 7. State of activity in "Kamijima teshigoto

This club sold bekkoame candy and karumeyaki, which are traditional Japanese sweets. They also made Lemonade flavored sweets from baking soda and citric acid. These sweets were more popular with adults than children because it resembled the taste that was once sold. From these experiments, the members decided what to do each time. The more they tried these experiments, the more successfully they achieved. This activity has been well-received by the organizer and visitors, so the club have continued to participate in the event

Conclusion

We launched a scientific experiment club to expand our studies and the opportunities for students who are interested in science. Negative students who did not belong to any other club also became members. At first, they were reluctant to experiments related to our studies. However, in the end, they became interested in studies about the regional revitalization and worked on them enthusiastically. "Yuge no shosen curry" was taken up by TV, newspapers, and journal, and its activities contributed to the regional revitalization (Saito,2017; Ehime newspaper ONLINE, 2014). The curry was also provided at an international cycling event, and the members volunteered and distributed curry. However, at present, there are no shops selling handmade curry, except for offering at school festivals and events in town. It is one of the issues to disseminate this product.

In addition, the club has produced soap and bath salt with algal salt. Similarly, fishermen ' s union of Kamijima town Uoshima Island asked the club about a new cooking of octopus. At present, they are studying how to cook octopus soft so that old people can eat it.

In Marche, members conducted outdoor experiments for children at the request of the residents. This activity has a high reputation not only in Kamijima town but also in another prefecture. These events often overlap with the school's test period and they could not participate in it. However, with the help of advanced-course students and other students, and local primary school students, participation in the event is ongoing. In these activities, they should talk with residents and small children, and they are often interviewed from the press and other media (SETOUCHI Finder, 2016).

In this club, at the beginning of the first year and activities, there are many shy members. However, through activities, members have become active, and their communication skills have clearly improved in the upper grades. They also show us interests in manufacturing and studies. We belong to the general education department and cannot have a graduation study. However, some of the members who did research related to our studies as graduation study, and they changed the course at the graduate school (M, Tokuda et, 2015).

On remote islands, it is required to contribute to the local area, such as revitalizing regional industries and participating in events. From now on, based on remote island engineering, the Science experiment club will continue to do studies and activities on problems that occur on islands.

References

Cabinet Secretariat Headquarter for Overcoming Population Decline and Vitalizing Local Economy in

Japan. *Regional Creation* Retrieved from https://www.kantei.go.jp/jp/singi/sousei/

T, Nabeyama, (2018). The case of regional revitalization and its evaluation. *The Japan Economic Research Institute*, 8, 60-69.

A, Kobayashi, (2015). Outline and problems of the regional revitalization. *KPMG Insight*, vol.13, 1-5.

T, Ito & M, Miyaoka, (2014). Development of the handmade soap using salt of Yu g e. *The bulletin of National Institute of Technology, Yuge College*, 36, 117-120.

T, Ito, (2016). Effect of public lectures "homemade bath salts, candles". *The bulletin of National Institute of Technology, Yuge College*, 38, 101-105.

J, Saito, (2017). Walking now in the Seto Inland Sea. “island” *The quarterly journal of canter of research and promotion Japanese island, Yuge College*, 63, 136-149.

Ehime newspaper ONLINE. (2014). Retrieved from http://www.ehime-np.co.jp/news/local/20140803/news20140803432.html

SETOUCHI Finder. (2016). *Island-pacific handmade, the 11th "Kamijima Teshigoto Ichi"*, Retrieved from https://setouchifinder.com/ja/detail/12653

M, Tokuda, M, Miyaoka, T, Ito, (2015). Modeling of the Hydrogen Ferment by Neural Networks. *The bulletin of National Institute of Technology, Yuge College*, 37, 53-58.

Pedagogical Suggestion for the Creation of Student's/Teacher's Beliefs and Japanese Language Curriculum Aimed at International Students at KOSEN

N. Fukuda*[a], M. Hyodo[b], N. Maharjan[c], K. Ichimura[d], and S. Akazawa[e]

[a,b,c,d]Division of General Education, [e]Department of Materials Engineering, National Institute of Technology (KOSEN), Nagaoka College, Japan

*[a] noboruf5814@nagaoka-ct.ac.jp

Abstract

From April 2019, Nagaoka KOSEN has started accepting first year students from Princess Chulaborn Science High School（PCSHS）under a new international project in collaboration with the Ministry of Education of Thailand. First of all, this project is an attempt to enroll international students in KOSEN as regular-course students after their Junior High School. The selected students with limited Japanese language proficiency are prepared to study major-courses in KOSEN for 7 years till their graduation. Generally, international students are transferred to third year in KOSEN after the completion of one-year Japanese language education. However, international students can hardly learn Japanese in their home country. It is necessary for them to learn not only specialized technological knowledge but also engineering skills from the first year of regular-course. For this reason, the aim of this study is to develop the early Japanese language education system which will instill the ability to use Japanese language in their regular classes.

Secondly, taking advantage of this opportunity, the clarification of the learner's and teacher's beliefs will be performed. The results will not only help to understand the internal changes in the learner's learning process, but also grasp the teacher's own internal change simultaneously. The word "belief" used here, is a mental attitude that supports the learner's (teacher's) autonomous learning behavior which is also the basis of learning. The objective of this clarification is to build a learning environment in which the teacher is closer to the learner.

This study will not only help to narrow down the gap between Japanese language education system of both sides, but also to build better class composition. Moreover, a questionnaire survey will be conducted including a free description column capturing the entire learning process. This study is the first step to clarify the transition of the beliefs of both the learner and his/her teacher under long-term learning. In addition, based on the results of this study, we will cooperate with PCSHS to organize workshops, and explore the possibilities of establishing new Japanese language curriculums applicable for both institutions.

Keywords: Princess Chulabhorn Science High School, Early Japanese language education, International students, Belief, Mental attitude

Introduction

Nagaoka KOSEN is one of the earliest Japanese KOSENs that have received foreign students since 1985, and has been engaged in international exchange activities (Figure 1).

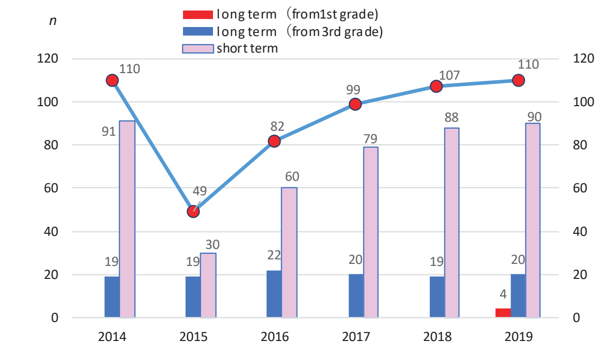


Figure 1. Number of overseas students accepted at Nagaoka KOSEN

Until now, foreign students have studied Japanese language education in advance for 1 to 2 years before entering our school and transferred to third graders. However, since this 2019, we have decided to accept foreign students from Princess Chulabhorn Science High Schools (PCSHS) to learn for seven years, which have 12 schools in Thailand (Figure2).

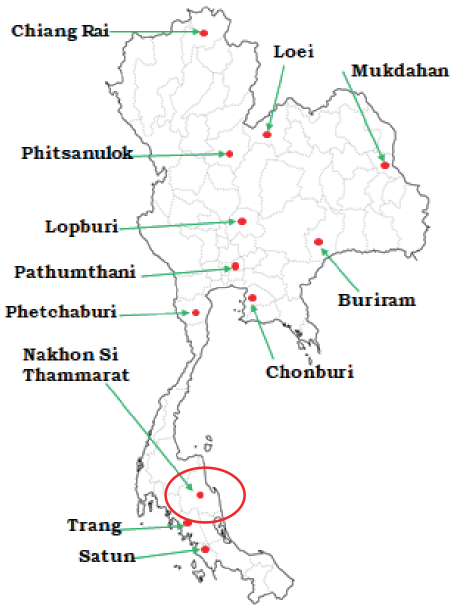


Figure 2. The location of 12 PCSHSs in Thailand

In other words, they will learn major subjects at our school from the first grade to establish the fundamental engineering knowledge and skills. The students in this school are at the top 0.3% in Thailand, and they have high learning ability especially in science, mathematics and English. The class consists of two teachers for 24 students per class and has introduced a small-group education which is similar to the schools of the USA, and the students are learning in a very favorable environment.

In fact, according to the information of PCSHS (2018), they are at a very high level of academic ability in English, mathematics, and science (for example, in the national uniform test conducted in Thailand, their average score is English 89.63, mathematics 97.74, and science 96.02, although the national average score is 50). Also, in science and mathematics, they use English technical terms in their classes together with Thai language. Also, from the survey results of PISA (2015), the average value of 12 schools of PCSHS is math knowledge 551, science knowledge 562, reading comprehension knowledge 533, and is located in the top schools in the world (Table 1).

Table 1. Average value across 12 PCSHS in PISA (2015)

Mathematical Literacy			Scientific Literacy			Reading Lieteracy		
1	Singapore	564		Average of PCSHS	562	1	Singapore	535
	Average of PCSHS	551	1	Singapore	556		Average of PCSHS	533
2	Hong Kong(China)	548	2	Japan	538	2	Canada	527
3	Macau(China)	544	3	Estonia	534	3	Hong Kong(China)	527
4	Chinese Taipei	542	4	Chinese Taipei	532	4	Finland	526
5	Japan	532	5	Finland	531	5	Ireland	521
6	B.S.J.G(China)	531	6	Macau(China)	529	6	Estonia	519
7	Korea	524	7	Canada	528	7	Korea	517
8	Switzerland	521	8	Vietnam	525	8	Japan	516
9	Estonia	520	9	Hong Kong(China)	523	9	Norway	513
10	Canada	516	10	B.S.J.G(China)	518	10	Macau(China)	509
54	Thailand	415	54	Thailand	421	57	Thailand	409

On the other hand, as a school that accepts foreign students from lower grades, enhancement of English education at KOSEN is one of the most important items (Yamada, 2018) (Figure 3).

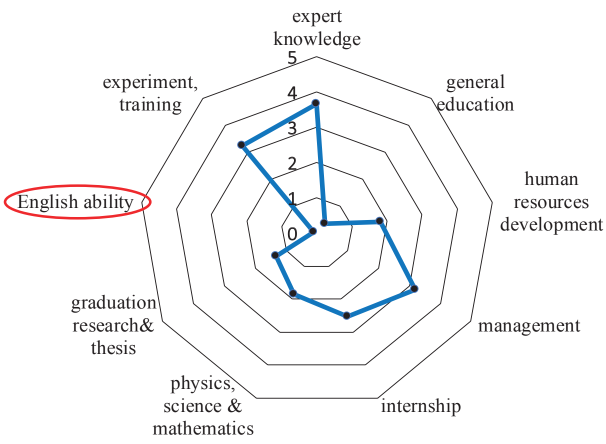


Figure 3. Educational Evaluation for KOSEN from KOSEN graduates (Yamada, 2018)

This assessment, however, has not only just started since few years ago. English language education in KOSENs is an item that has been strongly required to improve for a long time. (NIT, Tokyo College 2008; Mori & Sakata, 2013) (Figure 4).

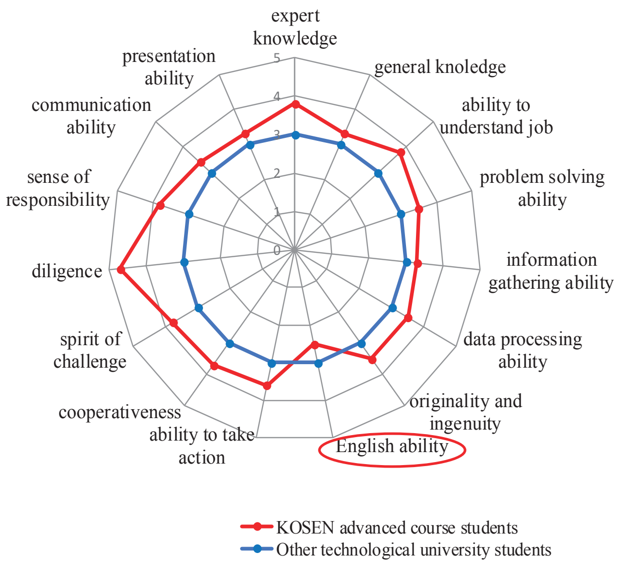


Figure 4. Corporate questionnaire survey of 317 companies (NIT, Tokyo College, 2008)

For this reason, our school has been working on problem solving learning with overseas partner schools since 2017 as one of the improvement of students' English abilities (Akazawa, 2017).

In addition, the Thai Ministry of Education imposes an obligation on Thai students to improve their Japanese language skills. Nevertheless, our school's educational curriculum does not yet have a sufficient support system to accept foreign students who have not studied Japanese from first graders.

Moreover, we had a Memorandum of Understanding (MOU) agreement with PCSHS Nakhon Si Thammarat on 22 May, 2019 (Figure 5). For these reasons, it is necessary to create an efficient education system for both foreign students and Japanese students.

Figure 5. MOU agreement with PCSHS Nakhon Si Thammarat

Pedagogical Purpose

Thai students from PCSHS entered our school as main course students from the first year and have studied for seven years before completing their majors. Therefore, in our school, it is necessary to link Japanese language education implemented in Thailand with Japanese language education in our school so that knowledge and operation ability of Japanese language can be smoothly performed. The ultimate goals are for Thai students to be able to construct a curriculum that has developed from early Japanese language learning level to practical operation level, and for Japanese students to be able to communicate smoothly with foreign students using English.

In this research, we only focused on Thai students, complete novices, in Japanese language. This year, as a first step to achieve this goal, we conducted three Japanese language intensive camps a year in Thailand (Figure 6 & 7). Then, a questionnaire survey was conducted at the third Japanese-language intensive camp just before Thai students were dispatched to Japan. From the results of this survey, we want to clarify the issues concerning the *kanji* learning approach, which is a major issue in acquiring Japanese.

First, we will clarify the common problems that occur in the *kanji* study class by Thai exchange students who are learning Japanese at PCSHS in 12 schools in Thailand, Thai teachers teaching Japanese, and native Japanese teachers.

Second, we will clarify the differences in thinking about Japanese language acquisition on the teacher side as well as the learner side. We think that this research can clarify the learning basis for teachers and learners to learn autonomously of Japanese language learning. As a result, it is possible to close gaps in the Japanese language education of both the learner and the teacher and improve the composition of the class. For this reason, a free description field was also provided in the questionnaire survey.

Figure 6. Practice of pseudo dialogue between students

Figure 7. Evaluation of communication ability by Japanese language teachers

Materials and Methods

Participants are Japanese language learners and Japanese language teachers. They took part in the 3rd Japanese Language Intensive Camp held in March 2019 in Thailand. The breakdown is as follows.

1) Japanese language learners of Thai foreign students: 12 Thai students selected from 12 schools of PCSHS. Their experience of studying Japanese is an average of 8.5 months.
2) Thai Japanese language teachers: There are nine Thai Japanese language teachers at 12 schools in PCSHS. Their experience of Japanese language education is 4.9 years on average.
3) Native Japanese language teachers: There are five native Japanese language teachers who are engaged in Japanese language learning for Thai Japanese language students in Japan's technical college. Their experience of Japanese language education is an average of 9.2 years.

The questionnaire survey of 46 items about learning *kanji* was conducted after the third Japanese language intensive camp in Thailand in February 2019. Thai students had already acquired the basic knowledge of hiragana and katakana at the first and second intensive camps in 2018.

In the third camp, they entered the stage of acquiring *kanji*. The acquisition of basic *kanji* is an inevitable task to advance the level of practical operation of education conducted in Japan, but it is also the first step that many students experience difficulties with Japanese. So, at this third concentration camp, a questionnaire survey on *kanji* learning was conducted.

Results

1) Questionnaire survey for learning *kanji*

We conducted a questionnaire survey of 46 items, of which 25 items were subjected to factor analysis based on the main factor method. As a result of analysis, judging from scree plot, five factors were adopted. For these factors, factor analysis was performed by least squares method and promax rotation (Table 2).

The factor loadings for all 25 items are those showing loadings of 0.4 or more. Factor I was named "Necessary condition learning strategy" for *kanji* because it mainly deals with conditions for learning *kanji*. Factor II was named "Semantic understanding learning strategy" of *kanji* because it handles understanding of *kanji* meaning. The factor III was named "Environment depending learning strategy" of *kanji* because it is learning to think about learning of science and mathematics subjects and vocabulary acquisition of everyday life to work on *kanji* learning. Factor IV was named "Self-affirmative learning strategy" for *kanji* because it deals with how to hold feelings towards *kanji* learning. Factor V was named "Step-up learning strategy" for *kanji* because it raises the level of difficulty from the easy level of *kanji* learning and handles the contents of teaching materials.

The Cronbach's alpha coefficient was 0.823 for factor I, 0.749 for factor II, 0.726 for factor III, 0.723 for factor IV, and 0.708 for factor V, respectively.

Table 2. Factor analysis results of belief research for *kanji* learning

item	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
Factor I: Necessary condition learning strategy — **Cronbach's alpha = 0.823**					
Q41 The most important thing in learning kanji is learning the regularity of kanji	0.86	-0.16	-0.05	-0.26	0.26
Q38 You need to understand the components of kanji	0.78	-0.13	-0.08	-0.12	0.21
Q42 The best way to learn kanji is from Japanese native speakers	0.74	-0.09	0.14	0.08	-0.23
Q34 You do not need to have the ability to write all kanji	-0.62	-0.09	0.14	-0.09	0.10
Q46 You should learn kanji in kanji class	0.55	-0.16	0.04	0.00	0.21
Q35 You do not need to read all kanji	-0.54	-0.16	0.11	0.17	0.12
Q29 Reading kanji is difficult	0.47	-0.21	0.07	0.10	0.17
Factor II: Semantic Understanding Learning Strategy — **Cronbach's alpha = 0.749**					
Q4 You want to be good at reading and writing kanji	0.07	0.86	0.39	0.00	0.15
Q30 You feel difficult to understand the meaning of kanji	0.23	-0.61	0.02	0.14	0.11
Q23 People who are good at kanji can understand classes well	0.26	-0.55	0.28	0.20	-0.27
Q31 It is good for learners to discuss learning methods for kanji	0.26	-0.49	0.05	-0.11	0.80
Factor III: Environmental Dependency Learning Strategy — **Cronbach's alpha =0.726**					
Q9 You can not learn kanji without a teacher	0.20	0.17	0.86	0.19	-0.12
Q22 Once you have studied one kanji, you should learn the related kanji	0.34	-0.03	-0.77	0.30	-0.01
Q12 Kanji used in science and science subjects should be learned before	0.09	0.30	0.62	-0.01	-0.07
Q27 You should better study kanji required for daily life, such as signs and	0.04	0.03	-0.49	0.14	0.00
Q18 It is not effective to decide the content of learning by yourself	0.08	0.06	-0.48	0.05	-0.30
Q5 You need to learn kanji even outside of class	0.21	0.25	-0.41	0.30	-0.17
Factor IV: Self-affirming learning strategy — **Cronbach's alpha =0.723**					
Q1 You are good at kanji	0.22	0.36	-0.03	-0.88	
Q36 You cannot be improve Japanese without being good at kanji	-0.10	0.41	0.09	0.82	0.32
Q13 You are easy to use kanji	-0.04	0.39	-0.09	-0.58	0.01
Q15 People in kanji countries are easier to learn kanji than people in non-kanji	0.02	0.00	-0.25	0.50	0.06
Factor V: Step-up learning strategy — **Cronbach's alpha= 0.708**					
Q37 You can not learn kanji without textbooks	0.33	0.05	-0.01	0.20	0.78
Q2 You should study from easy to difficult to study kanji	0.12	0.01	-0.08	-0.18	0.63
Q3 If you make an effort, anyone can become a good kanji learner	0.38	0.38	-0.03	-0.09	-0.50
Q44 You have difficulty in properly using kanji	-0.04	0.18	0.04	0.29	0.50
Factor correlation matrix	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
	1.00	-0.10	0.15	0.28	-0.04
	-0.10	1.00	-0.21	-0.13	-0.32
	0.15	-0.21	1.00	0.45	0.18
	0.28	-0.13	0.45	1.00	0.10
	-0.04	-0.32	0.18	0.10	1.00

After factor analysis, we calculated the mean value of the items that showed high loading for each factor and generated sub-scale scores. To compare factor relationships among Thai students, Japanese teachers and Thai teachers, analysis of variance was performed from the subscale scores. As a result, the factor main effect was recognized in two factors, that is, the factor I and the factor V ($F(2, 23) = 5.41$, $p < .01$; 4.79, $p < .05$ respectively) (Table 3, Figure 8 & 9).

Table 3. The result of one-way analysis of variance from the lower scale score

n=26	Factor I			FactorⅡ			FactorⅢ			FactorⅣ			FactorⅤ		
	Mean	*S.D.*	*F*	*Mean*	*S.D.*	*F*	*Mean*	*S.D.*	*F*	*Mean*	*S.D.*	*F*	*Mean*	*S.D.*	*F*
Thai St	3.54	0.91	5.41**	3.65	1.19	0.44	1.97	0.68	0.29	4.48	0.76	0.32	2.52	0.73	4.79*
Japanese Tr	2.86	0.84		3.20	0.65		2.17	0.72		4.50	1.39		4.00	4.00	
Thai Tr	4.30	0.64		3.44	0.46		1.91	0.44		4.78	0.72		3.31	3.31	

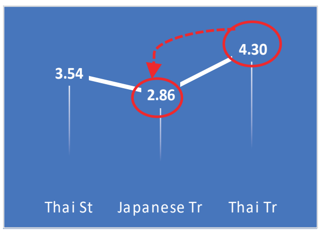


Figure 8. Factor I
Necessary condition learning strategy

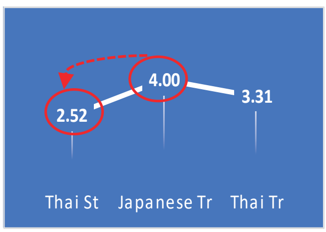


Figure 9. Factor V
Step-up learning strategy

Subsequently, as a result of multiple comparisons by Bonferroni's method, factor I was founded to be significantly higher for Thai teachers than Japanese teachers ($p < .05$). On the other hand, factor V was found to be significantly higher for Japanese teachers than Thai students.

However, there were no factor main effects for factor II , factor III, and factor IV ($F(2, 23) = 0.44$ns; 0.29ns; 0.32ns respectively).

2) Description Survey for Kanji Learning

2-1) Thai Students (Figure 10 & 11)

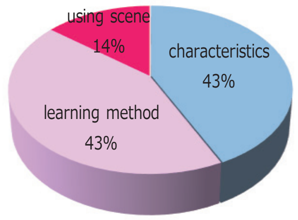


Figure 10. Difficulty learning kanji

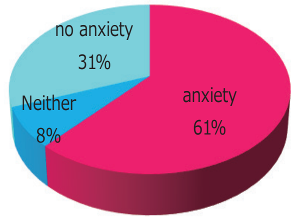


Figure 11. Anxiety levels in kanji

2-2) Thai Teachers (Figure 12 & 13)

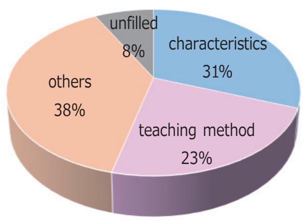


Figure 12. Difficulty teaching kanji

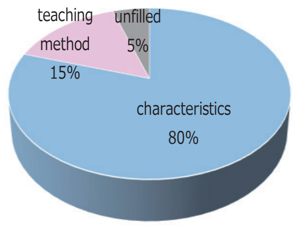


Figure 13 Anxiety teaching kanji

2-3) Japanese Teachers (Figure 14 & 15)

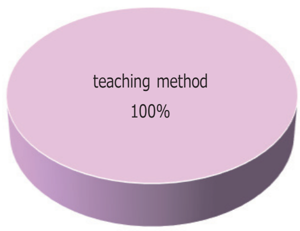


Figure 14 Difficulty teaching kanji

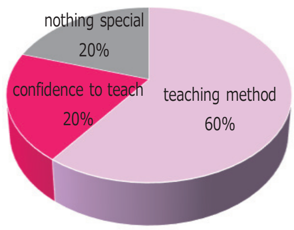


Figure 15 Anxiety teaching kanji

Conclusions

1) Questionnaire survey results

It has become clear that Thai Japanese teachers use "Necessary condition learning strategy (Factor 1) " more significantly than native Japanese teachers. This means that Thai Japanese teachers want to learn the knowledge of *kanji* formation rules than native Japanese teachers. On the other hand, it became clear that native Japanese teachers used "Step-up learning strategy (Factor V)" significantly more for learning *kanji* than Thai Japanese learners. This means that *kanji* has a level of learning difficulty, and it is important to use appropriate textbooks according to the degree of difficulty.

Thai Japanese teachers think that learning Chinese characters are very difficult for Thai Japanese teachers. Therefore, they want native Japanese teachers to teach more about the regularity of *kanji*. Furthermore, they are thinking to native Japanese teachers, who use *kanji* as their first language, know the effective way of learning *kanji*. On the other hand, however, native Japanese teachers believe that anyone who will make effort to learn *kanji* can master *kanji* well. They never think that Japanese people are significant in *kanji* learning. Rather, they think that Thai students should use Japanese textbook more effectively according to the level of difficulty.

There were no significant differences in "Semantic understanding learning strategy (Factor II)," "Environment depending learning strategy (Factor III)," and "Self-affirmative learning strategy (Factor IV). " From these results, we can understand that every learning group has a similar awareness for *kanji* in contexts, technical terms of science and mathematics subjects, information in everyday life, learning outside of class, and requirements of Japanese language improvement.

What can be said in summary is that native Japanese teachers are not confident that they can teach *kanji* regularity more efficiently than Thai Japanese teachers. But rather, they should say clearly that everyone will be able to learn *kanji* sufficiently if learners make efforts to learn *kanji* using textbooks which are graded difficulty levels. As you can see if you think about it, even we have written *kanji* many times in our notebooks since elementary school, and we have learned it hard. Because we speak Japanese as our first language, we cannot say that we can easily memorize any *kanji*. The difficulty exists in any country's learning language.

2) Description survey results

We can say that Thai Japanese language students are anxious about the fact that there are several different ways of reading *kanji* and the existence of many *kanji*. On the other hand, Thai Japanese teachers are uneasy about the fact that they cannot give students effective time to learn *kanji* characteristics in their classes, and that they cannot give students a willingness to learn.

Finally, native Japanese teachers think that they have learned *kanji* naturally in their daily living environment. So, they feel difficulty to teach *kanji* as a second language. For this reason, native Japanese teachers need to acquire proper knowledge of teaching *kanji* for second language learners.

Pedagogical suggestion

From this year, two Thai international students enroll every year in our school. It means that totally 14 Thai students will be in our school after seven years because they must learn here until the graduation of two-year-advanced course. The number of international students from one country will be quite large for our school. Considering this point, Japanese teachers and students need to communicate more actively with Thai foreign students. Thai students have far higher level to speak English while Japanese students are beginner levels. Thai students, however, cannot speak Japanese well because they do not have enough time to study Japanese in Thailand (Figure 16 ,17, 18 & 19).

For this reason, it is urgent that Japanese students and Thai foreign students use English and Japanese to incorporate interactive classes that can compensate for each other's language shortages in various subjects. Through exchange with Japanese students, we hope that Thai students make themselves feel their presence strongly at our school and learn Japanese daily in a collaborative life with Japanese students.

Figure16 & 17. Evaluation of Thai students by Thai teachers who mainly use Japanese grammar

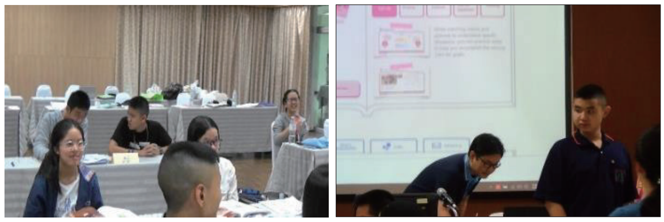


Figure18 & 19. Evaluation of Thai students by Japanese teachers based on active learning activities

References

1) Princess Chulabhorn Science High School. (2018). Retrieved from https://www.youtube.com/watch?v=WNF-gCwNd-E (May 14, 2019)
2) Yamada, H. (2018). "Chapter 6: College Alumni's Self-Defense and Disappointment- from the free description of the graduates. Yano, M., Hatanaka, Y., & Asano, K. (ed.) "Discovery of Kosen education-from educational background society to learning society". 120-145. Iwanami Shoten
3) Mori, I, & Sakata, H. (2013). Current status and issues of Japanese language education in National College of Technology. Naruto University of Education Japanese Language Education Society "Language and Education" 27, 70-84.
4) N I T, Tokyo College. (2008). Corporate evaluation between KOSEN advanced course students and other technological university students, and requests for major education "Report on the results of a corporate questionnaire survey concerning KOSEN advanced course graduates. "Retrieved from https://www.tokyo-ct.ac.jp/wp-ontent/uploads/2017/01/H20_kigyou_enguete-1.pdf（December 20, 2018）
5) Akazawa, S. et al. (2017). The educational effect of Global JSCOOP program activities done with Guanajuato and Salamanca KOSEN in Mexico. Transactions of ISATE, 395-398.

Disaster prevention education program in cooperation with prefectural area in Japan

Yasuyuki Hirose*,a

a National Institute of Technology, Gifu College / Department of Civil Engineering, Associate professor, Motosu city, Japan

*hirose@gifu-nct.ac.jp

Abstract

Many disasters have occurred in Japan. It is necessary for public and private sectors to cooperate on how to prepare for disasters. And disaster prevention education has been implemented in various places. Students and teachers prepare their own disaster prevention education tools. And they conduct delivery classes for the regional residents. In conjunction with conducting regional education activities, the disaster information system was released, and residents can easily register information on site. Many disaster prevention goods and educational contents are created by this activity. One of the proposals won Patent Contest sponsored by the Patent Office, and led to patent registration. At many places in Gifu prefecture, the enlightenment activities are carried out in cooperation with the local government. Students involved in the development of applications participate every year in "Forum on Information Technology" of Information Processing Society of Japan. They have won the FIT Encouragement Award twice in 2015 and 2016. The student group involved in the delivery class participate every year in "Project to solve regional problems by students" of "Gifu Network University Consortium" composed of universities and colleges in Gifu prefecture. They won 1st place in 2014 and 2nd place in 2015 and 2018. As participating students, developing educational tools becomes a good practice for deeper knowledge, facilitation, agreement formation and technology suggestion. Also, delivery class becomes a good practice for practical skills, presentation and communication. The program discussed here can be fully evaluated as sustainability education and engineer education.

Keywords: *Disaster prevention, Regional education, Delivery class, GIS, Patent*

Introduction

Large disasters occur frequently in Japan. In recent years, the possibility of occurrence of a huge earthquake in the Nankai Trough which is considered to cause very serious damage to Japan is very high. The government's earthquake research promotion headquarters reports that the earthquake will occur in 87% within the next 30 years [1]. In this way, there is information on frequent earthquakes, and the crisis consciousness of the Japanese people against disasters is steadily rising. It is necessary for public and private sectors to cooperate on how to prepare for disasters. And disaster prevention education has been implemented in various places in the country.

Students and teachers at National Institute of Technology, Gifu College collaborated with regional administration within Gifu Prefecture to conduct disaster prevention educational activities.

This research reports on the disaster prevention education program in the regional area where the writer is involved.

Outline of Disaster Prevention Education Program

The educational activities from the two perspectives of hardware and software are desired.

Hardware:

· Earthquake resistance of structures
· Maintenance of evacuation center and evacuation route
· Development of safety goods for disasters

Software:

· Information sharing of disaster and evacuation
· Acquire correct knowledge on disaster prevention
· Improvement of awareness and action

And considering part of the school's class activities, the disaster prevention education system of this time consists mainly of three activities.

(1) Development of Disaster information system
(2) Development of educational tool
(3) Delivery class

Each content is introduced in detail for each chapter.

Development of Disaster information system

1. The System of “Disaster Report ch”

Gifu prefecture operates "Disaster Report ch" as a system for sharing information on disasters and evacuation. This is a system in which residents can check dangerous parts at the time of a disaster by registering disaster information and dangerous spots on the prefectural website on the prefecture registered "Disaster Reporter" (**Fig.1**). Web-GIS (Geographical Information System running on Web site) is used for operation. This is a system that can connect each information and position data. It allows reporters to check dangerous places from the map.

Fig.1 Concept of Disaster Information System

2. Development of Disaster Information System

Gifu Gifu Prefectural Research Institute of Information Technology and NIT,GC worked on the development of applications for smartphones for disaster information registration of "Disaster Report ch". The application was developed and operated in 2014. They are updating to make security and privacy more powerful. Application for the iOS version is coded mainly by students of computer club [2][3][4][5].

The applications have the following functions.

· Browse Web-GIS map
· Display according to the screen of each smartphone
· Display current position in center of map
· Operation close to Google Maps
· Information registration
· Long tap the registration point
· Send the type of disaster, current status and photos

Fig.2 shows an example of the screen of the developed system. With long tap the point to register the information on the map (**Fig.3**), then input screen appear to answer the data (**Fig.4**). The markers to be displayed on the map are summarized in an easy-to-understand manner by examining the types of disasters. The legend of the marker is displayed as shown in **Fig.5**. By selecting the marker, it is expected that the operability of registration can be secured, registration by unified disaster type can be done, and it will be easy to distinguish when browsing and searching.

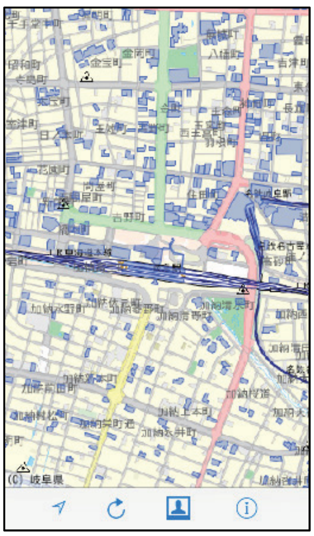


Fig.2 Default Screen

Fig.3 Registration Point

Fig.4 Input Screen of Application

Fig.5 Legend of marker type

Preparation of Education Tool

Various educational tools are prepared to promote disaster education. Examples of educational tools are introduced.

1. Development of Educational tools

(a) Educational tools for Tsunami

Tsunami often causes enormous damage immediate after earthquake and eruption in the ocean floor and coastal areas. Model experiment equipment is necessary so that people can feel Tsunami closely. The size of the model is considered for ease of carrying and ease of viewing. Also, except for water, it can be carried easily. The ground part is shaped with steel angles and a rubber plate, and the terrain can be changed. (**Fig.6**) Tsunami is generated by moving the piston strongly up and down. Wave blocks, breakwaters, houses and vehicles are set, and model experiment are carried out.

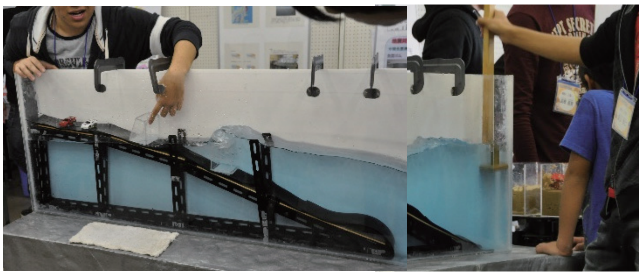


Fig.6 Educational tools for Tsunami

(b) Educational tools for Structural Earthquake Resistance

Tsunami For better understanding of structural earthquake resistance, equipment for model experiments is prepared.

The models to be prepared are as follows;

· Ordinary structure: General multilayer model

· Structure with seismic force-resisting systems: Install earthquake resistant wall

· Seismically isolated structure: Provide seismic isolation support

· Structure with damping systems: Incorporating rubber strings as a role of dampers

Rubber strings can be passed through the pillars of the model, and the model can be repaired easily even after collapsing. (**Fig.7**) The tabletop vibrator swings the structural model and the shake of the structure is reproduced. The tabletop vibrator is controlled by PC and can be excited with arbitrary seismic wave and sine wave.

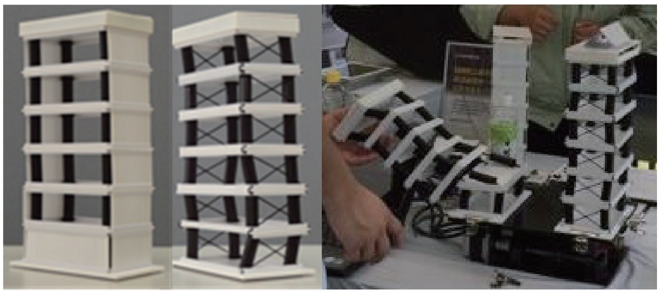


Fig.7 Educational tools for Structural Earthquake Resistance

(c) Educational tools for Liquefaction of the Ground

Liquefaction of the ground often causes severe damage to a wide area when an earthquake occurs. A model experiment device that can experience the liquefaction of the ground is produced. Prepare a model of a house hit by a nail that is effective when liquefied, a model of a house without measures, a model of electric pole, and a model of a water supply in the basement. Filling the container with sandy soil and add moderate water and mix. When the vibration is applied, the soil in the container becomes liquefied. (**Fig.8**)

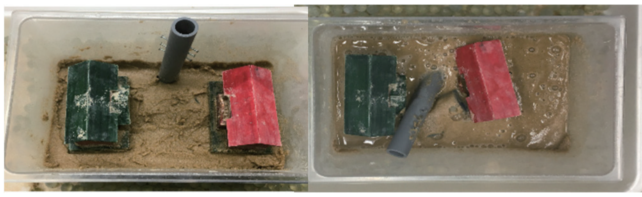


Fig.8 Educational tools for Liquefaction of the Ground

(d) Picture-story show

As small children can understand well, attentions to the evacuation when disasters occur are shown by picture-story shows. The story and picture of picture-story show for Disaster prevention are provided by the government [6] and NPO [7]. Students practice to become storytellers of picture-story show. (**Fig.9**)

Fig.9 Picture-story show [6][7]

(e) Enlightenment Posters

As Posters of introduction on hazard map, disaster information system, safety goods, liquefaction, structural earthquake resistance and so on are created. The posters are made easy to post as panels (Fig.10).

Fig.9 Enlightenment Posters

2. Development of Safety goods for disasters

(a) Newspaper Slippers

"Newspaper slippers" are made of one sheet of newspaper (**Fig.10**). These slippers are excellent in heat insulation and heat retention, and protect people's feet from cold and injury. Also, when these are put on hands, people can work with hot pots and iron plates. The students have improved the folding procedure of newspaper, making slippers more difficult to collapse.

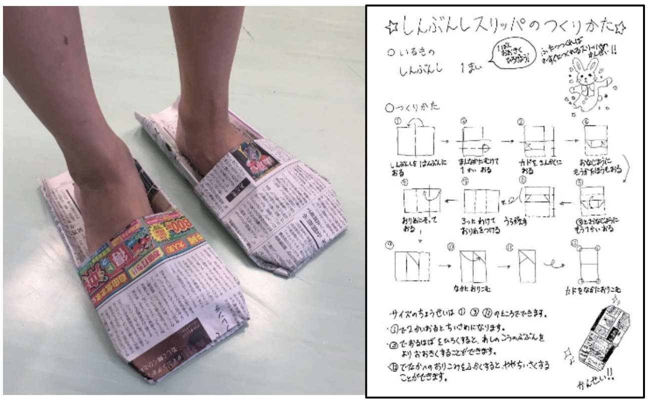


Fig.10 Newspaper slippers

(b) Combination of Safety Hood and School bag Cover

Students also work on the development of completely new safety goods for disasters. Safety hood is very popular in Japan to protect the head of children. But there is a problem in the place to clean up the safety hood. Also, no one carries a safe hood, so there is a problem in safety when going to school. They focus to the school bag that the school children use when going to school. Then safety goods have been developed that deform safety hood to a school bag cover (**Fig.11**). It becomes a school bag cover usually, and it can be used as a safety hood when a disaster occurs.

This work received the Excellence Award at Patent Contest 2017 sponsored by the national patent office. Therefore, they challenged patent applications and acquired patents in October 2018.

Fig.11 Prototype of Combination of Safety Hood and School bag Cover

(c) PET bottle Lantern

PET bottle drinks are distributed first in evacuation centers. By passing LED light of smartphone or flashlight through a PET bottle, the light can diffuse and create wide bright space. The color of the light changes depending on the color of the PET bottle, and changing color is possible to produce a more comfortable space. (**Fig.12**) This technique has the effect of improving the quality of life in evacuation centers and outdoor scenes.

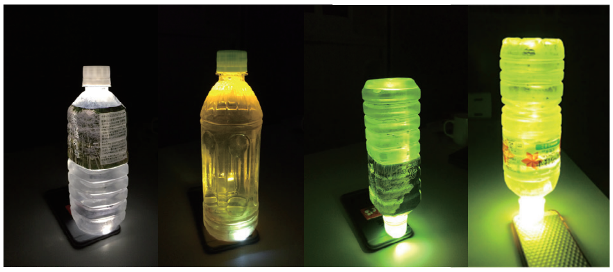


Fig.12 Sample of PET bottle Lantern

3. Delivery class

(a) Various awareness activities

Students and teachers make educational activities using the tools they created. Disaster prevention education is deployed to regional residents by many activities as follows. Considering the magnitude and duration of the event, the expectation of the age and number of the visitors, the educational tools shown in the previous chapter are selected and prepared, and the delivery class is carried out. (**Fig.13**)

Main activities in 2018;

- Gifu city library "Gifu Media Cosmos", 8.Jul.2018. Participants 80
- Kitagata town community center “Kirari”, 24. Sep.2018. Participants 20
- Ogaki city "Ogaki Future Festival", 21.Nov.2018. Participants 250
- Gifu city culture center "Gifu Science Festival", 17.Oct.2018. Participants 200

Fig.13 Various awareness activities

(b) Radio program recording and broadcasting

Students actively cooperate in making radio programs and broadcasting as one of radio programs on urban planning in the citizen media "Teniteo Radio" [8]. They recorded a 15 minutes corner on Sunday, 8.Jul.2018 (**Fig.14**). The radio program is repeatedly broadcast at 78.5 MHz of community FM [9] from Monday to Saturday one week after the recording.

They talk about as follows;

- Characteristics of educational system
- Risk of large-scale disasters
- Educational activities
- Thoughts through activities

・Future plans

Fig.14 Radio program recording

Conclusions

At many places in Gifu prefecture, the enlightenment activities are carried out in cooperation with the local government.

About the hardware, the educational program is realized through development of safety goods for disasters. About the software, the program is realized through disaster information system and delivery class. From the two perspectives, it seems to be effective in improving disaster prevention awareness and action of residents.

Students involved in the development of applications participate every year in "Forum on Information Technology" of Information Processing Society of Japan. They have won the FIT Encouragement Award twice in 2015 [3] and 2016 [4].

In development of educational tools, one of the proposals won the patent contest. Then, the proposal was made concrete and a patent was obtained.

The student group involved in the delivery class participate every year in "Project to solve regional problems by students" of "Gifu Network University Consortium" [10] composed of universities and colleges in Gifu prefecture. They won 1st place in 2014 and 2nd place in 2015 and 2018.

As participating students, developing educational tools becomes a good practice for deeper knowledge, facilitation, agreement formation and technology suggestion. Also, delivery class becomes a good practice for practical skills, presentation and communication. Therefore this program can be fully evaluated as sustainability education and engineer education.

The problems are listed below. Continuous organization and institutions, budget, space for development and storage of tools, retention of student motivation etc. Considering the expansion of the educational program in the future, it is good to verify the educational effect of the participating students.

References

[1] Earthquake Research Promotion Headquarters, Earthquake occurring in the Nankai Trough, Ministry of Edu., Earthquake Disaster Prevention Research, http://www.jishin.go.jp/main/yosokuchizu/kaiko/k_nankai.htm (2.Mar.2018).

[2] Hiroaki Shiraishi, Tomoki Nishinaka, Yasuyuki Hirose and 4 others, Development of Gifu Prefecture Disaster Information System Application for Smartphones, Information Processing Society of Japan, FIT 2014, RO-009, pp.69-74, 2014.

[3] Tomoki Nishinaka, Hiroaki Shiraishi, Yasuyuki Hirose and 4 others, Usefulness of Smartphone Application for Gifu Prefecture Disaster Prevention Information System, Information Processing Society of Japan, FIT 2015, O-019, pp.467-468, 2015.

[4] Tomoki Nishinaka, Yasuyuki Hirose, Haruka Osawa, Koji Tajima and 3 others, Usefulness of Smartphone Application for Gifu Prefecture Arian Species Information System, Information Processing Society of Japan, FIT 2016, O-038, pp.441-442, 2016.

[5] Yasuyuki Hirose, Tomoki Nishinaka, Koji Tajima and 3 others, Development and usefulness of Smartphone Applications for Gifu Prefecture Disaster Prevention Information Systems, Information Processing Society of Japan, FIT 2017, CO-011, 2016.

[6] Cabinet Office, Picture-story show "Tsunami! Do not put out the rice straw's fires", 2005.

[7] Civic group Kasumin, Picture-story show "Let's go with Harukaze chan", 2011.

[8] Citizen media group "Teniteo Radio", http://teniteo.net/ (7.Jul.2019)

[9] Community FM "FM WATCH 78.5MHz", https://www.fm-watch.jp/ (7.Jul.2019)

[10] Gifu Network University Consortium, Project to solve regional problems by students, http://www.gifu-uc.jp/daigakusei/chiiki_kadai/ (7.Jul.2019)

AN INTER-DEPARTMENTAL COLLABORATIVE PROGRAM TO MOTIVATE FIRST-YEAR KOSEN STUDENTS TO LEARN ENGLISH

M. Hirano[*,a], M. Nishi[**, b], Y. Matsutani[b], K. Goto[c], H. Irie[c] and F. Seki[d]

[a] Department of Biological and Chemical Systems Engineering,
[b] Department of Mechanical and Intelligent Systems Engineering,
[c] Department of Architecture and Civil Engineering,
[d] Faculty of Liberal Studies, National Institute of Technology (KOSEN), Kumamoto College, Yatsushiro campus, Kumamoto, Japan

[*]hirano@kumamoto-nct.ac.jp, [**]nishima@kumamoto-nct.ac.jp

Abstract

The National Institute of Technology (KOSEN) is a unique and successful Japanese higher-education system, providing a five-year engineering education for students (three-year secondary plus two-year tertiary education). One of KOSEN's goals is to cultivate global engineers in response to the globalization of industry. However, the English proficiency of KOSEN students is not high, as measured by TOEIC, a major English proficiency test, with the scores of KOSEN students consistently lower than general high school and university students. Survey results of first-year students at Kumamoto KOSEN Yatsushiro campus also indicated that 60 % of the students thought that they were not good at English. As a result, their motivation towards learning English tend to be low, even though they are interested in travelling abroad.

Here we report the effectiveness of an inter-departmental collaborative program for first-year KOSEN students taught by English faculty, and Science and Engineering faculty, and designed to enhance students' motivation towards learning English. The program consists of three parts: 1) English sessions on science and/or engineering taught by academic faculty, 2) group discussion sessions, and 3) student presentations in English on topics of their choice. The English sessions focused on five themes, namely "Biomimetics", "Robotics", "Materials Processing", "Structural Engineering" and "Sustainable Development Goals (SDGs)". Then, group discussion sessions were carried out on each of the themes, engaging students to think more deeply about the topic and at the same time improving their communication skills.

After the project, we conducted a questionnaire survey investigating students' motivation and comprehension. Results showed that most of the students enjoyed the program and improved their motivation to learn English. In addition, this inter-departmental collaborative approach seemed to have increased their interest in science and engineering as well. These results indicated that our inter-departmental collaborative program is effective to enhance students' motivation towards learning English.

Keywords: KOSEN, learning English, inter-departmental collaboration, motivational education, first-year student

Introduction

English has become one of the most useful and important foreign languages in non-native English speaking countries, and the effective ways in which English language skills can be improved are critical issues in those countries. Among the various learner factors in foreign language learning, motivation is undoubtedly an important factor in foreign language learning success (Oxford, 1996; Brown, 2004).

The National Institute of Technology (KOSEN) provides the unique and successful higher-education system, the main five-year engineering education, and is making efforts to enhance substantial activities such as English teaching and overseas internship. However, data from survey results of TOEIC program showed that the

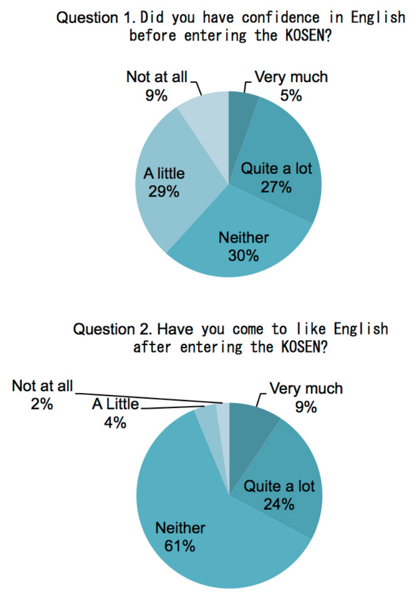


Fig. 1 Results of pre-survey questionnaires to first-year students regarding English learning.

English proficiency of KOSEN students is not high, and the average TOEIC score of KOSEN students is lower than that of general high school and university students (IIBC, 2018). In addition, our pre-survey questionnaires to first-year students at Kumamoto KOSEN, Yatsushiro campus, also indicated that a number of students do not think they have confidence in their English, accounting for about 60 percent of the total (Fig. 1). In our campus, to enhance the autonomous attitudes towards learning English, the blended learning approach for English learning was conducted, and the results indicate that use of ICT-related devices can trigger students' motivation (Ishinuki, 2014). Thus, approaches to enhance the motivation are effective for English learning.

With English proficiency, students are further required to acquire the knowledge and technical skills as an engineer. Therefore, to attract student's interest in English learning, we have tried making a program combining English and the specialized engineering field. This study attempts to address the effectiveness of an inter-departmental collaborative program for first-year KOSEN students taught by both English faculty and Science and Engineering faculty, and the program is designed to enhance students' motivation towards learning English.

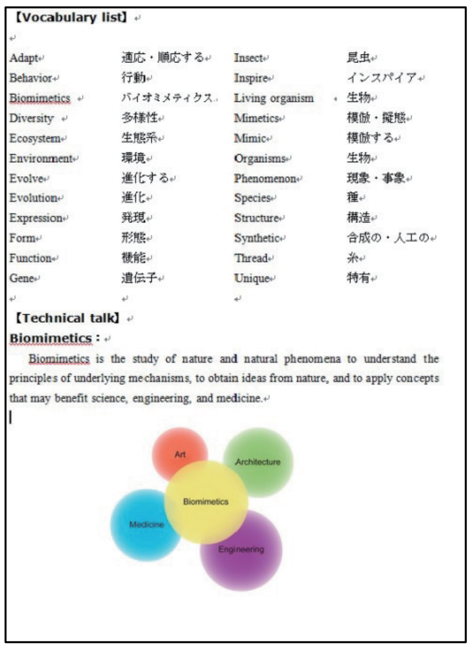
An Inter-departmental Collaborative Program

The target students of this program are the first-year students of the Mechanical and Intelligent Engineering Course (MI) and the Architecture and Civil Engineering Course (AC), and this program is implemented during the lessons of the English I class, and the language used is English. The program consists of two section components: sections by specialized faculty and presentations by students. This chapter explains each of the two components.

Sections by specialized faculty

The teachers prepare the following four materials in advance: a vocabulary list useful for their presentation, presentation slides, a worksheet for group work and a quiz sheet regarding their presentation. The sections by each teacher follow three steps. The first step is pre-studying. The students check the words and sentences of the vocabulary list by themselves. The second step is presentation time (15 - 20 minutes), followed by group work related to the presentation. The last step is time to review. The students take a quiz about the vocabulary and content of the presentation.

The faculty (Dr. Hirano, Dr. Nishi, Dr. Matsutani, Dr. Goto, and Dr. Irie) specializes in environmental biology and chemistry, mechanical design, robotics, structure construction, and spatial information engineering, respectively. They give lectures on basic knowledge and leading-edge topics in their research fields. The contents of each section are as follows.


【Vocabulary list】

Adapt	適応・順応する	Insect	昆虫
Behavior	行動	Inspire	インスパイア
Biomimetics	バイオミメティクス	Living organism	生物
Diversity	多様性	Mimetics	模倣・擬態
Ecosystem	生態系	Mimic	模倣する
Environment	環境	Organisms	生物
Evolve	進化する	Phenomenon	現象・事象
Evolution	進化	Species	種
Expression	発現	Structure	構造
Form	形態	Synthetic	合成の・人工の
Function	機能	Thread	糸
Gene	遺伝子	Unique	特有

【Technical talk】

Biomimetics :

Biomimetics is the study of nature and natural phenomena to understand the principles of underlying mechanisms, to obtain ideas from nature, and to apply concepts that may benefit science, engineering, and medicine.

Fig. 2 Vocabulary list about Hirano's lecture.

(1) Presentation title: Bio-Mimetics
Teacher: Masashi Hirano
Content: Biomimetics is the imitation of the models, systems, and elements of nature for the purpose of solving complex human problems. In the presentation, the teacher explained about organisms diversity, evolution, spider silk, etc. and presented some of the products that apply these technologies.

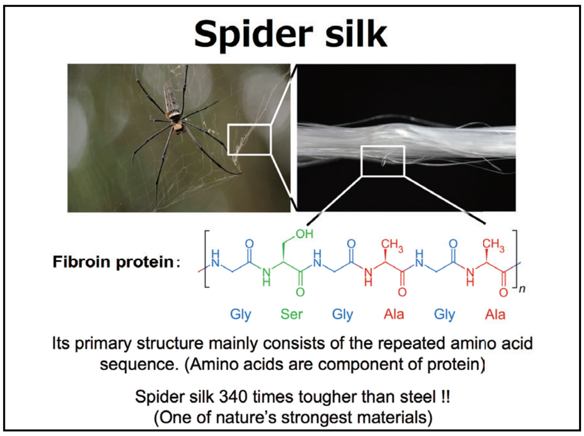


Fig. 3 Presentation slide about Hirano's lecture.


Worksheet 月 日 時限 学科 番号 名前
Organisms: 発表で出てきた生物や分かったこと.
Applied Technology: 発表で出てきた工業技術・製品
Group work: Please think about biomimetics.
Organisms:グループでディスカッションしてください.
Industrial products:
Presentation:
____(organisms name) can be applied to ____.
Because, ____.
発表者への質問および発表に関する感想や興味をもったこと:

Fig. 4 Worksheet for group work about Hirano's lecture.

(2) Presentation title: Uni-directional porous metal employing the explosive compaction
Teacher: Masatoshi Nishi
Content: After explaining the curriculum in the Department of Mechanical and Intelligent Systems Engineering, the teacher introduced to the students a unique material called porous material (metal). The porous material is characterized by low density, high energy absorption capability, high thermal and acoustic isolation properties. Then, the teacher discussed some of the latest researches in this field.

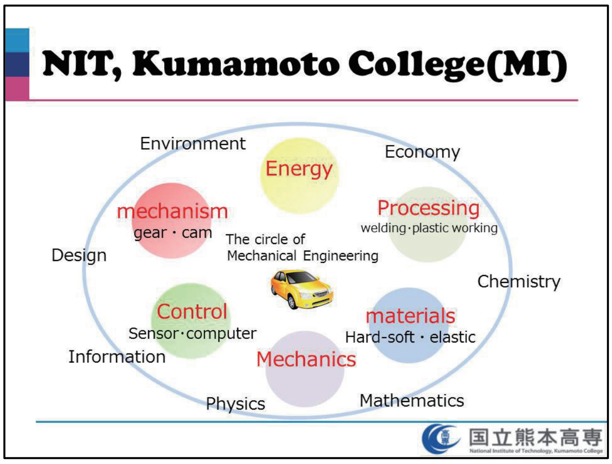


Fig. 5 Presentation slide about Nishi's lecture.

(3) Presentation title: Control and Robotics
Teacher: Yuki Matsutani
Content: The teacher gave the students some examples of robots invented by Japanese researchers, such as a partner ballroom dance robot, a musculoskeletal humanoid power effector and a multi-fingered robot hand. In addition, he encouraged the students by stating how important physics, mathematics and English are to become an engineer.

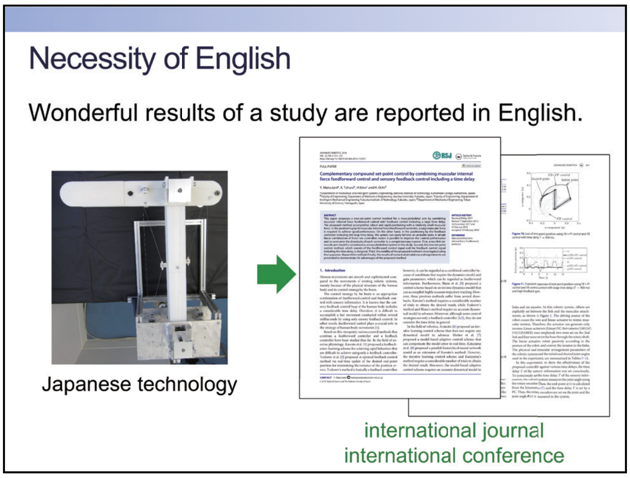


Fig. 6 Presentation slide about Matsutani's lecture.

(4) Presentation title: Structural Enginnering
Teacher: Katsuhiko Goto
Content: The teacher explained about the basics of

architectural engineering, and then about structural elements (columns, beams/girders, braces, plates, aches, shells), structural materials including composite materials, and types of loads.

Fig. 7 Presentation slide about Goto's lecture.

(5) Presentation title: SDGs
Teacher: Hiroki Irie
Content: The teacher specializes in spatial information engineering (satellite positioning system) and IoT (environmental monitoring system development), and he also works on some activities of Sustainable Development Goals (SDGs). He explained SDGs and presented some examples of the SDGs-related activities.

Presentation by students in English

In this program, the students did not just listen to teachers' presentations, but they were also required to make their presentations in English.

The purpose of the students' presentations in English is to improve their English speaking skills, overcome their hesitation of making mistakes, and enjoy speaking English. The students were divided into nine groups, each of which consists of five people. The presentation time for each group is about five minutes. Each presentation was concluded with a question-and-answer session.

In the presentation, the students become travel planners and choose cities in the world that they would prefer to visit. This city introduction activity is a good presentation topic for many students to become interested in and easily work with. The presenting students explain to the audience students how attractive their selected cities are so that they will become interested in visiting the cities.

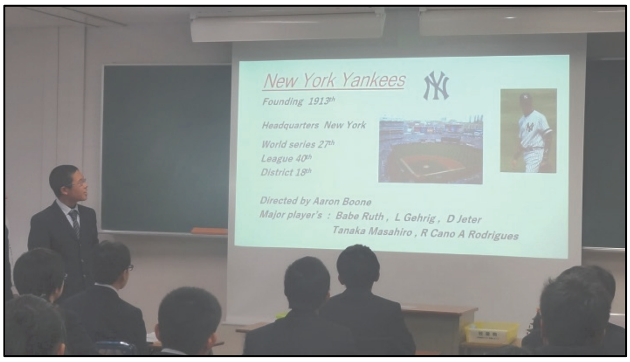


Fig. 8 Presentation by students in English.

Results and Discussion

To evaluate the effectiveness of this program on student's motivation for learning English, two kinds of questionnaire surveys were offered to first-year students. In this study, we conducted the surveys before and after the program, and compared the results obtained from pre- and post-survey.

The questions 1 and 2 were asked about interest in international exchange activities, studying abroad, and working overseas before and after taking that program by all specialized faculty. In the question 1, there is no significant difference between before and after the program (p = 0.46, chi-square tests), but the number of students interested in international exchange activities were increased. This result shows their positive reaction to participate in international exchange activities in the future. Moreover, a number of students who graduated from KOSEN have opportunities of working overseas. The question 2, related to working overseas, also shows that the number of students offering positive answers was increased, indicating that this program stimulates their interest in overseas.

Question 1 : Are you interested in international exchange activities and/or studying abroad?

	Before	After	Variation
Strongly agree	8	12	+4
Agree a little	23	23	0
Neither agree nor disagree	27	23	-4
Disagree a little	22	23	+1
Strongly disagree	8	6	-2

Question 2 : Do you want to work overseas?

	Before	After	Variation
Strongly agree	13	15	+2
Moderately agree	20	25	+5
Neither agree nor disagree	26	25	-1
Moderately disagree	22	16	-6
Strongly disagree	6	5	-1

To assess the effects of this program on the generic skills, the questions 3 and 4 were asked about problem-solving skills and communication skills through a group discussion after presentation by the specialized faculty. For example, in Hirano's session, the students discussed biomimetic products in groups, and presented their ideas. Thus, we expected to improve their generic skills. The results show that most students were able to communicate well with group members. This is partly because the group discussions are actively introduced in other classes. These results suggest that the group discussion contributed to the improved problem-solving ability for given issues.

Question 3 : Did you improve your problem-solving skills through the group discussion in this program?

	MI	AC	Total
Very much	3	1	4
Quite a lot	13	11	24
A little	23	22	45
Not at all	4	10	14

Question 4: Did you build good communication with your group members to solve issues in group discussion.

	MI	AC	Total
Strongly agree	4	5	9
Agree	18	21	39
Agree a little	18	12	30
Disagree a little	2	5	7
Strongly disagree	1	1	2

The questions 5 to 7 show the results of the survey for English presentation by students. The students who answered "improved vocabulary and grammar" and "improved presentation skills" were 88 and 82 %, respectively. Thus, through this presentation, a lot of students seemed to feel the enhancement of English skills. Moreover, in the question 7, 76% of the students answered "very enjoyed", indicating the effectiveness of this program. However, some students felt it difficult to keep up motivation in this presentation approach. This may suggest that these students are more interested in preparation for English proficiency examinations. Therefore, it is necessary to improve this program in order to meet students' different needs.

Question 5: Did you improve your vocabulary and grammar through the English presentation?

	MI	AC	Total
Very much	1	3	4
Quite a lot	18	15	23
A little	18	22	40
Not at all	6	3	9

Question 6: Did you improve your presentation skills through the English presentation?

	MI	AC	Total
Very much	2	3	5
Quite a lot	15	17	32
A little	19	16	35
Not at all	7	8	15

Question 7: Did you enjoy the English presentation?

	MI	AC	Total
Very much	4	5	9
Quite a lot	15	11	26
A little	17	14	31
Neither	6	12	18
No at all	1	2	3

Other questions include "Did you become interested in research in your own or other fields of study after the implementation of the program?" and "Do you have difficulty with English presentation?". As results, the students feeling less confidence in English were improved to positive. Therefore, this inter-departmental collaborative approach seemed to have increased not only motivation to learning English but also their interest in science and engineering.

Conclusion

In the present study, an inter-departmental collaborative program for first-year KOSEN students, taught by English faculty and Science and Engineering faculty, was designed to enhance students' motivation towards learning English. Our program could achieve a better learning outcome and motivation. In the future, to investigate whether students' English proficiency has actually increased, we need to trace their average scores of English proficiency tests. Additionally, more longitudinal approach in the context of our inter-departmental collaborative program is necessary in order to adequately understand how much our students' motivation for learning is increased.

References

Brown, R.A. (2004). Motivation for learning English among Japanese university students. *Information and Communication Studies*, 31, 1-12.

IIBC. (2018). *TOEIC program DATA & ANALYSIS 2018*. Tokyo: IIBC.

Ishinuki, F. (2014). Learning English with TED talks: blended learning for learner autonomy. *Sophia linguistica: working papers in linguistics*, 62, 133-155.

Oxford, R.L. (1996). New pathways of language learning motivation. In R.L. Oxford (Ed.). *Language learning motivation: pathways to the new century* (pp. 1-8). Honolulu: University of Hawaii Press.

THE EXPOSURE IS THE KEY: SIMILARITIES AND DIFFERENCES BETWEEN THE MALAYSIAN AND THE JAPANESE ENGLISH EDUCATION SYSTEMS

Yuko UESUGI

National Institute of Technology, Kure College, Japan
uesugi@kure-nct.ac.jp

Abstract

This paper aims to clarify the similarities and differences of English education systems between Malaysia and Japan in terms of learning and teaching. The research questions are as follows: What is required for Japanese students in order to develop especially English speaking skills? Why is the English level of Malaysian students so high? What do Japanese English teachers need to change in English teaching?

In Malaysia, English has been educated since primary school. It is noteworthy to mention that when entering the secondary school and the university, English is widely used as a mandatory language. Therefore, most of the lessons, even maths and physics, are taught in English.

On the other hand, in Japan, English has been educated since the fourth grade in primary schools. Junior high schools mainly focus on the English grammar lessons. The teaching methods also differ according to their school types. Recently, the educational reform of English has been heatedly discussed in order to nurture global engineers. It is time we searched and found a strategy in English education.

There are two main resources as follows: first, my local research of the language program in Malaysian high schools and universities conducted in 2017; second, the interviews to the international students who experienced English studies both in Malaysia and in Japan. They bring to the paper fresh and authentic aspects about leaning from the students' points of view. These aspects from different angles can eventually lead to unique and insightful future perspectives in the hope of the improvement of English learning and teaching.

As a finding, the exposure is the key in language education. Also, how to make an English speaking environment where students are exposed to English is significant.

In order to create this exposure and immersion environment, teachers' education is essential, which is one of the serious problems to conquer in Japan. Gaining teachers' understanding about the significance of the exposure should be pursued for the future discussion.

With this research, both countries could exchange their learning and teaching methods with the aim of improving the quality of English education in both respective countries.

Keywords: *exposure, English education system, teaching method, comparison*

1. Introduction

This paper is focusing on the comparison between Malaysian and Japanese educational systems in order to explore more effective, practical, and beneficial methods to teach English in Japan.

Why is the English level of Malaysian students so high, compared with that of Japanese students? Is there any significant difference between them? Are there any affective educational method conducted by Malaysian schools? These questions simply raised, the search for the key to develop English education in Japan has been started. What elements in Malaysian education excelled Japanese education in system? In order to search for the clue, this research has been conducted.

2. Materials and Method

Two main resources as materials to support this paper are as follows: first, my local research of the language program in Malaysian high schools and universities conducted in 2017; second, the interviews to the two Malaysian students who experienced English studies both in Malaysia and in Japan. These points of view from the students' angle give us insight to reach the educational clues in regard to the effective methods toward the improvement of English learning and teaching.

3. Historical Background of English in Malaysia

In the history of Malaysia, Malay language and English have been coexisting to be used. And the positons of these two languages have been severely and heatedly discussed for a long time. Recently the Malaysian government has maintained English as a strong second language and decided as a compulsory subject in primary and secondary schools (Chun, 2014).

There are two main approaches: the structural-situational approach and the task-oriented situational approach. The structural approach focuses on grammar and translation while the situational approach focuses on English education based on real situation or imagined real situation. They are blended in one approach.

On the other hand, the task-oriented situational approach focuses on the communicative competence of learners rather than the development of linguistic competence. It is characteristic that even the errors the students make are not supposed to be corrected because the errors are considered natural in the learning process.

The role of English language in Malaysia has expanded to not only a tool of international socio-political correspondence and involvement, but also as a global medium of interaction and knowledge exchange, according to Chun (2014).

In these educational transitional history in Malaysia, English has obtained a firm position with the purpose of the future globalization. With the globalization proceeding, exposing students to different foreign culture through English teaching materials have been strengthening more and more. Teaching materials of English language should not be limited to British and American cultures. The materials should be expanded into other English using countries, such as Singapore, the Philippines, India and so on.

4. Local Research in Malaysian School

In September, 2017, I participated in the study tour which was organized by Toyohashi University of Technology (TUT) with the purpose of the observation of the lessons and the local research on Malaysian English education.

TUT established Collaboration Centre at Penang, Malaysia, on December 4, 2013, with the support of Universiti Sains Malaysia Technology (USM), as an overseas education base of TUT, to carry out 'Global human resources development program' as a part of 'Tri-Institutional Collaborative/Cooperation Educational Reform Project-Fostering Globally- Engaged, Practical and Innovative Engineers-', which is one of the 'Project for promotion of National university Reform', supported by MEXT (Ministry of Education, Culture, Sports, Science and Technology). Penang was chosen as the location for the educational base because many international students from Malaysia are studying at TUT. In Penang, there are many international, local and Japanese companies, representing all categories of businesses. This environment is suitable to pursue educational activities in cooperation with industry.

Another reason for the choice of the location in Penang is the presence of Universiti Sains Malaysia (USM), a partner University of TUT. Moreover, there are also many Japanese residents, the Japanese association and Japanese Consulate-General in Penang, all of which makes the place more familiar for us.

Once TUT-USM Penang is fully operational, it will provide global educational programs conducted as a full academic year program, offered for Malaysian students and students from ASEAN countries. The mission of TUT-USM Penang is to provide for both Japanese and Southeast Asian students the best engineering education program to develop global engineers.

From the participant's points of view, TUT provides all the Japanese Kosen students a uniquely programmed study tour. The organized program with various thoughtful ideas includes a lot of discussions and interactions naturally to mingle Japanese and USM students. Not only the lessons at classrooms but also the outside activities as an extra curriculum are planned for both sides of the students to make friends with each other. Therefore, even a shy Japanese student can be easily involved in the discussion with the same aged Malaysian friendly student.

Although the topics for the discussion are high level such as problem-solving on environmental or social issues, they collaboratively and heatedly discuss the topics in order to find some solutions. All the activities were conducted in English but gradually it is true that Japanese students opened up themselves, without being afraid of making mistakes in English grammar or pronunciation.

The environment of Penang is also ideal for Japanese students because it is rather safe and has the World Heritage site in their walking distance, such as George Town, where the students can explore cultural diversity and its history. Japanese students enjoy hanging around the area with Malaysian students and develop cross-cultural understanding as well as their English skills.

Figure 1: The Study Tour in Penang in 2017

Kamahara and the two researchers (2016) reported the same program I mentioned above and analysed the effects very carefully. According to their report, English speaking environment has a positive impact on the students' attitude toward English and the wider world. This study tour expanded the students' horizons. They even started to regret not shaving studied harder before. Through this program, not only their motivation toward study but also that toward their own country, Japan were enhanced. They developed positive attitude to have their own ideas and conduct by themselves. They also enhanced the abilities to understand different cultures and various knowledge, the hospitality, the expressive skills and the communication skills as essential abilities to work actively overseas except English skills.

I totally agree with their report by participating this well-programmed study tour as my local research. From the English teacher's points of view, this programs contains variety of activities to enhance not only English skills but also essential attitude to be identified as an internationally active individual. The 15-day schedule of this study tour is as follows:

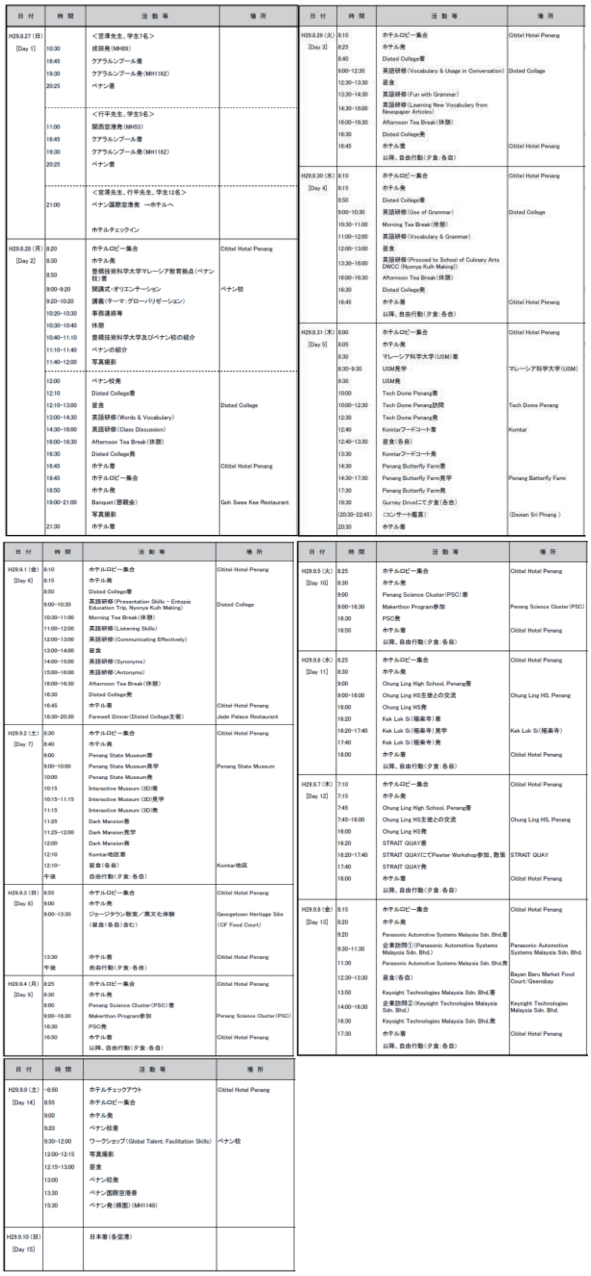


Figure 2: The Study Program in Penang in 2017

The activities both outside and inside the classrooms are thoughtfully mingled in order to inspire the students both culturally and socially. The authentic experiences broaden the students' world and new perspectives are even raised in themselves.

In fact, one of my students participated in this tour and I've never seen such a shining smile of his in Japan. The English speaking environment is supportively set up in an effective way where the cross-cultural understanding and English education can coexist.

5. Interviews to Malaysian Students Studying in Japan

I interviewed to the two Malaysian students studying at NIT, Kure, in June, 2019. The interviews were conducted individually. One male Malaysian student who has been studying for 4 years at NIT, Kure, in Japan experienced different styles of education systems both in Malaysia and in Japan. His TOIEC score is 985, which proves his outstanding competence in English. He aimed at mastering Japanese as well as the specific subjects related to his major, Civil and Environmental Engineering.

According to the interview to him, a significant difference between these 2 countries became clarified. He himself started learning English at the age of 5 and since then he has been studying English for 12 years. In primary schools in Malaysia students learn English grammar. Also they start to describe the situation in English about the given picture.

In junior high schools they complete leaning all the English grammar with all the subjects except sociology conducted in English. At that stage, grammar and composition are focused.

At high schools, grammar was reviewed once in a while and some new methods such as expressive performance from the novels are conducted with all the subjects taught in English. English writing, especially so-called creative writing, for the students to express their ideas and feelings freely, has been conducted. The entire classrooms in unison are filled with English.

At any school level, it was common to have a chance to get used to the TOEIC style tests with multiple-choice questions. He became good at this style and now it looks like a hobby to him.

In addition, even at home, TV drams have English subtitles all the time. Their ordinary life is full of English, although Malaysian students are too shy to speak English with each other. This English prevailed environment is significant in terms of the improvement in English.

Contrary to this Malaysian English education style, he was truly disappointed at English lessons where Japanese was always used by the teachers with long explanations. English lessons in Japan which seemed to be repetition of what he has learned in Malaysia to him in Japan were not as speedy as those in Malaysia. He even felt bored once in a while but he could develop both English and Japanese here in Japan. Why? The answer is that he could help Japanese students learn English and eventually he had many chances to use both languages. He has challenged some presentations in international conferences overseas, supporting his classmates' preparation in English. This supportive attitude of him has apparently had a good impact on his language acquisition.

The other female Malaysian student has given another clear clue to understand the different education systembetween 2 countries. She has been in Japan for 3 years, majoring in Mechanical Engineering. She received the Award from the Ministry of Education for her outstanding score in the Test for English Technical Communication, the 3rd Grade in 2019. She also achieved 985 TOEIC score.

In her opinion, language learning in Malaysia is like "water stream" with many different possible answers, but on the other hand, that in Japan is like "ice" because Japanese English test has a set of answers without flexibility. If the students choose a wrong answer, he or she is not rewarded.

In Malaysia, all the subjects except history in Malay were taught in English from primary schools. She went to a Chinese primary school where one subject was taught both in Chinese and English. In regard to the tests in junior high and high schools, the tests were composed of 2 parts: multiple-choice questions and essay. Therefore, the students need to fully comprehend what are important in terms of the target subjects.

She said she was surprised when she came to Japan to see English lessons conducted in Japanese. English lessons in Japan seem to be grammar review to her and the translation between English and Japanese. The students rely on the Japanese translation too much. Therefore, most of her English skills were acquired in Malaysia. What she prepared for the Test for English Technical Communication was studying not English but Japanese.

Malaysia is so-called an English speaking society where people don't hesitate to use English among friends, family members etc. all day. This English speaking environment is very important.

Also there were some incentives such as opportunities to enter the English poetry or essay contests. The winners' outcomes were to be published as a book. In the discussion time, they try to express their own feelings in detail, which drives them to know more vocabulary.

How can we improve English lessons in Japan? She suggested that Japanese English lessons should have "the speaking environment" with only one language. It's important for the learners not to be afraid of making mistakes and not be so shy when they speak their target language. "Using" the language is essential. The tests should have not only comprehensive questions but also subjective questions only in English.

Yet, Japanese students have gotten used to English lessons taught in Japanese, so it might be difficult to introduce Malaysian method to Japanese classes. She believes learning the language with the target language itself.

6. Conclusions and Future Perspectives

The study tour and local research in Penang show the authentic activities mingled educational and cross-cultural aspects have great effects on the enhancement of the students' motivations.

The two Malaysian students interestingly suggest that the speaking English environment is a significant key to master English. Even in Japan creating such environment can change the Japanese English education. How can we develop this environment? Relating to the Malaysian English education, the enlightenment to improve and develop Japanese system is surely "the exposure." To achieve the English speaking environment where the students are exposed, it is time that Japanese teachers of English are to shift our educational style from the original place to the global stage.

References

Chun, Pek Hoo., & Koon, Tan Seoh. (2014). "Globalization and the Teaching and Learning of English in Malaysia" *Journal of The Japan Association for Developmental Education*: 9,1,21-28.

Kamahara, Hirotsugu., & Eugene, Ryan., & Daimon, Hiroyuki. (2016). "Short-term Study Abroad Program in Penag, Malaysia for Undergraduate Students of Engineering Department" *Journal of Japanese Society for Engineering Education*: 65,5, 68-72.

Yamazaki, Yusuke. (2011). "English Teaching for Intercultural Understanding" *Journal of Contemporary Social Studies*: 9, 1, 41-48.

How to foster global mindsets among first year KOSEN students -from a seven-year survey of the "Korea Joint Study Tour" program

Hironori ARAKAWA*[a], Tomoyuki OHKUMA[b]

[a] Liberal Arts, National Institute of Technology (KOSEN), Akashi College, Akashi, Japan
[b] Liberal Arts, National Institute of Technology (KOSEN), Kitakyushu College, Kitakyushu, Japan

*arakawa@akashi.ac.jp

Abstract

This paper describes the "Korea Joint Study Tour" offered mainly to first and second year students at Akashi and Kitakyushu KOSEN. It is a program that Kitakyushu KOSEN launched jointly with Chonbuk National University in 2013. The following three points will be clarified based on the results of quantitative and qualitative surveys implemented to program participants. The first is the specific needs of "study tours" at Akashi KOSEN. The second is the change in the participants' mindsets before and after the study tour. The third is the most effective "study tour" approach in fostering the mindset of first year students who will become global engineers.

Recently, "Study tours" have been widely implemented in Japanese secondary and higher education. In Japan, the significance of these tours have come to be more deeply appreciated over the past five years. Within this context, Akashi KOSEN, a designated global pilot college, provides many overseas programs. However, there have been little research conducted on these programs. This study provides analyses of survey results conducted over the period of seven years. The quantitative analysis is based on questionnaire surveys conducted to students who participated in the study tour, while the qualitative analysis is based on in-depth interviews of these students and graduates.

The survey results reveal that in terms of students' reasons for participating in the program, the largest percentage wished to first of all get to know people and to make lasting friendships. After participating in the program, they came to realize the importance of talking to each other and creating networks for their future. Furthermore, follow-ups of graduates' reveal that many of those who participated in this "study tour" have again gone abroad. These results imply that the study tour had in fact functioned as startups towards becoming global engineers.

Based on these analyses, we found that the "study tour" had strong impacts on students. We believe that the study tour for first year students with the aim of fostering global mindsets and providing the experience of cooperating with foreign students in a foreign country might be the best approach towards nurturing global engineers.

Keywords: *Study tour, Global mindset, Sustainable relations, Overseas training, KOSEN*

Introduction

The Korea Joint Study Tour is charged by two KOSEN, Kitakyushu and Akashi Colleges, each Colleges selected about 10 students each, and taking approximately one week of training from the capital Seoul, the whole central province, to Busan in the south in every March. We call as "Study tour". This study tour is for lower grades' students in KOSEN, mainly from the first year to third year (15 to 18 years old) KOSEN students.

The theme of this tour is to study the history and culture of exchanges between Korea and Japan locally. However, the main purpose is to interact with the students of Chonbuk National University in Jonju, which is a partner school of Kitakyushu KOSEN.

Fig1: Picture of The Korea Joint Study Tour 2019

The origin of this tour was March 2012. Originally based on academic exchange, it was a tour only for the purpose of laboratory visits in Chonbuk National University for the students from Kitakyushu KOSEN.

In 2012, Arakawa came to Chonbuk National University with Kitakyushu KOSEN students. Arakawa realized that the students' needs for international exchange. Therefore, Arakawa asked the Korean coordinator to foster "unscheduled students' exchange events". Luckily, the coordinator accepted the request and provided something more than that. Fortunately, Mr. Jung Hee-Chul who was the coordinator of Chonbuk

National university and Japanese Colleges and a well Japanese speaker. Because he used to be a member of the Japanese Study Club at Chonbuk National University. From that connection, he made a suggestion to communicate with Japanese Study Club members and Kitakyushu students.

This coincidence event brought a big change in the tour at this time, before that which was just a visit to the laboratory. The students of the Kitakyushu KOSEN were inspired by sudden exchange programs, and the Korean students were also inspired. It was a totally splendid time. Furthermore, at the time of parting, it was an impressive result that Kitakyushu students were sad to say goodbye and suddenly cried out due to high emotions. Arakawa felt that such exchange events among Korean students and Japanese students at Chonbuk University are so useful for extending the interests for international understandings.

Fig2: Picture of the first Korea Study Tour in 2012

Since this accidental success in 2012, we have continued this tour for over 7 years, focusing on the contents for student exchange little by little. After Arakawa transferred to Akashi KOSEN in 2017, he planned the “Joint Study Tour collaborating with Akashi KOSEN, Kitakyushu KOSEN, and Chonbuk National University together with Mr. Ohkuma, who specializes in Korean modern history. Right now, nearly 100 students so far have experienced this study tour.

In the tour in March 2019, "Ideathon" was put in the program, those Japanese and Korean students were working together on the task almost all night.

Both Kitakyushu and Akashi KOSEN have “overseas training mainly for improving language skills” and “overseas training mainly for skill learning”. However, this tour’s most important purpose is to create a relationship between people and study culture and social experiences. At first glance, the targeted appeal is weaker than other tours. But, it is popular in lower grades students from each KOSENs. In addition, there are many "Global engineering students who go to the world" starting from this tour.

At present, in Japan's Society of Education for International Understanding(EIU), it is common to refer to “study tours” as a form of educational travel that involves social issues and history locally and interacts with local people. The trend of pedagogical researches are three points below: (1) To investigate and analyse how participants changed through these tours. (2) Analysing how the area targeted for the tour has changed. And (3) Considering what kind of evaluation will be given when adding these tours to school credits.

As for the present discussion, I analyzed the changes in students, the benefits and needs of this tour from the students' point of view from various surveys. In particular, we discussed the two questions, "Why is this tour popular in both KOSENs?", and "Why people who are experienced in this tour will advance further into the world?"

This report is not only the introduction of each KOSEN's individual case but the presentation of the paper as a part of the guidelines and its philosophy in conducting overseas training at KOSEN, Polytechnics, and some other industrial schools where would like to educate the global engineers.

Materials and Methods or pedagogy

There are three points in the survey method. The first is a quantitative survey. A questionnaire was conducted on approximately 50 people who participated in 2018 and 2019. Cross-tabulation of attributes, motivations, and impressions has not been conducted due to the small number. However, by many free answers at the questionnaire, it became cleared what kind of study tours they particularly want.

The second is a qualitative survey. Specifically, we analyzed the interviews with students who have participated in 2019, the reflections from the study tour participants from Akashi and Chonbuk held at Akashi KOSEN in the middle of July 2019 and the blog post that the participants wrote during the tour. This analysis was able to reinforce the results of the quantitative survey and also lead to consider about the need for more detailed lower grade study tours and their awareness.

The third is a tracing of a few examples of how students who experienced this tour specifically grew up for the “Global Engineer”. From here, it is possible to consider how it actually functioned.

Results and Discussion

(1) Quantitative survey

From the participants in 2019, 14 out of 17 responded, and in 2018, 20 out of 35 answered.

The questions from the questionnaire are below: ① attributes, ② Participation motivation, ③ Images of Korea before travel, ④Change of images about Korea after travel, ⑤ Satisfaction of each program, ⑥ Awareness of change through study tour, and ⑦ Improvement points

Also, there are some writing questions about the study tour.

“ Motivation for Participation”

Each question was asked on by the 5-point method. Especially the question of "I wanted to go abroad first" got a really high mark. In 2018, 14 participants thought "I strongly think so" and 5 answered, "I think so". In 2019, 12 participants answered "I think so strongly" and 2 thought "I think so". From that question, it reveals almost

100% of participants' needs are "they would like to go abroad".

Other items that showed high approval were "I wanted to touch traditional Korean culture" (70% in 2018, 92.9% in 2019), "I wanted to eat authentic Korean food" (70% in 2018, 92.9% in 2019), showing that interest in Korean culture is also a motivation for participation.

On the other hand, the high ranked response in 2019 indicates that “I wanted to make friends in Korea” (92.8%) and “I wanted to exchange views with young people from different countries” (92.8%).

“ Images of Korea before travel”

Before leaving Japan, the image of South Korea was mostly impressions that did not have very good impressions, such as “Many people have anti-Japanese discourses”, “Bad relationship with Japan” and “Still one of the developing countries” Just a small number of students who were interested in K-Pop, their opinions were positive.

However, after traveling abroad, the image has changed completely. In 2018, 85% answered that "the image changed dramatically (8 people) / changed (9 people)", and in 2019 92.5% answered similarly. In the detailed answer by texts, "There were many students who loved Japan", "Many kind people", "I felt humanity", "It was similar in historical idea and similar in concept, and I felt very close" (2018), "It was a highly developed country," "I made a lot of Korean friends who are friendly for Japanese people" (2019)

> "Yes, there were conflicts from political arguments, but I realize that it's only a fraction of what has been reported. I could touch the warmth of people who are trying to accept different cultures, trying to get over the barriers between the two countries. "

“Favorites and effective programs”

We carried out various programs such as excursions and student exchange in Seoul, Busan, and Jonju. From various programs, participants selected some favorites and effective programs.

“ The library visit by student ambassadors” ("I strongly think so" is 28.6%, "I think so" is 71.4% in 2019) is popular in each year.

“The exchange meeting with Jeonbuk University foreign students” ("I strongly think so" is 71.4%, "I think so" is 28.6% in 2019)

"Having dinner with Chonbuk National University students" ("I strongly think so" is 92.8%, "I think so" is7.1% in 2019)

"Exchange meeting with the Japanese Study Club member" (In 2019, "I strongly think so" is 85.7%, "I think so" is 14.3%), (In 2018, "I strongly think so" is 70%, "I think so" is 10%)

All of the activities showing a degree of satisfaction of over 90%, As we found that all these programs are strongly related to the local people and students in Korea.

In fiscal 2019, we introduced “ the ideathon”, which is frequently used in engineering education. Specifically, “Jonju City is famous as a tourist city in Korea, but what kind of innovations should be used to become more attractive for many outbound tourists from overseas”. We combined and mixed up the participants from Akashi, Kitakyushu, and Chonbuk and made several teams. They walked the city of Jonju and told each other.

Fig3: Picture of The Ideathon program in Jonju 2019

After that, they had to prepare a presentation with stay up almost all night. The next morning, they made a presentation to each other. The evaluation of this activity was also very high, 78.6% for "very good" and 21.4% for "good".

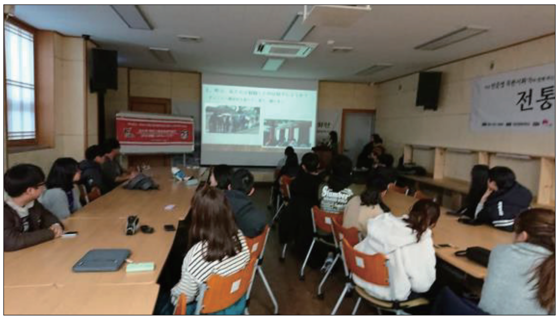


Fig4: Picture of The Ideathon presentation in Jonju 2019

“How were we changed after this study tour?”

57.1% in 2019 responded that "it changed greatly after Study Tour", and 42.9% participants answered that "it changed". From 2018's data, 35% said that "it changed greatly" also, 65% answered that "it changed". These results are also quite positive feedback.

Furthermore, We would like to show two text answer.There are positive feedbacks from their experiences.

> *"I met many people in Korea and touched the new world, I was able to know a new side of myself that I had not known before. I noticed that I still did not know me correctly." "Right now, I realized that I can become something more special."*

> *"Even if there is a difference in culture, I realize that the kind of same feeling and humanities in Korea." " And from now on, we may be involved with people who have totally different thoughts and cultures from themselves."*

(2) Qualitative survey

At first, We show an interview result of the 2019's participant. Especially, he was educated in Korean primary and secondary education system in Japan.

Therefore he can speak Korean. It is a little different from other Japanese participants, but his motivation after the tour is similar to the others.

"The fun of communication through words"

It was a lot more fun than the overseas English training I had before. The reason is that I did not have language problems. Korean students speak Japanese and I speak Korean, so there was no linguistic difficulty. There was a discovery that international exchange was so fun when words were understood. By knowing the fun of talking with overseas students, one is now more foreign-oriented to want to go anywhere in the world than I would like to go around the world. I also wanted to study English more because I understood the importance of language in order to enjoy 2 international exchange.

"Successful presentation experience"

I had the opportunity to announce in my previous overseas program, but I could only leave it to others. I was confident that the two presentations I made to the students on the study tour worked well. Before visiting Korea, I was asked to announce my overseas study experience for the first-year students, but at that time, I refused. But during the Korea study tour, I got the successful experience of presentations on a study tour.From this experience, I noticed that I would like to do my best when I received a request again. Then, the offers came again, therefore I accepted with confidence. In fact, I did well in front of 200 first-year students.

Also, we considered from the meeting from Japanese and Korean students in 2019 July held at Akashi KOSEN. Chonbuk National University students did visit Kitakyushu and Akashi KOSEN. Fortunately, their Japanese Cultural Study Tour was powered by Japan Foundation. When the Chonbuk students came to Akashi, Arakawa let the students have the meeting for the feedback.

Fig5: Picture of The Japanese Study Tour in 2019

Some of the reflections of the Japan-Korea reflection meeting overlap with the answers in the questionnaire, but the Korean side commented that "It was great for the Korean students could talk to Japanese students directly about Korea".

Furthermore, there were opinions "We were able to talk about a lot when we take a walk or eat together, and that friendship was formed from there."

These comments are so impressive. This study tour is not only for Japanese students' side but also the Chonbuk University Students' side. Therefore, from 2012 Arakawa has pointed out that this tour is mutually beneficial.

The Akashi students' side commented "It was the first overseas training, but we strongly learned positive attitude to jump out into the new world" or "not just learning as passive, we felt that it was necessary to actively carry out practical activities".

At last, we analyzed from the sentences from the weblog.

"I found a lot of my self that I did not notice.
I was so passionate about one thing.
I was able to actively challenge myself.
I love myself with studying specializes.
Above all, I thought I was trying to find a new one.
It is something I could not have experienced without participating in this Korean study tour."

"The best part of participating in this tour is 'Getting acquainted with Akashi KOSEN, Kitakyushu KOSEN, and students at Chonbuk National University.' Unfortunately, I did not know any of the participants before this tour was held. However, it was good to join alone. The skills for communication was really grown"

"When I bought ice-cream at the local stand of Jonju city. First, I told ice-cream seller in English, " I can not speak Korean, I am Japanese", suddenly he nodded in surprise, and started to handle the smartphone. Then, while handing over the ice cream, finally, he said, "Thank you" in Japanese. Maybe, he does the same thing to all foreigners. However, I was convinced that 'Japan and Korea can get along well' in that consideration. After that experience, I sheered tears suddenly."

(3) Trace survey

So far, Arakawa has conducted this tour for over 7 years, but there are very many students who will go abroad after this study tour.

For example, two students studied abroad with 1-year programs (Germany, USA), 3 students were chosen as Tobitate studying abroad JAPAN scholars by the Ministry of Education. Also, some shining students got other scholarships. Moreover, there are countless students who experienced short-term studying abroad programs.

In particular, One of the students who went to the United States for a year. During this Korea Study Tour, he asked Arakawa how to apply for long-term studying abroad programs. We told each other and spent almost all night in Korean style dormitory. After we came back to Japan, the student wanted to study abroad with scholarships formally. He and Arakawa prepared the documents for studying abroad and scholarship application.

As a result, He achieved to study abroad at a junior college in Illinois, the USA with full scholarships. And now, He is majoring in chemistry at a national university in Japan.

Discussion

Why is this study tour attracting many students and then becoming a global engineer as a result? It is thought that there are the following three points.

(1) *This tour is for first and second year KOSEN students*

The younger they are, the senses of the foreign experiences are so sharp. However, there are linguistic barriers. Fortunately, in this program, the counterparts students in Chonbuk National University are good Japanese speaker and really interested in Japanese culture. There are occasions not only good for experiencing foreign cultures but also becoming friends with each other. The first successful experience of going abroad will be able to connect the participants to the next foreign study tours.

(2) *Quality of experience of this study tour*

It is also important to learn languages and upgrading technology. However, this study tour is for exchanging the views of thinkings face to face. Human to Human, Soul to Soul. This program makes global Engineers with warm hearts.

(3) *KOSEN can provide long term global education*

What is important is the number of years that can be educated in KOSEN. It means that long-term advice and education are possible at least 5 years. This is really functional in the case of students who have long-term studying abroad and growing up as engineers. Therefore it is necessary to set up a study tour that encourages the interest of students, especially in lower year students. Faculty members in KOSEN must realize this precious benefits of long-term education.

Conclusions

We must consider what kind of experiential learning is necessary for first year students.

So far, we have mentioned individual cases, but there are a lot of general-purpose messages. The following three points are required when considering study tours which focus on the global mindset from the youngest students in other KOSEN, Polytechnics and other industrial College.

(1) *First of all, give confidence*

It is necessary to held tours that remove linguistic and economic barriers as much as possible. As the organizer, negotiations with various foundations who provide beneficial cooperation. And dealing with travel agencies is also required. The faculty members sometimes must be an education coordinator.

(2) Forster the willing to continue learning

During the tours, we must arrange the participants who would like to communicate with. Face to face communication is required.

It is our mission to provide the students experience encounters with people across cultures at a young age.

(3) Find out the issues and work together

This year's Ideathon worked very well. Working as a team, having an experience of success. This will lead to the opportunity to execute experiences beyond borders and nationalities, and to consider the role and mission of one's future.

As we know, there are many aspects of these practices that depend on local characteristics and social environment. However, the organizer is not just a chaperone. They must play roles in leading positive interaction with their counterparts, and in other words human interaction. Students are quick to sense whether the performers are in a trusting relationship with each other. For example, a student who was a student leader in 2018 has left the following comment.

> *Across the border, people can connect with deep bonds. As Arakawa Sensei and Jung Hee-Chul sensei, they can concrete relationships and be able to work together. Continue to this movement, their circle of friendships will eventually expand and the serious relationship between two nations will gradually be loosened.*

We hope that a study tour for from first year students, in which the Global Mind Set will be held in many schools, will be launched in the future.

Acknowledgments

At the beginning of this tour, Kitakyusyu KOSEN's honorary professor, Mr.Isamu Aakamo who firstly signed a partnership. Furthermore, the efforts of Former President Dr. Hiroshi Tsukamoto, Former Professor Hiroshi Otani, and Professor Abe Tsutomu, who have been promoted to modern exchanges.

We would like to thank you for all. On the Korean side, the Faculty members at Chonbuk National University, the International Exchange Department, and Mr. Jung Hee Chul, who made these study tour from Korea side. Mr. An Hyun Joon, who was the chairperson of the Japanese Study Club in 2012 and other members have really taken great parts in these programs.

Of course, there is a tour which continues to the present, because there are precious students who participated from Kitakyushu and Akashi KOSEN. We would like to express our heartfelt thanks to all the people who did participate in these programs.

References

Fujiwara, Takaaki & Kuriyama, Takehiro (2014). Program for Educational Tourism: From ‘Wandering’ to ‘Studying’. *International Education*, 20, 42-50

Ishiro, Katsuhiko/ Nakayama, Kyoko/ Oda, Yukie (2014). Transformative Learning in the Curriculum of Educational Tourinsm: Case Study of Educational Tourism in Guam. *International Education*, 20, 51-60

Otaki, Osamu/ Tsuyama, Naoki/ Morimo, Takeo/ Hashizaki, Yoriko (2014). A Practical Analysis of “Various Transformation” through an Exchange Program: A clinical Study of High School Oversea Field Trip. *International Education,* 20, 61-65

PROGRAMMING COURSE FOR ELEMENTARY AND JUNIOR HIGH SCHOOL STUDENTS

Toshie Matsumura*[,a], Shinji Uchida [a] , Takayuki Nishino [b], Yoshimichi Honma [a] and Tomohiro Yamaguchi [a]

[a] Department of Information Engineering, National Institute of Technology, Nara College, Japan

[b] Technical Support Section, National Institute of Technology, Nara College, Japan

*E-Mail namiki@info.nara-k.ac.jp

Abstract

According to the new educational guidelines announced by the Ministry of Education, Culture, Sports, Science and Technology in March 2017, "Children through programming experiences, they acquire the necessary logical thinking skills required to make the computer perform the intended processing." From then, many programming courses for primary school children have come to be held. In Nara Institute of Technology Information Engineering, the open courses of programming was conducted for elementary and junior high school students, using Squeak from 2007 to 2010, Scratch from 2011 to 2017, visual programming tools in 2018.

In this paper, we report the contents of this open course and the transition of the questionnaire results, as well as the subject of programming education for elementary and junior high school students and describe the issues. In the open course, we taught elementary school students to understand the flow of processing rather than teaching the basic structure of programming. On the other hand, we taught junior high school students conscious of the basic structure of programming. From the questionnaire results after the end of the open courses, both courses were well received, and the number of students interested in programming increased. Similarly, in the introductory education of programming at National Institute of Technology, we think that it is better to move seamlessly from programming that understands the flow of processing using visual programming to programming using the programming language that considers algorithms.

Keywords: *Programming Course, elementary and junior high school students, Introduction education, Visual Programming*

Introduction

The Ministry of Education, Culture, Sports, Science and Technology, in the new educational guidelines implemented after 2020, listed "enrichment of learning activities using computers, etc." and "acquisition of character input with computers, development of programming thinking" as important issues in elementary schools. Therefore many programming courses for elementary school children have been held mainly in each local government. In survey of Ministry of Education, Culture, Sports, Science and Technology in the Heisei 30 fiscal year, compared to the previous year, the percentage of local governments implementing programming classes has increased significantly from 16.1% to 52.0% [1]. We think that this percentage will increase further. The Ministry of Education, Culture, Sports, Science and Technology has created teaching materials for elementary school programming education for smooth implementation of programming education follow the new educational guidelines. There are many teaching materials created from Raspberry Pi and Lego Mindstorms to freeware such as Scratch and Viscuit[2]~[4]. On the other hand, ahead of the flow of programming education for such elementary school children, in Nara Institute of Technology and Technology, department of Information Engineering in view of the importance of programming education for elementary school children, we have implemented an open course with the purpose of getting elementary and junior high school students interested in computers. Open courses on programming using Squeak[5] from 2007 to 2010, using Scratch from 2011 to 2017 and visual programming tools in 2018, have been implemented for elementary and junior high school students [6][7]. Squeak and Scratch are Open Source Software. In 2018, we conducted an open course using "Keisokuseigyo-programmer" manufactured by Vstone Co.,Ltd[8] and using "Ozbot"[9]. We selected visual programing as a programming language used in our open courses. Because children can use freely at home, and even they who are not good at keyboard input can program with mouse operation to be easy to use.

Chapter 2 gives an overview of the open course used by Scratch from 2011 to 2016.

Chapter 3 introduces the questionnaire results of open courses we conducted using Scratch, and describes the overall trend.

Chapter 4 gives a brief overview of computer usage and skills for children who have taken an open course. And we will examine the contents of the future children's programming course.

Finally, we summarize programming education for beginners who has been seen from programming courses for elementary and junior high school students. We describes introductory education for college students and the conclusion of this paper.

Programming course

We have been offering open programming courses on Saturday or Sunday in the first half of summer since 2007. The students are elementary school and junior high school students. It is divided into the beginner's class and the intermediate level from 2016, and parent and child can participate in open course. The purpose of this open course is to learn programming by creating familiar games for children. The open course will be held from 10 o'clock to 16 o'clock, and it will learn programming in about 4 hours except for lunch, preparation and tidying up time.

Next, we will briefly explain the example of a public course using Scratch, which was conducted from 2011 to 2017. The timetable is the same from 2007 to 2010 and 2018.In the morning, after the instructor explains how to operate Scratch, the student solves a simple example. In the afternoon, students will program on the theme of games. As much as possible, in order to make it easy for the students to understand, the texts were sought to be easy expressions, referring to the questionnaires described later, and lectures were presented while the lecturer demonstrated. The text used was created by the instructor. In addition to instructors, teachers, technical staff and a few upper grade students will participate as assistants.

A scene of the open course is shown in Fig.1. This is a photo taken at the fiscal 2016.

Questionnaire results

Fig. 2 shows the ratio of elementary school students and junior high school students among the participants. In 2014 and 2015, we held a separate open course for junior high school students, so it is only elementary school children, but excluding this, there are few junior high school students and many elementary school students participate. In addition, since there is no tabulated result of 2012 questionnaire, it is excluded in the graph after this.

Fig.3 shows the difficulty of creating a game. Although it varies depending on the year, about 30% to 50% of the students say that it is difficult. In particular, the number of students who had difficulty in 2014 and 2015, who were only elementary school students, was increasing, and it seemed that elementary school students were a little more difficult. From this result, I explained to understand the flow of processing instead of teaching the basic structure of programming to elementary school children from this. On the other hand, junior high school students were given an explanation conscious of the basic structure of programming. This is also true for the introductory education on programming that we are teaching. At first, it is better to understand the algorithm and flow first than the grammatical content.

The results on the clarity of the course are shown in Fig.4. It was about 80% or more in all, that I understood and understood well. We consider that we described the text in a simple expression and demonstrated using a projector and an intermediate presentation monitor.

Fig.1 Photo of open course (2016)

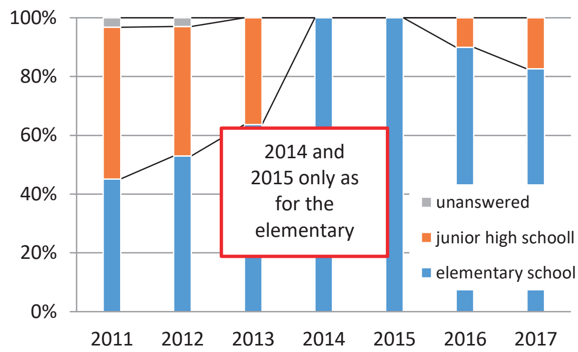


Fig2. The ratio of elementary and junior high school students

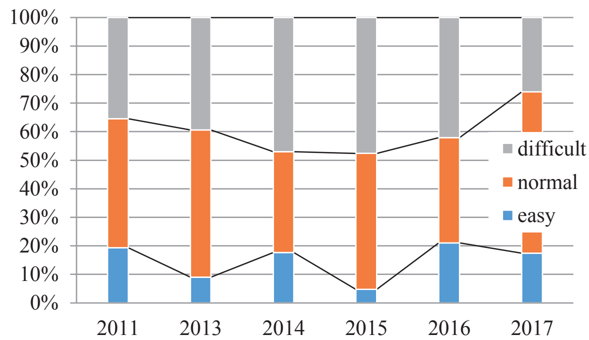


Fig.3 The difficulty of creating a game

Fig. 5 shows whether the students are interested in programming after taking the open course. About 80% of the participants answered "very interested" or "a little interested", this shows that participants are interested in programming after taking the open course. On the other hand, in order to research how the interest in programming changes before and after taking this open course, we asked questions about the interest in programming before taking the course.

The results are shown in Fig.6. The rate of increase indicates how many percent it has increased before and after the course, with negatives indicating a decrease. They are very interested, but are increasing, and from 2011 to 2016, the rate of increase for those who are “very interested” is higher than the rate of decline for other answers. It can be said that the number of people interested in programming is increasing by taking this course. On the other hand, in 2017, the percentage of people who are “very interested” is decreasing, and the number of people who are slightly interested is increasing. This can also be considered in relation to the satisfaction of the open course of Fig.7. This needs to be considered together with the clarity of the course in Fig.4. Together with being satisfied enough, it is about 70% in the lowest year and about 90% in the other years.

From this result, although there is a difference from fiscal year, it can be said that this open courses were highly satisfactory for the participants.

Student’s usage and skills of personal computer

In this chapter, we describe the use situation and skills of the open course students' personal computers. Table 1 shows the use of PCs (including tablets) in their classes. However, the data from 2014 to 2017. It turned out that children use pc once a week or that children are not used pc at all in their classes. As programming classes become essential after 2020, it is possible to increase more.

Table 2 shows the number of PCs owned by each home. You can see that almost every home owns a PC. It can be said that the computer is not special for the children.

Table 3 shows the use of personal computers outside schools. It can be seen that some children do not use a computer at all, while others use it daily. Even if children do not use much in class, it can be said that they use PCs to a certain extent, considering their use at home.

Finally, the skills of personal computers are described in Tables 4 and 5. It is an answer when asking if “you are good at keyboard input” or “good at mouse operation”. While most of the children are good at or normal with mouse operation, there are some children who are not good at keyboard input. From this also, in programming for elementary school students, it is considered that one with less keyboard input is better. Also, although the table is omitted, there are quite a few children who do not know "scroll", "copy and paste" and "drag and drop". On the other hand, most children answered that they knew "double click", "enter key", and "space key". The above results will be helpful when creating open course’s text.

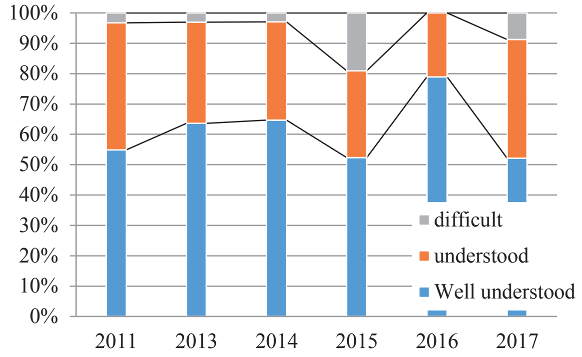


Fig.4 Clarity of the course

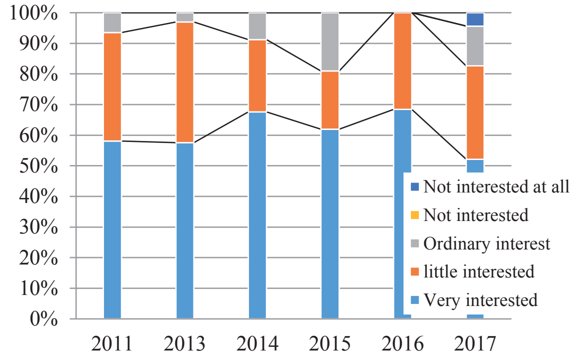


Fig.5 Interest in programming(After)

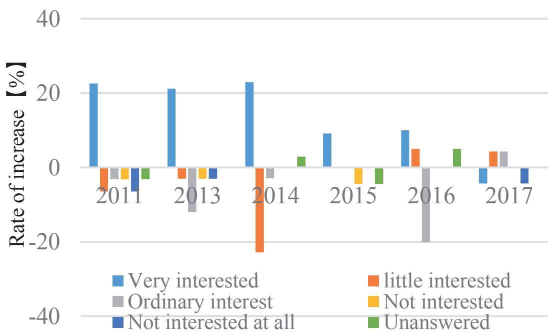


Fig.6 Interest in programming before and after

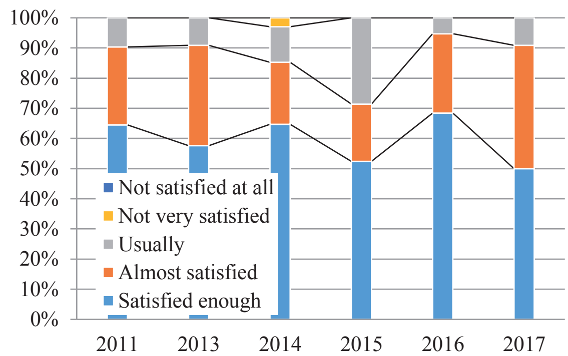


Fig. 7 Degree of satisfaction of course

Table1. PC (including tablets) usage in class 【Number of persons】

	2014	2015	2016	2017
every day	1	0	0	0
Four or five times a week	0	0	0	0
A couple of times a week	1	1	2	1
Once a week	15	4	7	8
Absent	14	8	9	13
Other (one or two times a year)	0	0	0	1
Other (2 or 3 times a year)	1	2	0	0
Other (once in 2-3 months)	1	2	0	0
Other (once a month)	1	2	1	0
Sometimes	1	1	1	0
Unanswered	3	0	0	0

Table2. Number of owned PCs 【Number of persons】

	2011	2013	2014	2015	2016	2017
Yes	31	31	32	19	19	21
None	0	1	0	0	1	2
Unanswered	0	1	3	1	0	0

Table3. The use situation of PC except school 【Number of persons】

	2011	2013	2014	2015	2016	2017
every day	8	9	6	2	3	4
Once every 2.3 days	5	5	9	3	4	3
Once a week	4	8	3	6	3	0
Once a month	12	6	10	6	4	10
Not use at all	3	5	7	3	6	6

Table4. Are you good at mouse operation? 【Number of persons】

	2011	2013	2014	2015	2016	2017
Good at	7	7	14	5	8	8
If anything	5	7	12	3	4	6
Usually	13	11	9	9	5	6
Not good at	6	6	0	3	1	3
Weak	0	0	0	0	0	0

Table5. Are you are good at keyboard input? 【Number of persons】

	2011	2013	2014	2015	2016	2017
Good at	5	3	4	3	4	2
If anything	3	9	8	1	5	4
Usually	11	14	11	9	4	7
Not good at	9	4	11	5	5	7
Weak	3	2	1	2	1	3

Conclusions

We have been offering open classes for elementary and junior high school students on the theme of programming since 2007. The open courses were very well received. This open courses gave us many insights on how to teach programming beginners programming. We explained not to teach elementary school students the basic structure of programming but to understand the flow of processing. On the other hand, junior high school students were explained with the basic structure of programming in mind. This is the same as we teach programming students in NIT, Nara College. Also in the introductory education of programming, it is thought that the method of the lecture which carries out visual programming and understands the flow of processing seamlessly and shifts to the programming language is good. The Nara Institute of Technology's Department of Information Technology has conducted introductory education using visual programming tools until now, and has further advanced the class to alternately learn Scratch and Java by programming in the first half of 2019. We believe that students can learn programming while understanding language differences by alternately learning Scratch and Java. The evaluation of the effectiveness of this educational method is for further study.

Acknowledgements

The contents of the open course organized by National Institute of Technology, Nara college, are summarized under the support of "Joint Science Education Event for elementary and junior high school students" sponsored by the Kansai Section of the IEICE. We thanks for all the students joined in this course and all the supporting our college technical staff and students.

References

(1) The approach situation about elementary school programming education in the Board of Education (H30) (PDF: 1219KB),(2019),from http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2019/05/28/1417283_001.pdf

(2) Training materials for elementary school programming education,(2019),from http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2019/05/21/1416450_001_1.pdf

(3) Viscuit,(2019),from https://www.viscuit.com/

(4) Scratch - Imagine, Program, Share ,(2019),from https://scratch.mit.edu/

(5) Welcome to Squeak Land,(2019),from http://squeakland.jp/

(6) Toshie MATSUMURA , Shinji UCHIDA and Katsuya KONDO ,(2009), Programming Lecture Using Squeak for Elementary and Junior high school

students - Report of Extension Lecture in Nara National College of Technology Department of Information Engineering, *Research reports of Nara Technical College*,45

(7) Toshie Matsumura，Shinji Uchida，Tomohiro Yamaguchi，(2011)，Programming Lecture Using Squeak for Elementary and Junior high school students ー Extension Lecture in Nara National College of Technology Department of Information Engineeringー , *Japanese colleges of technology education journal*,34, pp. 685-689

(8) Vstone Co.,Ltd ,(2019),from http://www.vstone.co.jp/english/index.html

(9) Ozbot,(2019),from https://www.ozobot.jp/

(10) Toshie Matsumura, Shinji Uchida, Yoshimichi Honma, Takayuki Nishino ,Tadaaki Shimizu , (March 2016), A *Trial of Effective Introductory Computer Programming Education using Visual Programming Tool*, Education System Information Society,2015 Special Feature Article Study Group

IMPLEMENTATION OF ENGINEERING CLASSES IN KOSEN AND POLYTECHNICS IN MALAYSIA

Fumitake KATO*

*National Institute of Technology (KOSEN), Ibaraki College, Hitachinaka, JAPAN

*katobnbf@mech.ibaraki-ct.ac.jp

Abstract

This paper describes the sequel part of the contents which was published in ISATE 2018 which was held in Hong Kong. Addition to the first project which was carried out last year, the teaching materials had been newly developed and implemented in the classes of polytechnics in Malaysia and Ibaraki College. The teaching contents are made to learn the basic part and the concept of industrial image processing technology to apply product inspections in the production line of factories or plants. The project was conducted under the program of "Research Supporting Project for Technical Human Resources Development" of Toyohashi University of Technology. The developed material has been introduced as the practical training of the class in each institute of NIT Ibaraki College and two polytechnics (Politeknik Tuanku Sultanah Bahiyah and Politeknik Seberang Perai) in Malaysia. The materials are prepared to teach and make a training for the basic of image processing supposed to be used in the product inspection. To expand the teaching method and provide the advanced contents to the students, the teaching and training materials are developed in interactive way for the students. Compared with the first contents which was conducted last year (2018), the training style is more practically designed so that the students can actively operate the system. After the class, discussions were carried out, and the survey had been conducted to evaluate the students' comprehension and the reaction. Making the feedback with the survey result, the teaching materials are going to be updated for the next activities. In this paper, the teaching contents, the students' training process, and the survey result are described. It is to share the ideas among the teachers, instructors, and/or engineers to make discussions for the new teaching & learning methods for the engineering under the global education environment

Keywords: *Engineering Education, Global Faculty Development (GFD), Teaching Material Development, Teaching in English, Image Processing, Product Inspection, Quality Control*

Introduction

As the progress of the globalization, the movement of people has been expanding worldwide. It is not limited only in the area of international region such as big city or industrialized district, but also being spread to local and rural region as well. To respond the movement, the field of education is also needed to find the new teaching method and/or the solution of it. Various researchers and educators has proposed and reported to grope the ways in the globalization (e.g., Ness and et al. (2017), Moore C.B. and et al. (1997), and Hoff. E (2009)). Focusing to the field of engineering education also, new trial or style is also discussed to encourage the reformation and improvement of the education environment (e.g., Banks, J.A. (2007) and Downey, G.L. (2010)).

In 2017, the author have joined the project of Global Faculty Development (GFD) which is provided by Toyohashi University of Technology. The programs have been conducted under the Tri-Institutional Collaborative/ Cooperative Educational Reform Project, since 2014. In order to develop and reinforce the teaching skill to conduct lectures and practical workshops, the author and the colleagues participated the conducted programs. During the project, there were opportunities to have lectures in the polytechnics in Malaysia, as the accomplishment of the project. The students had good reactions of the lecture, and their motivation and enthusiastic stance were also impressive. The technology learning in the globalization does no longer depend on the area. Corresponding to the needs of teaching and learning, teachers should be able to provide the teaching services.

This paper describes the details of conducting the lecture. It consists of main three parts, the preparation, the implementation, and the feedback & assessment. In the section 2, the concept and the topics of the lecture are described as the preparation. In the section 3, the implementation of the activity is described. In the section, the contents of the activity for the practical training, the class going, and the communication with the students are described. In the section 4, the survey of the lecture by the students and the results are described as the results and the discussion. In the fifth section, overview and the consideration are described as the conclusion.

2. The preparation of the lecture and the students' practical activity

2.1 Structure and the flow of the class

In order to conduct the technical class which is supposed to implement in international circumstances, the teaching material, the flow of the class, activities for the students should be designed and prepared properly and systematically (e.g., Caspi and et al. (2005) and Ambrose and et al. (2010)). Especially in the case of having a part of activity which students try practical trainings, the flow of the class, and the balance between the lecture part and the activity part must be planned well in the time length of the class. To conduct the students' practical training sufficiently, the time was spared about sixty to seventy percent in the whole of class time length. To spare time of practical training for students, the teacher's lecturing and related explanation part should be properly and effectively done in limited time length. As mentioned in the previous paper in the last year, the part of the lecture has been prepared following the idea of global circumstances teaching style, to encourage and support the comprehension of the students. The flow of the class in each part, teaching contents, and the ratio in the whole time of the class is shown in the table below;

Table: The flow of the class

Part	Teaching Contents	Time Ratio
Introduction	Background, Concept, and Theory	20 to 30 %
Students' Activity	Practical Operation, Discussion, and Group Work	60 to 70 %
Summary & Closing	Review, Q&A, Discussion, Quiz, and Summary	10 %

2.2 The technical concept of the teaching contents

In order to teach the basic and introductory part of image processing technology for the product inspection of the production line, the contents are developed. For the introductory learning, the technology is focused of color structure of the image i.e. Red, Green, and Blue components, and spatial & size distribution processing of the image in intensity of each color components. The Color decomposition and three primary colors are shown in the Figure 1, which was displayed for the explanation of the color structure.

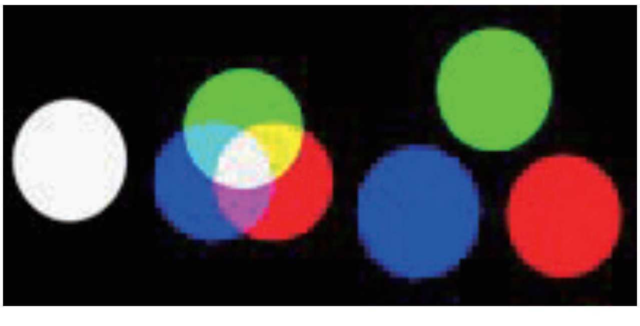


Figure 1: Color decomposition and three primary colors

Each color component's intensity is numerically digitized in the range of 0 to 255, from darkest to brightest i.e. 256 levels. A color which is displayed in digital imaging, are combined with the three color-components. The combination number is numerically calculated as shown below:

$$256(R) \times 256(G) \times 256(B) = 16{,}777{,}216$$

That is to say, digital imaging color is theoretically able to display 16,777,216 colors. To encourage and attract the students' interest for the technical part, an example is given. That is supposing that students are the engineers of quality check of the toy factory's production line. The mission is to find out the target object (standard and/or defective item) by writing the programming codes of the product inspection. The concept of the production line is shown below in Figure 2.

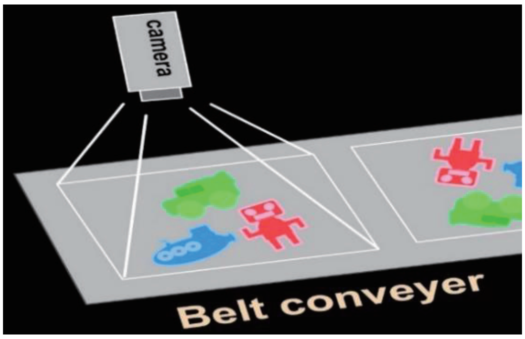


Figure 2: The concept image of the production line

As shown in the figure, a camera for the products inspection is installed above the belt conveyer. The aim of the lecture is to learn the function and the algorithm to detect a standard and/or defective item in the image for the product inspection. Corresponding with the three primary colors components, the products are designed, and shown in Figure 3. They are Red Robot, Green Car, and Blue Submarine.

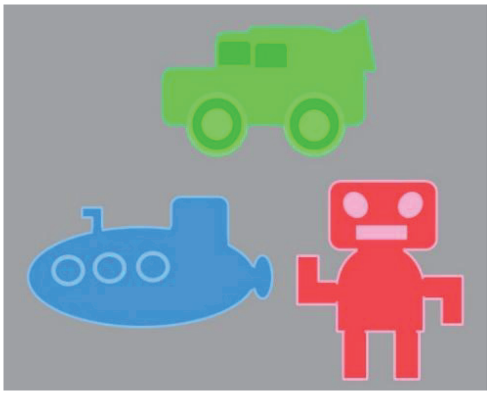


Figure 3: The reference objects' image

These three objects are the standard products, which are the reference images to compare with objective images. Each product has each color, shape and size. These factors (color, shape, and size) are the keys to differentiate with other objects. As the first step of the image processing, the color image is decomposed into three components i.e. Red, Green, and Blue ones. By the use of the color-decomposition function, the images are displayed. Figure 4 shows the result of the process.

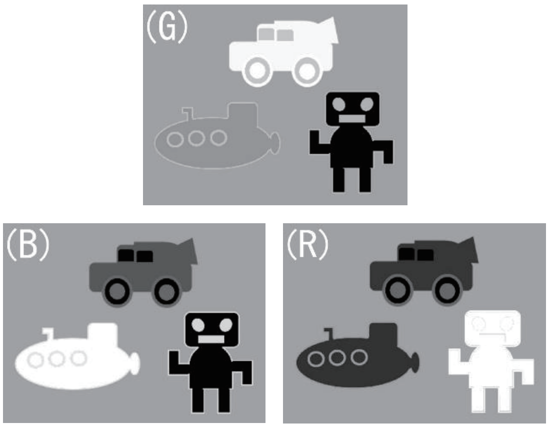


Figure 4: Color-decomposition of the reference image
(R) Red-component image,
(G) Green-component image, and
(B) Blue-component image

As shown in the figure, each colour component's object (e.g. Red Robot for the red component) is brightest color (white) for the detection. By the color decomposition process, we can choose which component is the best one to find the target object. As the next step, threshold is processed. The process screens the part by the specified intensity of the brightness. And as another step, 'select-shape' is processed. The process selects the target image shape of the threshold processed image in size such as area, length and/or contour length. By the use of three steps mentioned above, the target object image is detected and displayed with colored edging. In the lecturing part, these are explained and proceeded to the activity part. The next section describes about the part of the activity.

3. Implementation of the students' practical operation

In the part of practical training as a students' activity, students tried programming the system which is described in the previous section. The group which has three to four students is organized, and each group solved the prepared problem to detect the specified object in the image. Following sections describes each problem and the result.

3.1 Detection of Red Robot

As the first problem is to detect Red Robot in an image. It is shown in Figure 5.

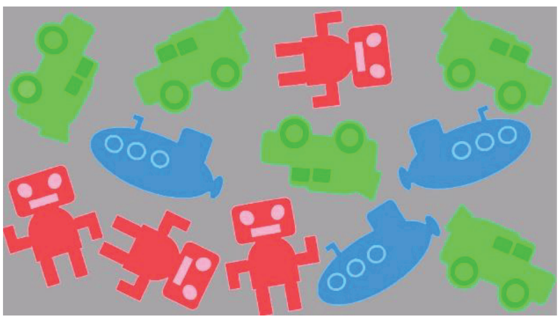
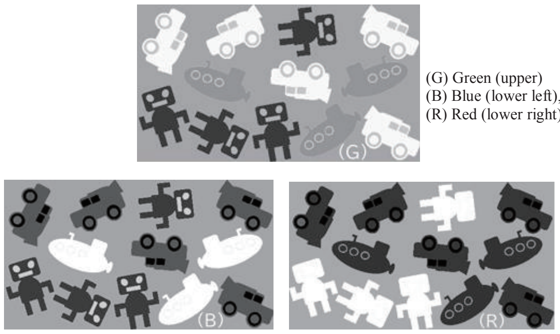


Figure 5: First image to detect Red Robot

To clarify the difference between each color components, color decomposition is processed for the image. The processed images are shown in Figure 6.



(G) Green (upper)
(B) Blue (lower left),
(R) Red (lower right)

Figure 6: Color-decomposition of the target image

After the process, students choose the best component image to detect the target. Consequently, red component image is chosen. By the threshold and select-shape process, the target part is marked with light-blue edge as shown in Figure 7.

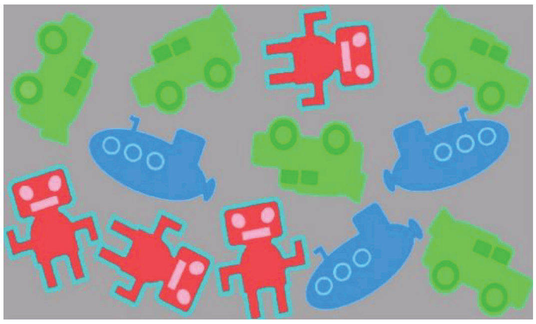


Figure 7: Result image of detecting Red Robot

3.2 Detection of Broken Green Car

The second problem is to detect the part-missing Green Car from an image. It is shown in Figure 8.

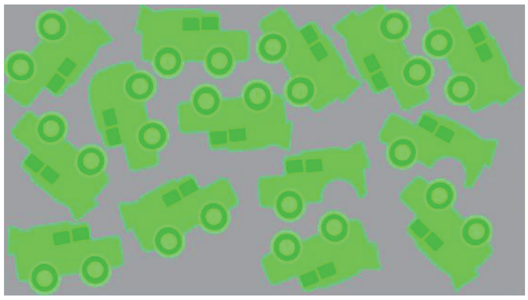
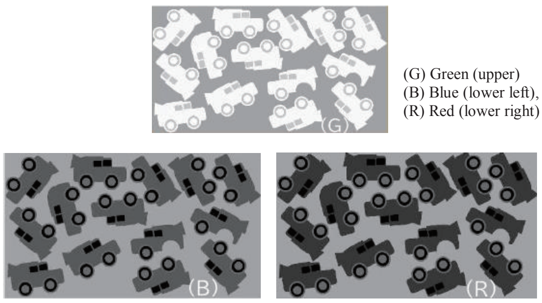


Figure 8: Second image to detect part-missing cars

The color decomposed images are shown in Figure 9.



(G) Green (upper)
(B) Blue (lower left),
(R) Red (lower right)

Figure 9: Color-decomposition of the target image

After the choice of green component image as the brightest intensity image, the threshold process is done, the area of the brightest part is displayed. It is shown in Figure 10. The number shows the area size (pixel) of the object.

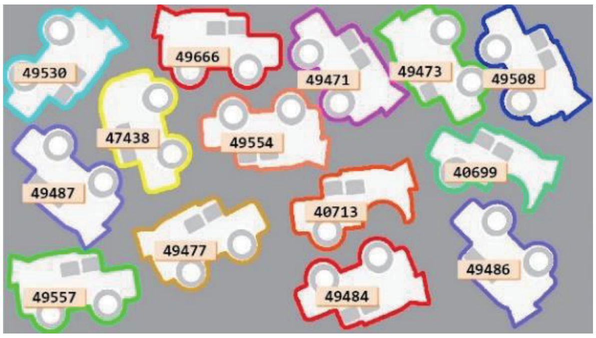


Figure 10: Threshold processed image of the target

Selecting the numbers of area size, select-shape is processed. The detection result is shown in Figure 11.

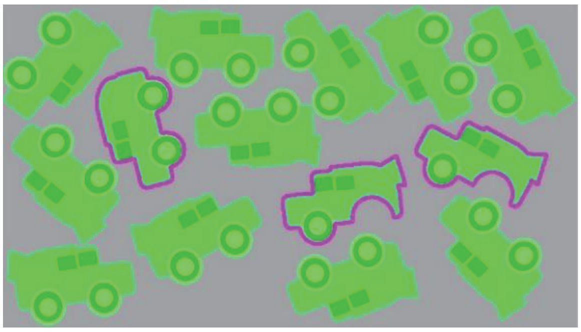


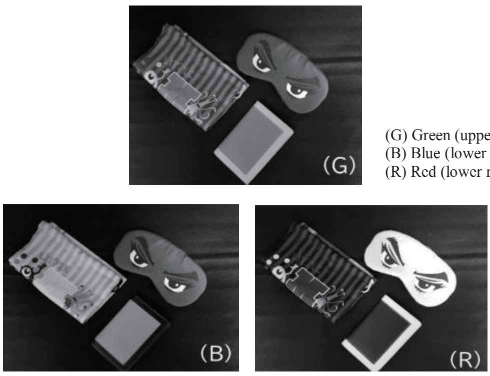
Figure 11: Detection result of the defect products

3.3 Detection of the target of photo image

Addition to the painted picture image, a real photo image has been also used for the detection to recognize practical usage. The given problem is to detect the red-coloured sleeping mask. The photo is shown in Figure 12.

Figure 12: Photo image to detect the target

The color decomposed images are shown Figure 13.



(G) Green (upper)
(B) Blue (lower left),
(R) Red (lower right)

Figure 13: Color-decomposition of the target image

After the choice of red-component image, the threshold is processed, and the area of the brightest part is displayed. It is shown below in Figure 14.

Figure 14: Threshold processed image of the target

Selecting the numbers of area size, select-shape is processed. The detection result is shown in Figure 15.

Figure 15: Detection result of the red-coloured sleeping mask

As shown in the figure, the sleeping mask which is the target is marked with light-blue coloured edging. Addition to the display of the detection, the position, area size, and/or number of the objects are also contained as the data. The system is designed in the way of interactive with the user, by using dialog style and rewriting the code of the system. It encouraged the students' active participation for the activity. By the experience of try and error of the training, the students could understand the important concept of introductory part of the image processing for the product inspection. During and the after the students' activity, we had many discussions and questions such as the application and usefulness. The photograph below shows the scene of the activity.

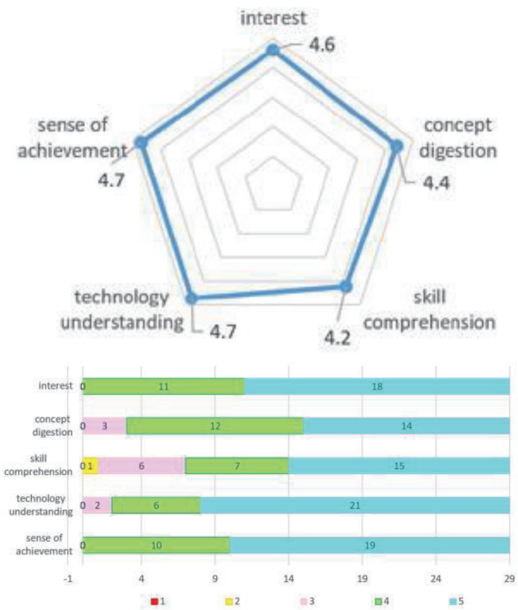
Figure 16: The scene of the activity

4. Results and Discussions
(The survey for evaluation of the classes)

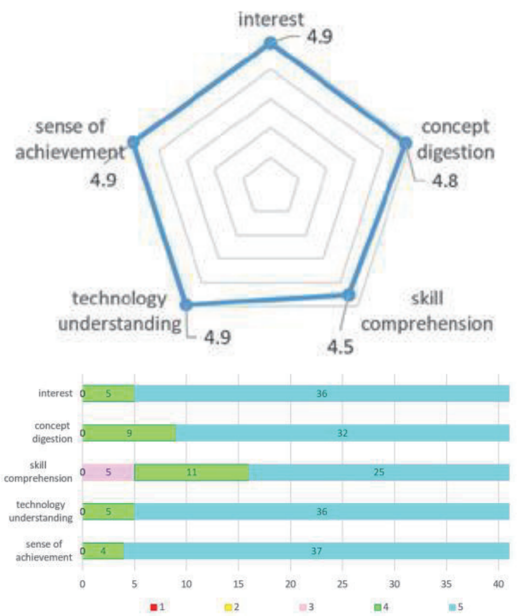
At the end of the lecture and the activity, the survey of the class has been conducted to make an assessment of the quality of the lecture and the class going. The contents of the survey are as follows:

(1) Interest level of the topics
(2) Concept digestion level
(3) Skill comprehension level
(4) Technology understanding
(5) Achievement and the satisfaction

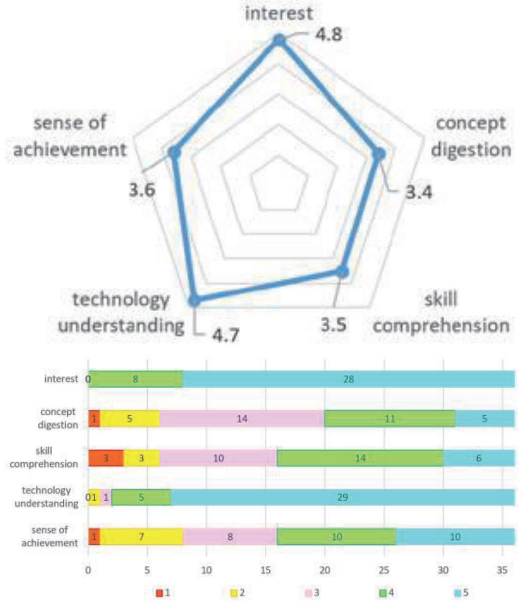
Each item's evaluation is ranged from 1 to 5. Higher number is, higher the evaluation is. Totally three classes were carried out in three institutes, and every class is surveyed for the evaluation. The evaluation results which were surveyed in three institutes are shown as radar and bar chart in Figure 17.



(a) The result of PSP



(b) The result of PTSB



(c) The result of Ibaraki College

Figure 17: The survey result of the class
(a) The result of PTSB
(b) The result of PSP
(c) The result of Ibaraki College

The bar chart shows the break down of the each item's of the survey. The number of the chart shows the students' number. As shown in (a) and (b) of the figure, the variation of the data is not so high in the bar chart, and it suggests that most students could learn and understand well about the main theme of the class. These results imply that the learning motivation of students in polytechnics in Malaysia have quite positive, and high feasibility of further level of learning in the field of advanced image processing technology and quality control engineering for the practical level of the industry. On the other hand, the shape of the radar chart is deformed and each data varies as shown in the bar chart in the group of Ibaraki College. Comparing with the results of polytechnics in Malaysia, the result seems lower evaluation. However, the students of Ibaraki College also had good performance and motivated trial in the class. The reason of the result may be derived from the curiosity and/or the imagination of application for the technology. Therefore, the way of understanding and having the future vision of the technology is more important for the beginning of the learning technology.

Conclusions

In order to realize the implementation of engineering classes under the international circumstances, a faculty development project has been carried out. It was conducted as the sequel part of the project which was carried out in 2017. Addtion to the last year's contents, teaching material and contents has been more developed for the upgrade and enhancement of the teaching method. As the material and the contents, the introductory learning for the image processing of the production engineering is designed in a way of activity style as well.

To learn and train more actively, the teaching system was developed more interactive with the learner. It is oriented to teach the students of engineering such as mechanical, electric & electronic, computer science, and so on. The implementation of the classes were evaluated by the participated students in two institutes in Malaysia and Ibaraki College. The evaluation results have been feed backed, and considered. And the further steps for the global engineering education will be continued. To maintain the global connection and the network of engineering education, international exchange of teachers and students will be more essential, and should be more developed worldwide. The trials as described in this paper may be a part of the realization of the movement. However, it is hoped that the activities as discribed in this paper would be more spread and developed in the engineering-educational institutes of the world.

Acknowledgements

The conducted project which is described in this paper had been supported by "Research Supporting Project for Technical Human Resources Development" of Toyohashi University of Technology. The author greatly appreciate the opportunity to conduct the project. To implement the project, TUT, PSP, and PTSB had great contributions and the cooperation. I thank all of the professors, lecturers, officers, and students involved this project.

References

Ambrose, S.A., Bridges, M.W., DiPierto, M., Lovett, M.C., and Norman, M.K. (2010). How Learning Works. Jossey-Bass

Assessing Student Learning, Teaching Commons, Stanford University (2014). https://teachingcommons.stanford.edu/resources/teaching/evaluating-students/assessing-student-learning

Banks, J.A. (2007). Diversity and Citizenship Education: Global Perspectives. Wiley

Caspi, A, Gorsky P., and Privman M. (2005). Viewing comprehension: Students' learning preferences. Instructional Science 33: 31-47. DOI: 10.1007/s11251-004-2576-x

Downey, G.L. and Beddoes, K. (2010). What is Global Engineering Education For? The Making of International Educators, Morgan & Claypool Publishers

Goel, V., Singhal, S., Jain T., and Kole, S. (2017). Specific Color Detection in Images using RGB Modelling in MATLAB., International Journal of Computer Applications, (0975 – 8887), Volume 161 – No 8, March 2017

Hoff, E. (2009). Language Development. Language acquisition. Wadsworth Cengage Learning Academic Resource Centre.

Kato, F. (2018). Implementation and the consideration of the global engineering education. ISATE 2018

Moore, C.B., and et al. (1997). Science Teaching Reconsidered a handbook. National Academy Press Washington, D.C.

Ness, D., Farenga, S.J., and Garofalo, S.G. (2017). Spatial Intelligence. Routledge

AN INTERNATIONAL HACKATHON WITH THE THEME OF DISASTER PREVENTION COLLABORATING WITH INDUSTRY

N. Shirahama[*a] and T. Fukuda[a]

[a] National Institute of Technology (KOSEN), Kitakyushu College, Department of Creative Engineering, Kitakyushu, Fukuoka, Japan

*E-Mail naruki@kct.ac.jp

Abstract

One of the skills required for the next generation engineer is the ability to discuss with international staff. Taking this current situation into account, we conceived that it is important to organize international teams consisting of students who learn basic engineering from various countries and make them accumulate experiences to solve problems or create new values. In November 2018, we invited students from Hong Kong and Singapore to Japan and held a hackathon in Fukuoka with the Kyushu Okinawa KOSENs.

The theme of the hackathon should be socially meaningful and familiar to the participants. We decided the theme of the hackathon was "Robots x IoT x Disaster Prevention." Participants constructed a prototype, and demonstrated it, using the provided IoT-enabled robot kit and various sensors. The total of 40 students participated, 12 of whom were from overseas. Each team consists of five students, and we organized it into a multinational team.

The hackathon reviewers, teaching staff, and the people in the media have highly praised their works. Moreover, the original goal of teaming up with students from abroad, building a prototype and presenting the idea in English, was fully achieved. We were able to provide the participants with a place to practice communication on the theme of the construction of a robot, as a place of English communication with a discussion about technology, not just language learning.

Also, we conducted a self-evaluation of competencies for the participating students, and they were rated higher in all categories than the same self-evaluation in the previous ideathon. As an overall evaluation, it can be said that it was possible to make the participants actively aware of the social contribution by technology.

Industry particularly needs human resources who can collaborate and solve problems and propose new services and values. In response to such a request, we have launched an industry-academia collaboration consortium "ProPolys" (Progress Polytechnic Resources Growth Consortium) and held ITS ideathon in May, and International hackathon in last November. With the cooperation of a variety of sponsor companies, we aim to achieve sustainable organizational management that continues to develop human resources for engineers.

Keywords: *Hackathon, Robot, IoT, Disaster Prevention, Independent and collaborative learning, and Competency evaluation*

Introduction

The importance of 21st-century skills in engineering education is further increasing. We are focusing on the following items, such as creativity, innovation, problem-solving, communication, collaboration, and local and global citizenship, and we are working on human resource development for engineers. We report here because we carried out an international hackathon in November, following the ITS ideathon (reported in ISATE 2018) which was carried out May 2018. KOSEN education is highly valued in practical manufacturing, and it can be expected that KOSEN students are active not only in the ideathon but also in the hackathon. We also perform a comparative analysis of self-assessment competencies in this paper.

Materials and Methods or pedagogy

The outline of the hackathon implementation is shown in Table 1.

Table 1 Outline of the Hackathon

Period	16-18, November, 2019
Venue	Fukuoka City Science Museum
Accommodation	Youth House (Uminonakamichi)
Language	English
Theme	Robot x IoT x Disaster Prevention
Materials	mBot

The robot kit used for the Hackathon is the mBot. mBot is a robot teaching material for STEM education provided by Makeblock in China. Followings are the reasons for adopting mBot. It is made for beginners in programming, and programming is done with a tool "mBlock" based on a visual programming environment called Scratch. The mBot control board is compatible with Arduino so that users can program with Arduino IDE. In other words, students who are in KOSEN and overseas college also can make a program using the C-like Arduino IDE.

The hackathon program consists of the following three items at this time. We mainly focused on the idea before the hackathon.

1. Prior ideathon (Day 1)
2. Hackathon (Day 2)
3. Presentation, Demonstration (Day 3)

Students who are used to an hackathon are fine. However, students who have joined the ideathon / hackathon for the first time may be puzzled. The reason is that they lack the experience of expressing their ideas, listening to others' ideas, and agreeing. These include expressing their ideas, listening to others' ideas, and forming a consensus. It's also essential to learn a method to expand a little idea or inspiration into a useful idea. Besides, Japanese students tend to lack experience in communicating in English. It's essential to be familiar with each other first in a team of first-to-face members. In consideration of this kind of thing, we designed the previous ideathon of the hackathon.

Ideathon - Day 1

First, we explained the purpose of this ideathon. Participants shared objectives and understood what they could gain from this learning experience. The central theme of this ideathon is to create a prototype with a given robot kit based on the ideas related to disaster prevention. Then, the participants understood that it is essential to team with various international students, work on one theme, create a prototype, and develop an international knowledge that is necessary for future engineers. Next, the participants were in pairs and interviewed each other. The questions and answers are the following three sets.

Q1 "What is your name?" A1 "My name is xx"
Q2 "Where did you come from?" A2 "I came from xx"
Q3 "What do you feel now?" A3 "My feelings are xx"

The participants can get an opportunity to participate in the place of discussion voluntarily by having all the participants express their current feelings.

Exercise using sticky notes

First of all, we explain activities using sticky notes to organize small ideas. This is an activity to learn how to create ideas and how to organize them. Participants performed the following three tasks using the color of the sticky note.

1. Write out one "disaster" per pink sticky note.
2. Write about "disaster prevention," one for each yellow sticky note.
3. Write out "What to protect," one for each blue sticky note.

Students from various countries and regions participate in this hackathon. It is expected that the disasters, disaster prevention, and protection that are rooted in each area are different. We believe that the participants must be aware of these differences to foster global engineers who recognize various values in the world.

Mandala chart thinking method

Next, we explain how to expand the small ideas. We adopted a kind of thinking method called Mandala chart. Here we outline how to use Mandala chart. We prepared a sheet of nine squares. Participants fill out one idea in the center of this form.

Moreover, they fill in what is relevant to the eight squares around it. Also, they fill out the eight related ideas in the center of the nine squares of another form. The participants can deepen their thinking by developing, organizing, and externalizing ideas in this way. We set that the first words to be filled in at the center of the first nine squares were "disaster," "disaster prevention" and "thing to protect" which used in the activities using sticky notes.

Idea sketch

At the end of this day, participants defined the requirements of ideas and design outlines in activities called idea sketches. Participants make an idea sketch using a sheet with fields for "theme," "headline," and "detail of idea." In the "headline" column, you have to write short words that express an idea. These short words maybe a catchphrase or the name of a product or service. "Details of Idea" describes supplementary explanations. An illustration is also recommended in this field. The several idea sketches are selected by voting from among these idea sketches. A team was formed with the creators of the idea sketches. Several good ideas were chosen by voting, and a team was formed.

The above is the outline of the ideathon on the first day. Each team prepared for the next day's presentation after returning to the accommodation. This presentation requires a definition of requirements and outlines of design for realizing ideas, clarification of roles, and an explanation of the sharing of vision.

Hackathon - Day 2

The main task is to create prototypes and presentation materials at the hackathon. The staff checked the progress at the point of need. First, we distributed the robot kit and asked them to check the parts. Also, optional sensors were provided upon request. Once the participants have checked the hardware and development environment, technical staff go through each team and confirm their goals. For example, when their goal setting is technically challenging, we give them appropriate advice. Once we have confirmed that all team goals are appropriate, we encourage them to focus on prototyping on their own. The technical staff check again the progress of each team at 4 pm and make sure that they have achieved their goals. None of the teams failed to make a prototype in time.

We also tell participants that they have to make presentation materials, but they work again at the accommodation, as they are not able to complete the creation of the presentations unless they are wholly completed the prototype robot.

Presentation - Day 3

A presentation contest was held on the last day. We assigned the time for checking the robot's movement n the morning. Each team made a final check of the robot's function, action and movement. They also prepared for the presentation at the same time. In the afternoon, each team moved to the presentation hall in turn and rehearsed.

Results

Table 2 shows the list of teams formed by this hackathon. Here is an overview of each team.

Table 2 Team List

No	Team	Title
111	Lazy Boys	Disaster guidance system @ home
112	Family Protection	Protect your family safety
113	TMJ	Management Energy
114	Team K	Fight Against Tsunami
115	Rocket Gang	Causing rain to prevent flooding
116	UMA	Smart Escape
117	Hakatathon	Supplying water for people affected by disaster
118	Flying Distributor	Drone Rescue System

Team number 111 "Lazy Boys" proposed and prototyped the idea of a disaster guidance robot for children and the elderly. The idea of team number 112, "Family Protection" is a system that detects fires in the home and shares information with the family. Team No. 113, "TMJ" has proposed a system that measures the electricity consumption of terminals in office buildings to promote power saving, and uses sound, temperature, and flame sensors to warn in the event of a disaster. Team number 114, "Team K" proposed a system to predict and notify the occurrence of a tsunami based on the sensor value. Team No. 115, "Rocket Gang," presented a unique idea of firing condensation on cloud particles to make it rain and prevent flooding. The idea of team number 116, "UMA" is to display the optimal evacuation route with LED based on the route search algorithm. Team number 117, "Hakatathon" is to install a water level sensor in the storage tank, transmit water supply information at the time of the disaster, and appropriately supply life water as needed. Team No. 118's "Flying Distributor" has defined a new coordinate system based on color information and proposed a drone rescue system that can be used in environments where GPS can not be used. It turns out that both ideas are proposed from the engineer's point of view.

Here we explain the outcome of each team. The idea sketch poster created on the first day is shown in `Figure 1`. The style is five elements of target, value, profit, activity area, and success factor so that it is not just an exciting idea but a highly feasible idea.

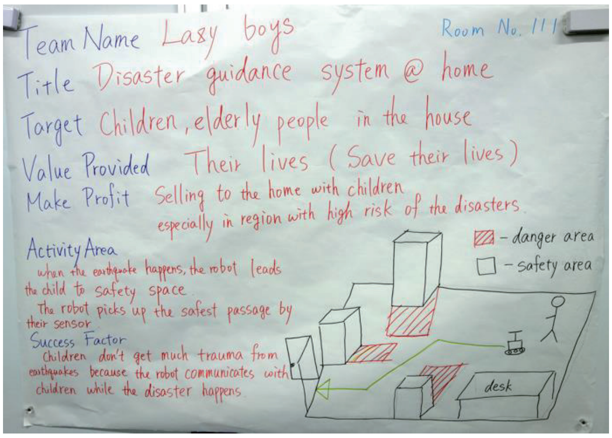


Figure 1 The poster of team 111 "Lazy boys"

`Figure 2` shows an example of a slide for the sensor used. Thus, each team properly selected the sensor and controlled the system based on the measured value. As shown in the slide of `Figure 3`, the team using API of external SNS service was also seen. There was a team that proposed a system based on the experience of suffering from the earthquake. The importance of the government to supply water at the time of disaster is shown in `Figure 4`, and a system for detecting water shortage is shown in `Figure 5`.

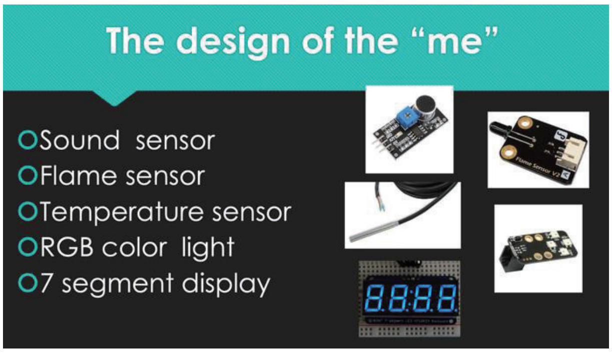


Figure 2 An example slide for the sensor used

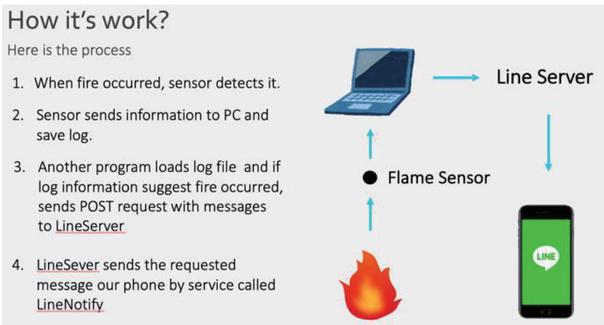


Figure 3 An usage example of external SNS service API

Figure 4 Proposed example of problem-solving based on social perspective

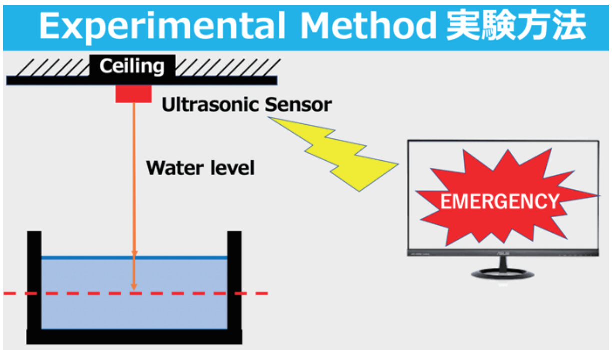


Figure 5 Water shortage determination system by an ultrasonic sensor

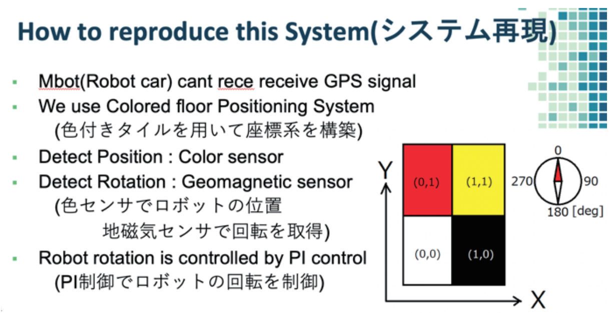


Figure 6 Proposal of a coordinate system based on color

A very challenging and novel idea was also presented. Figure 6 shows a proposal for a coordinate system without using GPS. Finally, Figure 7 shows a demonstration using a prototype machine.

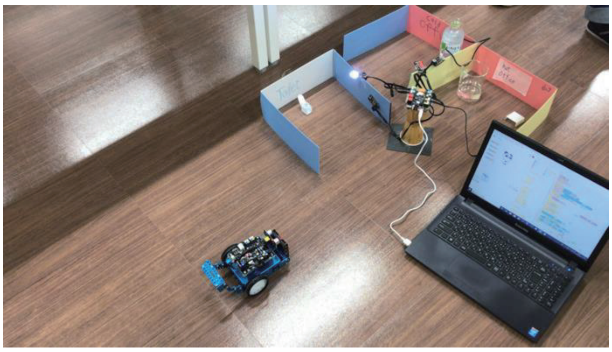


Figure 7 A demonstration of a prototype machine

Self-assessment competencies

The ideathon and the hackathon are widely and actively conducted, but there are few cases where the competency evaluation of the participants is performed from the educational viewpoint. We conducted a self-assessment-style competencies survey similar to implementation form used in the ideathon on last May.

Teamwork
A. I can evaluate the activities of the team members.
B. I can mention my opinion or put out ideas actively and can contribute to the team.
C. I can understand the importance of that work for the team.
D. I could not do anything.

Leadership
A. I can act with the leadership.
B. I can understand the way of better leadership.
C. I can understand the importance of leadership.
D. I could not do anything.

Solving Problems
A. I can understand several solutions and can narrow down.
B. I can describe with organizing and structuring the essence of the problem.
C. I can explain my proposal of solution.
D. I could not do anything.

Communication
A. I can understand the process of consensus and can improve if necessary.
B. I can present a keyword that triggers the idea.
C. I can present description and figure properly.
D. I could not do anything.

Social contributions
A. I can explain the possibility that our ideas can solve world problems.
B. I can explain the possibility that our ideas can solve regional problems.
C. I understand that our ideas do not contradict laws and morals.
D. I could not understand anything.

Technology
A. I can propose an excellent prototype by combining multiple functions.
B. I can create a prototype according to the technical theme.
C. I can explain the function of parts.
D. I could not understand anything.

Figure 8. Four achievement levels of skill Rubric

Survey outline

Before the analysis, we show the breakdown of the participants. The sample number n of the questionnaire is 40. Figure 9 shows the gender and participant count of the participants. The number of participating students was 40. There are 39 male students and one female student. Figure 10 shows the number of participating students for each educational institution.

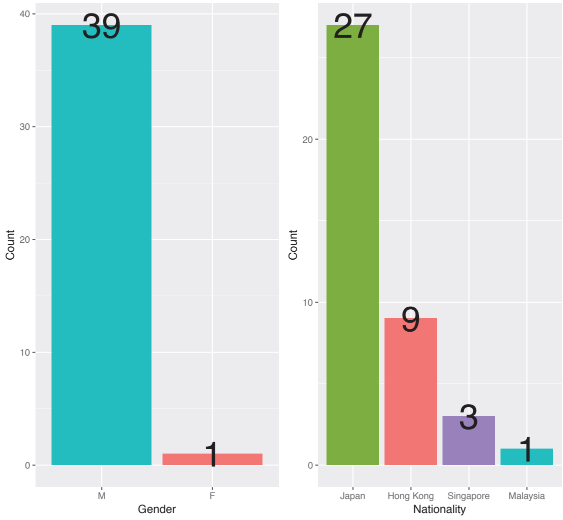


Figure 9. Participant gender and nationality

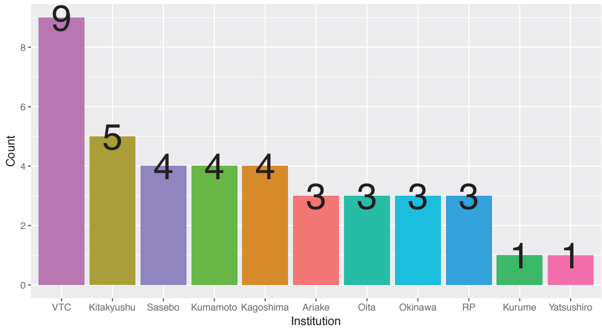


Figure 10. The number of students for each educational institution

Discussion 1 - Japan VS International

First, we analyzed six competencies for all participants. Figure 11 shows the histogram of self-assessment by six competencies.

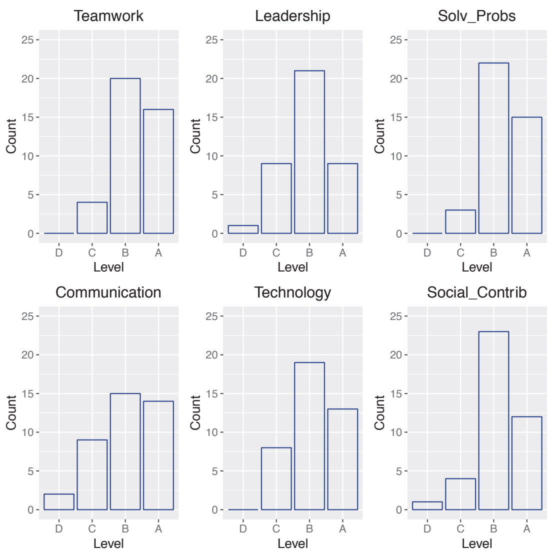


Figure 11 The histogram of self-assessment by six competencies

Participants rated their skills highly in Social Contribution and Solving-problems. Teamwork is also highly rated. The item of leadership has a little lower rating. It seems difficult for all participants to show their leadership. The lowest is the item of communication. Language barriers and mental barriers seem to be affecting.

Next, we analyzed whether there was a difference between KOSEN students and foreign students. Figure 12 shows a comparison of Japanese and international students with for the histograms of these six self-evaluations. We also analyzed whether differences exist between KOSEN students and international students. KOSEN students tended to have high social contribution items, while international students tended to have high problem resolution.

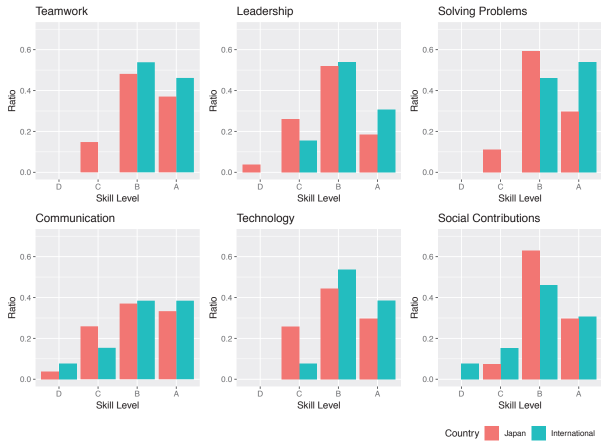


Figure 12 The six self-assessed rates (compared to Japan)

Discussion 2 - Ideathon VS Hackathon

We compare and analyze the ideathon conducted in last May and the results of this self-assessment of hackathons. Figure 13 (Japan), Figure 14 (International) and Figure 15 (all) show a comparison of the four skills measured during the ITS ideathon in May and the Hackathon in November. The four common skills to compare are Teamwork, Leadership, Solving-problems, and Communication.

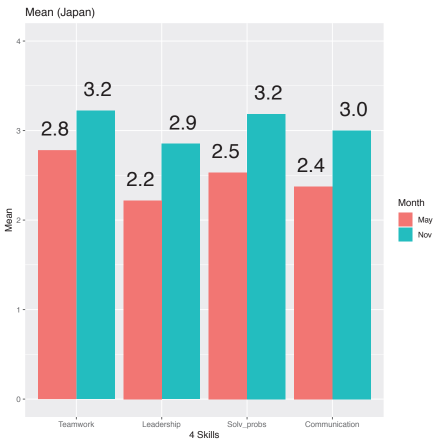


Figure 13. Comparison of self-evaluation of 4 skills in May and November (Japan)

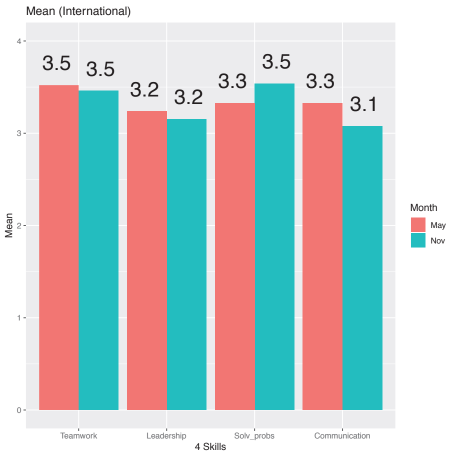


Figure 14. Comparison histogram of self-evaluation of 4 skills in May and November (International)

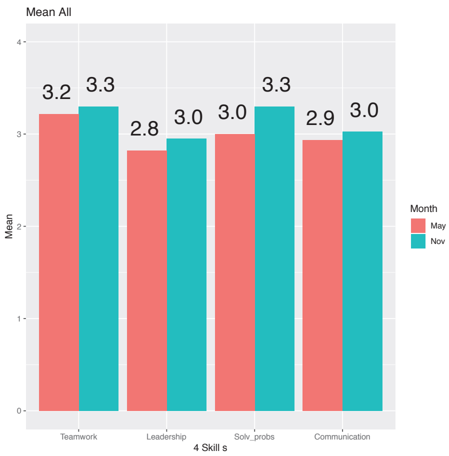


Figure 15. Comparison histogram of self-evaluation of 4 skills in May and November (All participants)

As for the KOSEN students, it is clear that at the time of hackathon self-evaluation is higher. International students have a slightly higher score for the ideathon in May for three skills. Although it can not be affirmed because the participating students are different, it was suggested that the KOSEN students may have a tendency to prefer hackathon to ideathon.

Conclusions

The original plan to make communication and collaboration in English in the form of teaming up with international students and shaping their ideas was fully achieved. We were able to provide participants with a place to practice communication on the technical theme, which is not only English as knowledge but also English as a practical communication tool. A large number of students commented that they were satisfied to participate. We also selected the six skills required for engineers based on 21st-century skills, created four levels of rubrics, conducted participant self-assessment, and analyzed the results. It is possible to analyze the comparison numerically with the previous ideathon and the comparison between Japan and overseas.

This hackathon was highly appreciated at the Kyushu-Okinawa KOSENs and overseas participating colleges. A request for continuation has been issued for the internationalization of future KOSEN education. We plan to carry out the international hackathon in August 2019.

Acknowledgments

We would like to be deeply grateful to the Fukuoka City Museum for providing the venue and many useful suggestions, and QTnet and Toyota Production Engineering corporation for supporting this hackathon as a sponsor. This work is partially supported by JST Sakura Science Plan for the exchange program.

Finally, we would like to express our sincere appreciation to ProPolys, the organizer of this hackathon.

References (Media)

[1] KOSEN and overseas students show their disaster prevent robots, Nishinippon Shimbun (West-Japan Daily, 西日本新聞) 15, Nov. 2018 (in Japanese)

[2] KOSENs in Kyushu Okinawa district holds next-generation human resource development international hackathon, Education Report (文教速報), Ministry of Education, 18, Dec. 2019 (in Japanese)

[3] Photo Report, FUKUKEI (福岡経済) January issue, pp.213, Jan. 2019 (in Japanese)

[4] Development of next generation engineers by small mobile robot hackathon, SAKURA Science https://www.facebook.com/sspjapan/photos/p.1231072097053251/1231072097053251/ 24 Apr. 2019 (in Japanese)

References

Naruki S. (2018). An International Ideathon with the theme of ITS collaborating with industry. *Transactions of ISATE 2018, The 12th International Symposium on Advances in Technology Education*.

Naruki S. (2017). An Approach to Introduction and Improvements of Ideathon in ICT Education. *Transactions of ISATE 2017, The 11th International Symposium on Advances in Technology Education*, pp.291-296.

Naruki S. (2016). The practice of Active Learning by Role-play of Start-up Companies. *Transactions of ISATE 2016, The 10th International Symposium on Advances in Technology Education*, pp.275-280.

ITS-AP Forum 2018 Fukuoka Executive Committee. (2018). *The 16th ITS Asia-Pacific Forum FUKUOKA 2018*, https://www.itsap-fukuoka.jp

ATC21S (2017). Assessment & Teaching of 21st Century Skills. *http://www.atc21s.org/*

EVALUATION OF STUDENT FEEDBACK ON EXCHANGE PROGRAMMES FOR CONTINUOUS IMPROVEMENT

SH Lee*,a, WY Leung[a], CK Chan[a], YN Chan[a]

[a] Department of Engineering, Hong Kong Institute of Vocational Education (Tuen Mun), Hong Kong, China

*sh.lee@vtc.edu.hk

Abstract

The Hong Kong Institute of Vocational Education (IVE) has organized a variety of exchange programmes for its Higher Diploma (HD) students over the years. The aims, the objectives and the scopes of these programmes would be very different from department to department due to the fact that each department in various campuses has a very unique expertise and programme profile. And the type, the location and the relationship with overseas partnering institutions would also be the determining factor for setting the aims, the objectives and the scopes for each exchange programme in different department.

This paper presents a continuous improvement exercise for student exchange programmes by evaluating the feedback from students through questionnaire and focus group interviews. Two very different exchange programmes both conducted by the Department of Engineering at IVE (Tuen Mun) in 2018 were selected as the subject to be studied. This study based on mainly the view from students from IVE after completing the exchange programmes. The result of this study is intended to enhance student satisfaction by a better planning, organizing and operating of other exchange programmes in the Department of Engineering, IVE (Tuen Mun) and perhaps other relevant overseas institutions.

Both survey studies and group interviews indicate the evidence that these exchange programmes are able to achieve the objectives for the exchange programmes, e.g. boarding the horizon of the students, acquisition of engineering knowledge in another country. Furthermore, reported levels of satisfaction for students were very satisfactory. However, cultural difference and language proficiency were found to be the major hurdles to the exchange programme.

This paper discuss the activities of the exchange programmes and the major barriers, i.e. the language proficiency and the cultural differences. Improvement actions will also be discussed.

Keywords: *Exchange programme, exchange activities, cultural difference, language proficiency*

Introduction

Just like other international cities, Hong Kong higher education is now putting emphasis on an international student exchange programme. This exchange programme not only enhance student's own development and international exposure (Sowe, 2002), but also can increase student's motivation to acquire knowledge and skills (Altbach and Knight, 2007). Students with international exposure are found to be more self-confident with great knowledge of international affairs (Kelly and Robert, 2004). Furthermore, students joining the exchange programme can have more chance to practice English, which can definitely improve their communication skills and language ability, which are the key elements for the workplace's success.

As an university institution in UK and VTC jointly offered a top-up degree programme of Building Services Engineering for higher diploma graduates, a UK exchange programme was organized by IVE (Tuen Mun) in order to promote the top-up degree programme. Another exchange programme with a Japan technology institution was organized by IVE (Tuen Mun) to strengthen network and relationship with the overseas institution.

This article describes the evaluation of the effectiveness of a student exchange programme organized by IVE (Tuen Mun) to Japan and UK for enhancing students' knowledge in engineering. The exchange between UK and IVE (Tuen Mun) was held from 22 to 31 July, 2018. 24 students participated the exchange activity. Through collaboration between the 2 institutions, a group project and a site visit to BREEAM Excellent Low Carbon Building were arranged to let students learn the building services systems in UK. Another exchange programme between a Japan institution and IVE (Tuen Mun) was held between 16 and 25 May 2018. 10 students from engineering department joined this exchange programme. This exchange programme consisted of seminars, laboratory session and industrial visits to broaden the students' horizon on science and engineering.

UK Exchange programme

This exchange programme was a 10-day study tour, which aims to provide higher diploma building services engineering students an opportunity to enrich their exposure and horizons in the Building Services Engineering industry in UK. The objectives of this exchange program is shown below:

- To enhance students internationalization under VTC 8-year Strategic Plan
- To exchange and learn state-of-art technology in the field of Building Services Engineering for a university in UK
- To enhance students' professional knowledge on technology for Building Services Engineering in the UK
- To develop the potential of the students through their creativity and skills to prepare them to compete with the global society

The exchange trip was held from 22 to 31 July, 2018. The trip comprised vising laboratory and facilities in the UK university, group projects for the students, technical visit and field trips. Students can visit various laboratory facilities in the department. They can also appreciate various projects works to be done by the university students in UK.
Besides, the students from both institutions were teamed up in groups to conduct projects related to building services in UK buildings. Five groups were formed with about 5 HK students and 1 UK student for each group. Each group was assigned with a specific project title and a UK building for investigation. Projects are related to building services, including lighting, humidity level, temperature, acoustics and accessibility. The UK buildings are located in Bristol downtown, ranging from fire station, commercial building and university. Since site measurements were required to be carried out, students were trained to use those laboratory instruments. Through site investigation and field measurement, the difference in built environment between HK and UK were compared by the students. Finally, students were required to prepare their posters for presentation of their findings. Staff from both institutions listened the presentation and provided comments to each group of students.

There were a technical visit of BREEAM Excellent Low Carbon Building. The technical visit enabled the students to explore how a low carbon building can be achieved under the BREEAM requirement. There were field trips to Hampton Court Palace, Cardiff and Bath. Those field trips provided platforms to students to appreciate the building architectural styles, building services system and built environment of UK buildings.

Japan Exchange programme

A 10-day exchange programme was held and the objectives were shown below:

- To provide opportunities for students to expose the industry development
- To enhance the network with the institution in Japan
- To enhance students' professional knowledge on technology for engineering and science in Japan

The exchange programme to Japan was conducted from 16 to 25 May, 2018. The activities of the trip involved the campus visit, fundamental Japanese language lesson, chemical and mechanical engineering workshops, and cultural activities and industrial visit. The language lesson class equipped students with some basic Japanese language. Besides, the students can also recognize the development of engineering and science in Japan through the technical workshop. There were also some cultural activities, including Kendo and Japanese tea ceremony. Some industrial visits were organized for students to let students know more about the engineering development in Japan.

Methods

Data collection methods

The feedback from the students on the exchange programme identified in this research was collected by the following methods:

a. Questionnaire survey —the questionnaire survey consists of two major parts, namely overall assessment of the activity and the extent to which the activity can enhance the students' understanding of the visited country. The overall assessment comprises of 4 multiple choice questions to let respondents weigh for the following issues, namely living experience, seminar/training course, company visit, tourist attractions and exchange activity with foreign students. The other part involves 6 multiple choice questions to let respondents weigh for the six criteria, namely culture, communication skills, team spirits, self-management skills, willing to study/work in the visited country and the foreign language ability

b. Group interview — A group interview was also conducted to ask students about their opinions after completion of the exchange programme. Students were asked:

1. Will you recommend other students to join the exchange programme?
2. To identify the language and cultural barriers for this exchange programme.

Questionnaire Result

The survey results indicate that the respondents were generally satisfied with the exchange programme. Figure 1 indicates that both exchange programmes can provide a good living experience to the participants as more than 90% of students weighted excellent on this item. A significant number of respondents were also satisfied with the seminar/training course, and company/tourist visit. They were also happy for the exchange activities with overseas students, while only small amount of students were not satisfied with these activities.

Figure 2 illustrates that comparison of the extent in enhancing students' understanding on the culture of visited country and personal ability for the exchange programmes in Japan and UK. This figure shows the comparison for six criteria, namely culture, communication skills, team spirits, self-management skills, willing to study/work in the visited country and the foreign language ability. The figure indicates that the exchange programmes were very successful in enhancing students' ability in team spirits, self-management skills and willing to study/work in overseas. However, the survey results also unveiled that both programmes were unsuccessful in increasing students' understanding and appreciation of hosted country culture and society. Besides, the figure also indicate that no significant improvements on their communication skills and foreign language ability can be achieved through joining these exchange programmes. These may be because the period of the exchange programme is relatively short and there is little interaction with the foreign students in these exchange programmes, which is in line with the findings by Gillespie (2003). Furthermore, foreign language barrier may also be a hurdle to hinder the communication between these students.

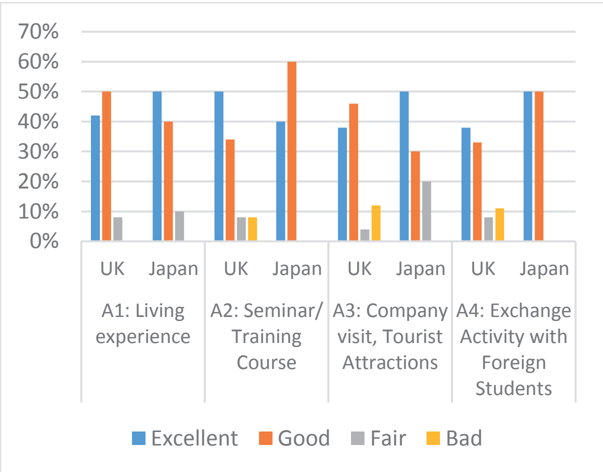


Figure 1: Comparison of overall assessment of the exchange programmes in Japan and UK

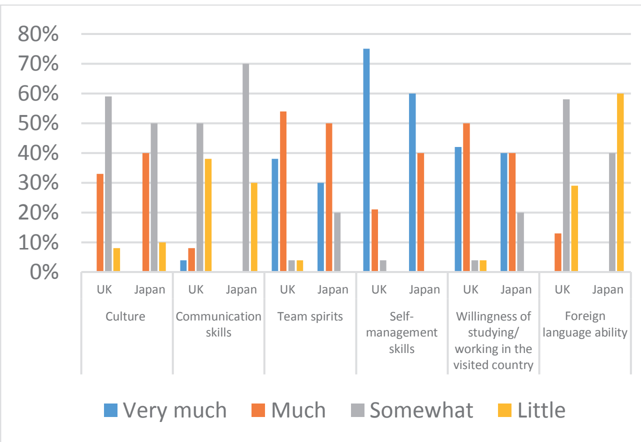


Figure 2: Comparison of the extent in enhancing students' knowledge of the culture of the visited country and the personal ability for the exchange programmes in Japan and UK

Figure 3 shows the overall satisfaction of the exchange programmes. Overall, the programmes were successful as an overwhelming majority of the respondents felt happy for the exchange programmes.

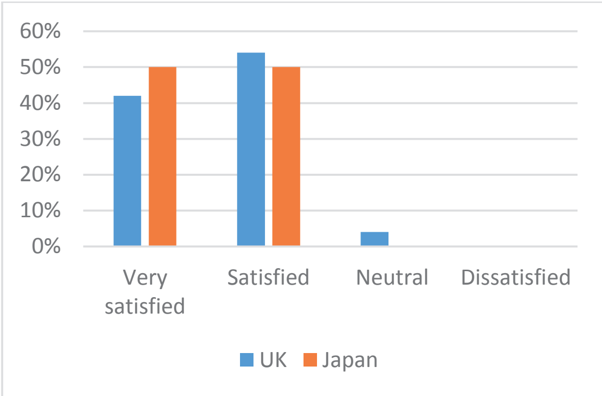


Figure 3: Comparison of the overall satisfaction for the exchange programmes in Japan and UK

Group interview results
A group interview was also conducted to ask students about their opinions after completion of the exchange programme. They were asked if they recommended the other students to join the exchange programme and the results were very encouraging, as shown in Figure 4.

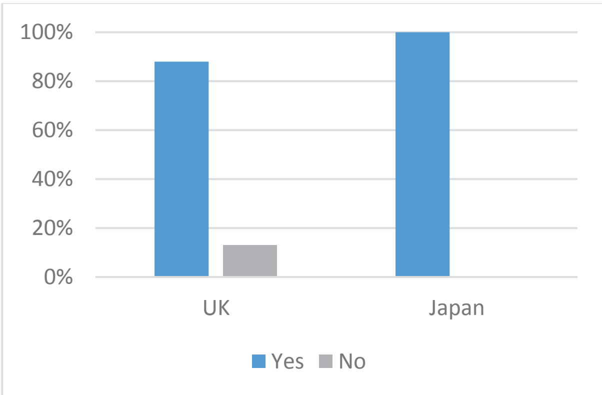


Figure 4: Recommendation of other students to join the exchange programmes to Japan and UK

Questionnaire survey results show that the exchange programmes are not able to enhance students' understanding on other country's culture, the communication skills and foreign language ability. A further group discussion was done to identify the barriers to hinder the success of these exchange programmes. The discussion results unveiled that the language barrier and cultural difference may be the major barriers for the exchange programme.

Discussion

Language proficiency

For UK exchange programme, many students were reluctant to speak to UK students. This may not rule out the probability that there is only a little chance for them to interact with each other. Besides, some students were scared to talk to overseas students. However, the findings from group interviews indicate that students had difficulty in communicating with foreigners because their English language proficiency was limited. The following quotes support the reason:

- "As I remember, it was so weird and awkward to meet the students and the staffs of University in UK at the beginning because I had to settle myself in first. The language was difficult so it was a big challenge at the beginning that everything in English, but it was better with time."
- "The main communication language in the UK is English, but English is not my strong language, so it takes more time to communicate"

For the exchange programme in Japan, the communication problems occurred between the students in the host institution and the IVE(Tuen Mun) in HK. Some students think that it was a burden because they found difficulty in communicating with Japanese students, as stated in one of the quotes by HK students:

- "I can only use English to communicate with Japanese student, so I had to speak English usually. It was very difficult in a first few days in Japan, because we had no such opportunity to speak English."

Furthermore, some students reported that language difficulties also cause problems even though they spoke in English in communication. The students claimed that it was hard to communicate with Japanese due to different accent. The accent of English between HK and Japanese are different. HK students may have problem of Chinglish, while the Japanese may pronounce English with Gojūon. Group interviews indicate that the students are hard to communicate with using full sentence and they can only communicate with using some simple English words with a body language. Some HK students may also try to mix English and Japanese for communication if they know some Japanese words.

The language barriers also cause some daily inconveniences. For instance, a HK student wanted to go to toilet and asked the Japanese for assistance. However, the Japanese seems not understanding the question. HK students also found that they were difficult to read directions, menus, etc, in Japanese.

Moreover, students also reported that Japanese students were not willing to speak English in front of class. During their daily conversation, Japanese students usually spent a long period of time to think a word and speak it very carefully. This may be because the Japanese were afraid of making mistakes. HK students reported that

"In the journey, I met a lot Japanese students, they are shy to speak English to overseas student"

Cultural difference

After a group discussion with the HK students, the cultural barriers between HK and the visited country are shown in Table 1.

Table 1: Culture barriers for exchange programmes in Japan and UK

	Japan	UK
Diet	1.HK students think it is strange for Japanese to eat rice in breakfast 2. HK students do not expect Japanese to eat so much in breakfast but few in dinner	1. Students in HK are not satisfied the British diet
Tran-sport-ation	1.No transportation nearby the host institution after 10pm.	1. No transportation nearby the host institution after 10pm.
Shops/ super-market s		1. Most of shops/ supermarkets are closed after 7pm.
Other cultural differ-ences	1. Japanese need to take off their shoes and wear slippers when entering rooms 2. Japanese student is very punctual and polite 3. Little rubbish bin are in the streets and HK students thought these were very inconvenient 4. HK students do not know how to differentiate with the type of recycling bins for the garbage sorting system in Japan	

Cultural difference on food issues

As shown in Table 1, the British food is one of the major concerns for HK students. It was found that Hong Kong students were not satisfied with the UK food. They disliked eating fried food every day in their tour. One student complained that:

"Food is not as diverse as that in Hong Kong, and not very healthy, many burgers, deep fired fish. In the UK, I do not like to eat."

On the other hand, for the Japan exchange programme, most of students enjoyed the Japanese food. It is because Japanese food is very popular in Hong Kong. Students liked eating dishes, e.g. sushi, tempura and ramen. However, some HK students were still unaccustomed to some Japanese diet culture. For instance, they think it was strange for Japanese to eat rice in their breakfast. Furthermore, they also did not expect Japanese to eat so much in breakfast but only few in dinner.

Moreover, the flavours between Hong Kong and Japanese students are different. For instance, HK students felt salty for soup of ramen in Japan. Another example is that Japanese liked adding Nattō in rice, which was unacceptable by most of Hong Kong students. Hong Kong students commented Japanese food as follows:

- "People in Japan like to eat tamagoyaki and Miso soup for breakfast. For my first time that try to eat Nattō, it looks like a lot of beans and honey. I do not like it."
- "I though the (Japanese) breakfast was not as good as I imagined."

No transportation or shops at night

For exchange programme in UK, students commented that it was very inconvenient as most of the supermarkets in UK were closed after 7pm. Furthermore, no public transportations were provided after 10 pm in the area where the hosting institutions of UK or Japan were located. Most HK students think that these were very inconvenient for them to travel around, while they expected that most shops and public transportation are open until the mid-night so that they can go shopping or go around at night.

Other culture difference in Japan

For those students travelling to Japan, they made other comments on cultural difference between Japan and HK. They reported that cultural differences made it difficult to understand the culture of Japan as they said that the Japan culture was very different from HK. For example, Japanese is very polite and punctual. In addition, Japanese need to take off their shoes and wear slippers when entering rooms. These may lead to a cultural barrier, which may hinder the students to form an interpersonal relationship between them.

Furthermore, students also reported that only few rubbish bins were found in streets and they thought this was also very inconvenient for them. Furthermore, they also commented that they did not know how to differentiate the recycling bins for the garbage sorting system in Japan because they did not know the rules and not being able to read owing to language barriers.

Recommendations

Despite a huge language and cultural barriers to be identified in the study, several measures can be taken to overcome the barriers:

Pre-trip programs

Pre-trip programs should be provided to students before the exchange programme and this programme should include introduction on society and culture of the visited country, health and safety issues and intensive language training. Furthermore, some students who previously joined the exchange programme can be recruited to assist the pre-trip programs. These students may also serve for the language tutors and help recruit students to participate the exchange programme. These programs may enhance the student's language ability and the knowledge of the culture and society of the visited country.

Need for translators in Japan exchange programme

For the Japan exchange programme, more planning should be considered on the language issues in the exchange programme. There may be a need to have a translator in the exchange programme in order to break the language barriers between the students.

Group arrangement for UK & Japan exchange programmes

Small groups with about 3 HK students and 1 foreign student should be formed. With a small group, the students can have more chance to communicate and interact with each other. They can learn the language, their cultures and society between each other more easily.

Housing for student for UK & Japan exchange programmes

HK students were arranged to live in the campus dormitory during their exchange programmes. However, in order to give more chance for students to communicate and learn more about the social and cultural life of the visited country, a homestay in a foreign students' family would be more valuable. However, more arrangement and coordination should be done by the visited institution.

Communication after exchange programme

Cross-cultural education can be enhanced by the interaction between the students in both country. Once our students return to their home, they are encouraged to communicate with the foreign students with email/skype in order to keep a good relationship between them. HK students are also expected to share their knowledge and culture with their classmates through presentation in the class.

Conclusions

It is believed that the survey result and the group discussion can confirm the importance of the student exchange programmes in achieving the objectives of the programmes. The results also indicate that the cultural difference and language proficiency were the major hurdles for the exchange programme. Several measures are proposed, which are especially helpful in improving the future exchange programmes to overcome the barriers.

References

Altbach, P.G. & Knight, J., (2007). The Internationalization of Higher Education: Motivations and Realities. Journal of Studies in International Education, 11(3-4), 290-305.

Gillespie, S. (2003). Toward "genuine reciprocity," reconceptualizing international liberal education in the era of globalization. Liberal Education 89(1):6-15.

Kelly and Robert, (2004). Outcome Assessment of a Short-Term US Thailand Student Exchange Program. NACTA Journal, 48(4), 51-56

Sowa, P.A. (2002), How valuable are student exchange programs? New direction for Higher Education. 117:63-70

SURVEYS ON CAREER AND GLOBAL EDUCATION FOR PROGRAM TO DEVELOP LEGAL MIND

Kanaho MATSUDA*[a], Yuko MATSUO[b] and Sai SASAKI[b]

[a] National Institute of Technology (KOSEN), Tomakomai College / Department of Engineering for Innovation, Professor, Tomakomai, Japan
[b] National Institute of Technology (KOSEN), Tomakomai College / Department of Engineering for Innovation, Associate professor, Tomakomai, Japan

*matsuda@tomakomai-ct.ac.jp

Abstract

We aim to make a new cooperative program to develop global engineers based on the results of surveys on career and global education in Hong Kong and Singapore, which have been growing as global nations. Amid the ongoing globalization, English or global education among KOSENs has been changing effectively, and it has given KOSEN students some good results. However, we also think it necessary to give students more opportunities before they graduate from KOSEN to consider their future career and legal issues that might be a cause for concern at work. To organize such a program, we interviewed some teachers of an institute each in Hong Kong and Singapore about their curriculums and course projects for career and international exchange. We also conducted surveys of the remaining teachers of the two institutes on what conditions students should be aware of when they think of their career, what skills or knowledge, and how much of those, students need to acquire to adapt to globalization, and so on. In this paper, we will give the results and their analysis. One of the remarkable points was that some teachers regarded understanding of laws or social rules as important and chose the item "difference in laws or social rules" as a possible cause for concern when students work overseas. We are now planning to organize a program that features not only communication skills but also laws or social rules, so that students can develop a "legal mind," which means an ability to solve problems based on the knowledge of laws. We believe it will get more and more important for engineers to have a "legal mind" when they work overseas or with foreigners. The information we got from teachers in the two countries is very helpful and a good reference. We would like to improve our college's international exchange program based on such survey results.

Keywords: *Career education, Global education, Laws, Legal mind, Asian countries, Cooperative program*

Introduction

The National Institute of Technology, Tomakomai College (hereinafter called Tomakomai KOSEN), has conducted some overseas programs for students to develop the qualities of global engineers. One of them is the exchange program with an institute in Hong Kong (hereinafter called HK institute). During the program, students get a variety of opportunities to learn specialized subjects of technology in English and visit public facilities related to construction, environmental issues, and culture. We believe this has a positive effect on students' future career as engineers. However, amid the ongoing globalization, we should try to keep improving the program, so that students can respond to the globalizing world properly. What we have had our eyes on, as a new aspect of our global education, is to develop competence among students to manage legal issues. We think that students should consider their future career before graduation and learn more about legal issues that could be a cause for concern when they work overseas or with foreigners. Based on the assumption that having opportunities to learn legal issues would help students develop their careers as global engineers, we are planning to organize a new program between HK institute and Tomakomai KOSEN that focuses not only on communication skills and technological knowledge but also on understanding the difference in laws or social rules.

Before organizing such a program, we conducted surveys of teachers in HK institute and another institute in Singapore (hereinafter called SP institute) to understand the actual situation of career and global education in Asian countries that have been growing internationally.

In the following chapters, we will show the results of the surveys and try to find some tendency that would be a great help to our new program for career and global education.

Importance of Legal Mind

Hong Kong and Singapore, which have long been regarded as international logistics hubs in Asia, have grown since World War II with the aim of becoming Asia's financial capital. These two countries have lower tax rates (corporation tax, income tax, etc.) compared to Japan and have given permanent residency grants as well as a clearly defined work visa system for foreigners. Therefore, it is easy for companies to have business opportunities; however, at the same time, they have high competition rates.

In conducting business in these countries, where various races, religions, and languages come together, it is essential to be familiar with laws related to contracts and labor. Keeping in mind the fact that many KOSEN students will work internationally, particularly in such globalized Asian countries, we are trying to give our KOSEN students a program to develop a "legal mind" to solve problems based on knowledge of laws. A legal mind is one of the most important qualities that students should acquire before graduation.

Implementation of Surveys

We visited the institutes in Hong Kong and Singapore to explain the outline of our study and also had the time to exchange our and their curriculum and programs for career and global education with each other. We asked the representative teacher to give survey papers to the other teachers, and then collect and send them back to us. Table 1 shows the list of questions.

Table 1 Questions

Career Education	Q1.Which items do you think students should be aware of when they think of their future career? Q2. Do you mention or teach course content related to students' career? Q3. If you answered "Yes" to the above question, which items do you mention or teach?
Global Education	Q1. From the following items that help students adapt to globalization, how much of each do you think students need to acquire? Q2. From the following items, how much of each do you think have students acquired? Q3. From the following items, how much of each do you think your institute's curriculum covers? Q4. What do you think will cause trouble or difficulties for your students when they work overseas? (Choose 2 items)

The questions on career education were what conditions the teachers thought their students should be aware of and what they actually taught in their courses. In the questions on global education, we asked what competences the teachers thought their students needed to acquire and had acquired, and how many of those, the teachers thought, their institute's curriculum covered. The items we offered as options were taken from a report by the Ministry of Education, Culture, Sports, Science and Technology, which lists the competences required for global human resources. We also asked what the teachers thought would cause trouble or difficulties when students work overseas.

We got survey answers from 28 teachers of HK institute and 8 teachers of SP institute. Although it is true that the total number of teachers answering might not be enough to present accurate information, we discuss on the basis of the assumption that these answers should refer to some tendency in education in the two institutes.

Results and Discussion

The graphs of each figure below are shown by percentage. In the case of choice on a scale of 1 to 5, we rank items based on the total percentage of "5" and "4." If it is equal, the item that has more percentage of "3" is ranked higher. If that also is the same, the item that has more percentage of "5" is ranked higher.

(1) Career Education

On question 1, we asked the teachers to choose all the items they thought students should be aware of for their future career. The results are shown in Figure 1. The top three items chosen in HK institute were: 1. Life plan / Acquisition of qualification, 2. Business ethics, and 3. Salary. The top three items chosen in SP institute were: 1. Life plan, 2. Promotion / Place of work, and 3. Business ethics.

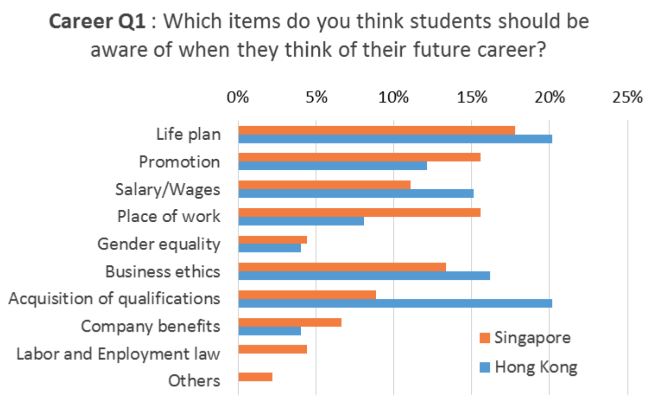


Figure 1 What students should be aware of

It is natural, in a sense, that they chose "Life plan," "Promotion," "Salary," and "Place of work" as important aspects of students' career, but it is interesting that "business ethics" is ranked high in both institutes. This might reflect the current world tendency that companies should conform to norms in a socially responsible way. As shown in Figure 2 on question 3, the teachers actually teach or mention "business ethics" in their courses at a relatively high rate. We can say that teachers would like their students to have a strong sense of business ethics for their future career, so that they will not be involved in business troubles or commit a business crime. We recognize giving students opportunities to learn business ethics under career education as important.

Figure 2 What teachers mention or teach in courses

From the survey results of career education above, we think we should put more emphasis on a sense of ethics, which is related to compliance of laws or social rules, as one of the course contents; it will help students avoid business troubles or crimes when they work overseas.

What is remarkable is that HK institute emphasizes on getting qualifications. It suggests that the acquisition of qualifications will directly lead to a successful career in Hong Kong. This tendency is interesting as the reflection of social background of Hong Kong.

(2) Global Education

Question 1 on global education asks what competences students need to acquire to respond to globalization. The results are shown in Figure 3, and Table 2 shows the rankings of each institute.

According to the results, it can be said that both have the need to acquire "Sense of responsibility" and "Cooperativeness" as well as "English proficiency" and "Communication skills." It shows that teachers think it important for students to have qualities and abilities to get along with other people without inconveniencing them. This tendency is also shown as the result that "understanding of other cultures" is ranked high in SP institute.

As for "the understanding of laws or social rules" that we assume as important, it seems that both institutes have a little higher need to acquire it. This item is also related to the ability to get along with other people because obeying laws or social rules should be mandatory, so as not to make trouble with other people. In this way, from the fact that the items associated with relationship with others are ranked high, we can say that both institutes think it necessary for students to be social to respond to globalization properly.

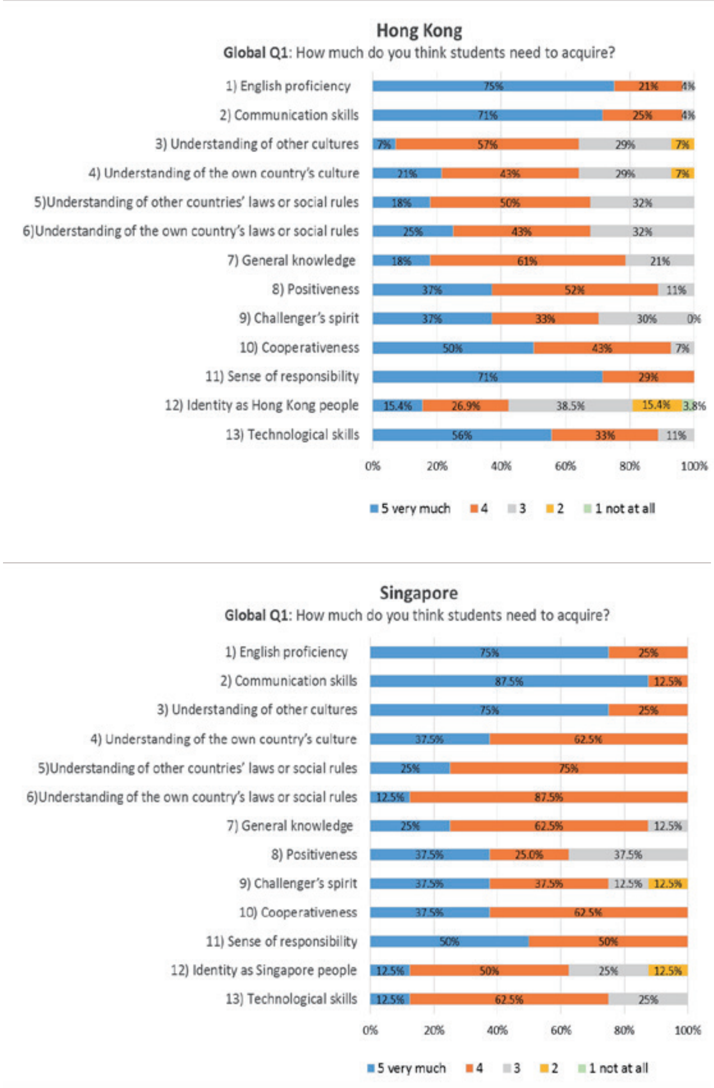


Figure 3 What students need to acquire

Table 2 Rankings of what students need to acquire

Hong Kong	
Ranking of Q.1 "students need to acquire"	
1	Sense of responsibility
2	English proficiency
3	Communication skills
4	Cooperativeness
5	Technological skills

Singapore	
Ranking of Q.1 " students need to acquire"	
1	Communication skills
2	English proficiency
2	Understanding of other cultures
4	Sense of responsibility
5	Understanding of the own country's culture
5	Cooperativeness

We compare the results of question 1 with those of question 2 that asks how much of those qualities and abilities have students already acquired. The results of question 2 are shown in Figure 4 and the rankings in Table 3, corresponded to the results of question 1.

According to Table 3, teachers of both institutes think that their students have sufficiently acquired the capabilities of "Sense of responsibility," "Cooperativeness," and "Communication skills." However, the teachers in HK institute think that their students' level of "English proficiency" is not good enough. As we know, English is one of the official languages of Hong Kong, and the Hong Kong people, especially the youngsters, can speak and use good English, but their level seems to be considered inadequate to adapt to the global society. On the other hand, the teachers in SP institute think that their students' "understanding of other cultures" is not good enough. The Singapore people might be more strongly aware of the importance of understanding other cultures because Singapore is a multicultural and multireligious country.

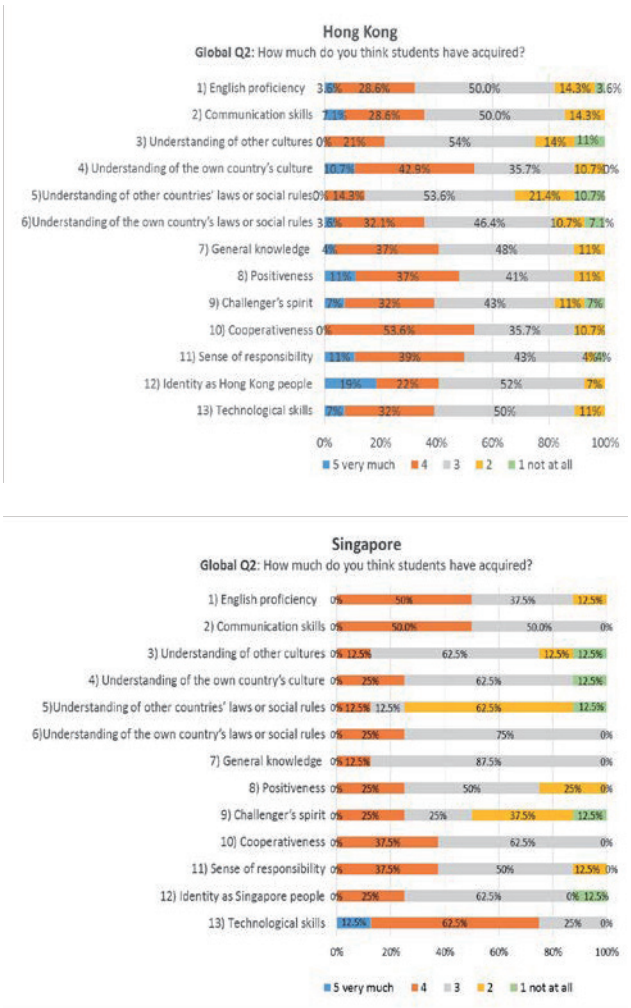


Figure 4 How much students have acquired

Table 3 Rankings of Q. 2 and 3

Hong Kong			
Ranking of Q.1 " students need to acquire"		Ranking place of Q.2 "students have acquired"	Ranking place of Q.3 "curriculum covers"
1	Sense of responsibility	3	6
2	English proficiency	11	2
3	Communication skills	9	5
4	Cooperativeness	2	3
5	Technological skills	7	1

Singapore			
Ranking of Q.1 "students need to acquire"		Ranking place of Q2 "students have acquired"	Ranking place of Q.3 "curriculum covers"
1	Communication skills	2	1
2	English proficiency	3	5
2	Understanding of other cultures	12	3
4	Sense of responsibility	5	8
5	Understanding of the own country's culture	7	6
5	Cooperativeness	4	4

Figure 5 shows the results of question 3 that asks how much of every item does each institute's curriculum cover. Table 3 shows the rankings of question 3 corresponded to those of questions 1 and 2. As seen in Table 3, almost all the capabilities that teachers think students need to acquire are covered enough in each institute. In short, HK institute's curriculum puts emphasis on "English proficiency" and SP institute's curriculum gives students good opportunities to "understand other cultures;" yet, students have not acquired these sufficiently.

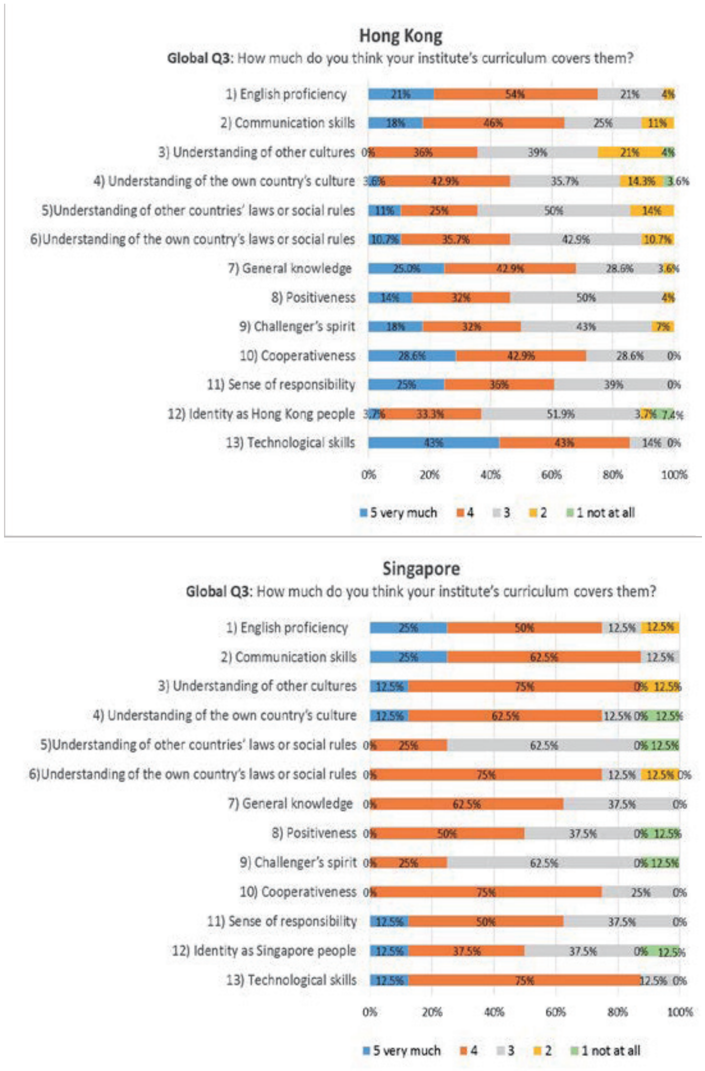


Figure 5 How much the curriculum covers

Lastly, we discuss the item "understanding of other countries' laws or social rules." Table 4 below shows the rankings of the item in questions 1, 2, and 3. As we can see from the result, the item appears to be insufficiently covered in both institutes. Furthermore, the teachers regard students' understanding of other countries' laws or social rules as the worst and recognize its necessity to some degree. In this situation, teaching how to develop a "legal mind" presents a possibility of bringing about positive change in both institutes. If students have some opportunities to learn and consider the different laws or social rules of different countries, it could help them improve their qualities to respond to globalization.

Table 4 Understanding of other countries' laws

"Understanding of other countries' laws or social rules"			
	Ranking of Q.1 "students need to acquire"	Ranking place of Q2 "students have acquired"	Ranking place of Q.3 "curriculum covers"
Hong Kong	10	13	12
Singapore	7	13	12

(3) Causes of trouble or difficulties

We also asked question 4—what will cause trouble or difficulties when students work overseas. The respondents chose two out of the seven items we gave. The results are shown in Figure 6 and the rankings in Table 5. As expected from what we have discussed above, teachers in HK institute chose "English proficiency" and those in SP institute chose "Difference between cultures" as the top item. Another point to pay attention to is that "Difference in laws or social rules" is fourth among the seven choices in HK institute and third in SP institute. It suggests a possibility that education on developing a "legal mind" could be an important point under global education.

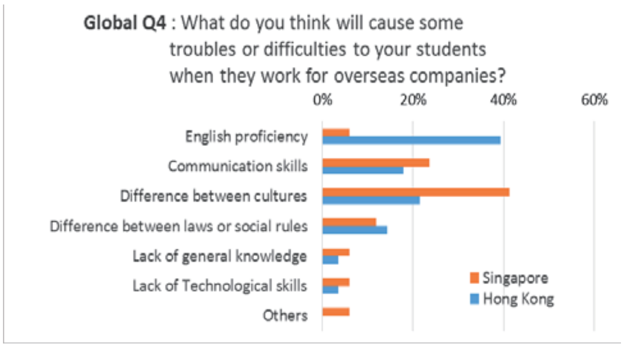


Figure 6 Causes of trouble or difficulties

Table 5 Rankings of Q. 4

Hong Kong	
Ranking of Q.4 "What will cause troubles"	
1	English proficiency
2	Difference between cultures
3	Communication skills

Singapore	
Ranking of Q.4 "What will cause troubles"	
1	Difference between cultures
2	Communication skills
3	Difference between laws or social rules

Conclusions

From the results and discussions in the above chapters, the following things became clear. First, teachers in both institutes think that their students need to have a stronger sense of "business ethics" for their future career. Second, teachers in HK institute think that the English proficiency of their students is not good enough, and teachers in SP institute think that their students' understanding of cultures is not good enough, while each curriculum covers them sufficiently. Third, understanding of other countries' laws or social rules is not covered in the curriculums of both institutes. Finally, being aware of the difference in laws or social rules can offer good help to students, so as not to cause trouble or difficulties when they work overseas.

Based on these results, we will organize a cooperative program with HK institute that includes a workshop for both Hong Kong students and Tomakomai KOSEN students to discuss some problems caused by the difference in laws or social rules and find a way to deal with the problems from the viewpoints of business ethics and legal mind. This will help students develop their ability to cope with foreigners, as global engineers. We would like to look at the effects of the workshop and reflect them in the improvement of our global education.

Acknowledgements

This work was supported by JSPS KAKENHI (Grant-in-Aid for Challenging Exploratory Research) Grant Number JP 18K18679.

References

Ed. by J. Erling, Elizabeth & Seargeant, Philip (2015). *English and Development : Policy, Pedagogy and Globalization* (Japanese translation by Koji MATSUBARA). Tokyo: Shumpusha Publishing Co., Ltd.

Kent E. Calder (2016). *SINGAPORE Smart city, Smart State* (Japanese translation by Kazuhiro HASEGAWA). Tokyo: Chuokoron-Shinsha, Inc

Labour Department of the Government of the Hong Kong Special Administrative Region.
A Concise Guide to the Employment Ordinance
https://www.labour.gov.hk/eng/public/ConciseGuide.htm

Ministry of Manpower of Singapore Government.
Employment practices
https://www.mom.gov.sg/employment-practices

Implementation of Global Mind Training Camp for KOSEN Students in Japan

M. Kobayashi[*,a], Y. Ichikawa[b], J. Park[c], M. Sekiguchi[d],
Y. Matsumoto[e] and T. Okawara[f]

National Institute of Technology, [a]Anan College, [b]Tokyo College, [c]Oshima College,
[d]Kisarazu College, [e]Toyota College, and [f]Kitakyushu College, Japan

*kobayashi@anan-nct.ac.jp

Abstract

This paper reports an implementation of the Global Mind Training Camp (GMC) for KOSEN (National Institute of Technology) students, which was a collaborative project between Toyohashi University of Technology (TUT) and KOSEN planned by KOSEN teachers who have completed the Global Faculty Development program (GFD). The GFD was conducted among three institutes, TUT, Nagaoka University of Technology, and KOSEN, from 2014 to 2017, and 26 KOSEN teachers have participated in the program. The purposes of the GFD were to improve their English skills for teaching special subjects in English. As one of the follow-up projects of the GFD, the GMC was incubated.

The GMC has been held annually since 2017 in TUT. In 2017 and 2018, 19 and 7 KOSEN students participated in the GMC, respectively. The GMC became a 5-day program and the one of the topics of the open campus programs in TUT in 2018. The slogan of GMC is "Know Yourself and Know the World". In the GMC, we focused on cultivating open-mindedness of students to other cultures.

The contents of the GMC consist of an Ice-breaking activity of building tall towers with a piece of paper, creating a vision map, conversation with students in TUT, a campus tour in TUT, a lecture about how to make an effective presentation in English provided by native English teachers, and the wrap-up speech.

In the survey conducted after the GMC in 2017, the session of the conversation with TUT students who have an experience of studying abroad was the best evaluated session, whereas, in the survey in 2018, the wrap-up speech, the activities of building a tall tower, and creating a vision map were well evaluated by the students. The reason of the different results between two years was that most of the students participated in GMC in 2017 have not been abroad before the GMC, whereas those who participated in the GMC in 2018 have sufficiently experienced abroad. Actually, three of the seven students joined GMC in 2018 were foreign students. The GMC is going to be held in 2019 as well.

Keywords: *Global Mind Training Camp, TUT, KOSEN, Global FD, collaborative project*

Introduction

The Global Mind Training Camp (GMC) [1] is a collaborative project between Toyohashi University of Technology (TUT) and KOSEN incubated by KOSEN teachers who have completed the Global Faculty Development Program (GFD) [2]. The GFD has been conducted among three institutes, TUT, Nagaoka University of Technology, and KOSEN, from 2014 to 2017, and 26 KOSEN teachers have participated in the program. The purpose of the GFD was to train KOSEN teachers to be able to conduct their lectures in English because KOSEN has recently put importance on education of students who can be globally active in their special fields after they graduate from the college. Also, the GMC is the one of the follow-up project of the GFD. The GMC is focusing on training KOSEN students who have few international experiences to make their mind expanded and acceptable for other cultures. The first GMC was held in three days during September 11 to 13 in 2017, and 19 KOSEN students joined. In the second GMC, which was held in five days from September 3 to 7 in 2018, seven students were participated in the program. In this paper, the details of the GMC are introduced, and the results of the survey for the KOSEN students after each GMC program are reported.

About the Aim of GMC

The motivation of planning the GMC was to build a follow-up project of GFD after the program. Even though there were some GFD participants who developed a collaborative research with faculties in Queens College in NY, or TUT in Japan, where the GFD program was placed, there was no project which trains KOSEN students by making good use of the network among the GFD members and the relationship between the institutes, KOSEN and TUT. Hence, we proposed the GMC program to educate KOSEN students based on the experiences which the teachers obtained through the GFD program, and to develop the GMC as the collaborative and sharing project between KOSEN and TUT.

Even though the most of the sessions in the GMC are given in English, the purpose of the GMC is not to improve English skills of the students. Of course, it is important for the students to improve their English skills to become a professional engineer who can actively work on a global scale. However, we believe that the most important things needed for such engineers are the communication ability and the mentality that leads them to accept different cultures and to be tolerant to diversity. We defined the theme of the GMC as “Know yourself and know the world”, and make students recognize the importance of understanding own culture and that there are multiple ways to think of things which are different from how they think. Also, expressing own opinion in a discussion and taking actions positively in a practical situation are important in terms of a global-minded engineer.

In the GMC program, we focused on three abilities of students that we need to enrich as follows:

1. Ability to use English as a communication tool
2. Ability to discover and generate new ideas derived from the differences between opinions of themselves and others.
3. Ability to accept diversity and perceive the things in multiple perspectives.

As for the final destinations where students should reach after the GMC, we set five things as follows:

1. Having own opinion to given topics
2. Expressing own opinion to others in English
3. Understanding different opinions from the other point of view
4. Generating new ideas through the communication using English
5. Actively joining teams with multiple perspectives

To achieve those objectives, it might be better and faster to take students abroad and make them experience in the international environments than making them join the domestic training camp. Furthermore, there have been many scholarship programs to encourage students to study abroad lately in Japan. However, that is true that only a handful of students can apply to such scholarship programs and expand their own perspectives by themselves. Actually, there are a lot of Japanese students who can not take a step forward to experience abroad even though they are interested in studying abroad. For this reason, we believe that GMC could be a good opportunity for such students, and give them a trigger to expand their world.

Another benefit of students to join the GMC program is that students can deeply know about TUT. TUT is the university established for the graduated students from KOSEN, and about 70% of all students in TUT are from KOSEN. The GMC program is held in the classrooms in TUT and includes a lab tour and the sessions of the conversation with domestic and international students in TUT. For the students who want to enter the university after their graduation from KOSEN, joining the GMC program is a great opportunity to know how the TUT is in advance.

Detailed program description of GMC

Figure 1 shows the schedule of the GMC program in 2018. The first-half sessions in the schedule were facilitated mainly by KOSEN teachers who were joined in the GFD. The last-half was given by teachers in TUT. In 2018, the GMC was held for five days whereas it was for three days in 2017. In 2017 and 2018, we had 19 and 7 students from 7 and 4 KOSEN campuses, respectively. The reason of the decline in the number of the participants in 2018 is that the GMC was incorporated as

TUT Global Mind Camp 2018 Program Schedule

	Day1 (3rd Sep)	Day2 (4th Sep)	Day3 (5th Sep)	Day4 (6th Sep)	Day5 (7th Sep)
9:00	Orientation	Session 2: Effective English Studying -- How did you learn English?	Session 5-2: Know yourself and find out your future goal	Session 9-1: Presentation by international students and discussion	Session 10: Wrap up speech & presentation
10:40		Session 3: How do we conduct effective interview and presentation	Session 6: Introduction to TUT study abroad program		
12:10	Lunch Break	Lunch Break	Lunch Break	Lunch Break	Farewell BBQ
13:00	Opening Session				
13:40	Session 1: Paper Tower Building	Session 4: Pro-con (Discussion)	Session 7: Presentation by TUT students who have studied abroad	Session 9-2: Lab tour& Meeting with TUT English Advisor (15:30-16:00)	***Venue*** *Session 1-6, Presentation preparation:* ***IGNITE 105*** *Session 9-1&10:* ***Library 1F***
14:40		Session 5-1: Know yourself and find out your future goal	Session 8: Talk session : Learn from international students		
15:40	Campus tour	Presentation preparation	Presentation preparation	Presentation preparation	
17:00	Welcome Party				

Fig.1 Schedule of GMC in 2018

one of the programs of the open campus event in TUT from 2018. Actually, we had only one student who wanted to join GMC in 2019. The problem is that the announcement of the GMC could not reach to the potential participants appropriately. To solve this problem next year, the GMC will be separated from the open campus event in TUT.

Figures 2-7 show the actives implemented in the GMC. As an ice-breaking activity, we adopted a paper tower building as shown in Fig. 2. Students were separated into groups and one or two international students in TUT joined in each group. We prepared a piece of A3 size paper and seven pieces of adhesive tape cut into 10 cm each to each group, and students competed to build a high paper tower by using them. During the activity, students communicated with the members in the group, and cooperated to build a building.

Figure 3 shows the fabrication of a vision map. To recognize their own ambitious and desired future, we let them create their vision map by their impression. In advance, students prepared their preferable photos and pictures cut from books, magazines, the Internet sites and so on. Students pasted them on a pasteboard following their intuition. After completing creation of a vision map, they had a presentation in English about their ambitious and dreams with showing the vision map.

Figure 4 shows the presentation of a Japanese student in TUT who has experienced the internship abroad. The participants were interested in the presentation because they are close to the presenters in age, and they could know the detail about the international internship program in TUT.

Figure 5 shows the conversation session of the GMC. We invited some international students in TUT to the GMC and had them talk with the participants of GMC. Before the GMC started, we asked the participants to prepare to be able to introduce themselves in English. In the conversation session, the partners changed every 10 minutes so that the participants could repeatedly practice the self-introduction.

The last day of the GMC, the participants made their final presentation in English. During the GMC, the participants have spared about one hour for the preparation of the final presentation each day. In the presentation, an English teacher in TUT gave them some advise to improve their presentation.

Besides those activities, the KOSEN students studied how to make an effective interview and a presentation in English, and important things to be a global-minded engineer in the future.

Results of survey

After the GMC held in 2017 and 2018, we conducted surveys for each participant. In 2017, we asked the participants based on multiple options of good, understandable, and useful about each session. Figure 6 shows the result of the survey. The most evaluated session was the conversation session with the TUT students who experienced studying abroad. The participants of the GMC in 2017 were matched to those we targeted, and we believe that the KOSEN students

Fig. 2 Paper tower building.

Fig. 3 Making vision map.

Fig. 4 Presentation of TUT students.

Fig. 5 Conversation with international students in TUT

must have expanded their perspectives through the conversation with experienced students in TUT. Aside from whether the sessions were useful or not for students, basically they were satisfied with the GMC program in 2017.

In 2018, we surveyed the three most interesting sessions in all sessions for each student. Figure 7 shows the result of the survey in 2018. The participants in 2018 includes two international students from Malaysia, and English ability of other students was also very high. Therefor, we set the English level of the sessions and lectures in 2018 to be higher than 2017. We got the answer from 5 of 7 students, and all of them answered that the final presentation was the most impressive one. Then, the session of the paper tower building and the fabrication of the vision map was the next most evaluated. From the results of the questionnaire asking what kind of activities the participants wanted to do, we found that students preferred to group work than lecture style leaning, and they wanted to have more opportunities to speak and use English. When we planned the schedule of the GMC in 2018, we tried to include many active learning style sessions, but eventually the GMC in 2018 contained many presentations by students and international students in TUT. In those sessions, we set to spare long time for the discussion among KOSEN students to give them the opportunities to use English, but they did not actively discuss together. As our future tasks, we need to think of the way that students can prepare for the discussion in advance and actively join it. In addition, it is also important to make the good atmosphere for students to feel comfortable to express their opinion in English.

Conclusions

In this paper, we reported the GMC program which has held since 2017. In 2017 and 2018, 19 and 7 KOSEN students participated in the GMC, respectively. The purpose of the GMC is not to teach English to the students but to develop the international-mindedness of students to become an active engineer who can work on the global stages in the future. After the GMC, we made surveys to evaluate each session in the program. The results showed each participant was satisfied by the GMC program. As for our future tasks, we need to develop an evaluation scale to measure the international mindedness of students to analyze the effectiveness of the GMC and to improve the sessions in the program. Also, we have to revise the notification procedure of the GMC from the administrative office of TUT because the GMC was included one of the programs of the open campus event of TUT from 2018, and the information of the GMC became difficult to reach to potential participants in KOSEN. Consequently, the number of the participants reduced. To improve this point, the GMC should be separated from the open campus events, and the procedure of the notification of the GMC to KOSEN students should be revised.

Activities	Good	Undestandable	Useful
Paper tower building	16	7	2
Know yourself and find out your future goal	14	8	7
Learn from experiences in abroad	12	8	12
Break with game	18	5	2
Effective English Study	11	7	13
Let's write CV	9	11	10
How to make reactions and express your opinions	14	7	8
Campus tour	11	6	8
3min. Speech	11	8	9

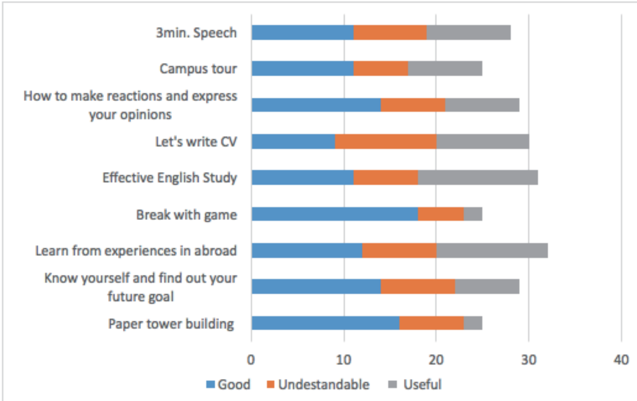


Fig. 6 Result of survey for 19 students in 2017

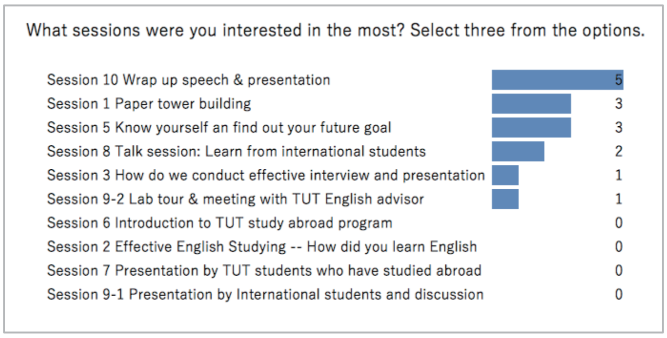


Fig. 7 Result of survey for 7 students in 2018

Acknowledgements

I would like to thank Prof. Hiroyuki Daimon who enormously supported us during the GMC. I would also like to thank Prof. Akihiro Wakahara, Prof. Eugene Ryan, Prof. Levin David Michael, Mr. Hirotsugu Kamahara, Ms. Yasuko Suzuki, Ms. Shino Okazaki, Ms. Hiromi Saigo, the students in Daimon Lab. and the International students in TUT who helped us very much in the GMC.

References

[1] Hitoshi, Y. et al. (2019), “Eigo de okonau jyugyou kaizen guide book [The guide book for improvement of lectures in English]”, *Koyo Honsha*, 160-170.

[2] Toyohashi University of Technology, “Faculty Development Program”, http://ignite.tut.ac.jp/cie/english/activities/fd.html

ENHANCED ENGLISH COMPETENCY OF TEACHERS USING GLOBAL APPROACH FOR MARITIME COLLEGES IN JAPAN

Jongdoc Park [*,a] and Osami Yanagisawa [b]

[a] Shipping Technology Department, National Institute of Technology (KOSEN), Oshima College, Yamaguchi, Japan

[b] Maritime Technology Department, National Institute of Technology (KOSEN), Yuge College, Yamaguchi, Japan

* park@oshima-k.ac.jp

Abstract

Five Maritime Departments under the National Institute of Technology (KOSEN Colleges) have been working together to improve the ability of Japanese students and instructors to use Maritime English efficiently. Toyama, Toba, Hiroshima, Yuge and Oshima Colleges are aiming in improving English quality in line with maritime services to provide more flexibility on varying circumstances. Since 2015, the English study and training program has been performed at NYK (Nippon Yusen Kabushiki Kaisha) - TDG (Transnational Diversified Group) Maritime Academy (NTMA) in the Philippines and has been referred to as the "NYK project". We decided to join the project with Japanese students and instructors. Aside from the students' English training, Japanese instructors were given several chances to give lectures to Filipino students and it was successful. For the second step, one of the KOSEN Colleges, Oshima College decided to send a representative to Singapore Maritime Academy (SMA) that is a partner school in Singapore, based on the faculty exchange program. The faculty was requested to conduct the technical educational program in English based on STCW (*Standards of Training, Certification and Watchkeeping for seafarers*). A survey questionnaire was conducted when the program was over amongst the Singaporean students, and analyzed about the invited foreign instructor depending on each year and course. The results reflect how we should prepare course information and understandable topics as well as teaching skills by using the active learning style. This paper reviews how the English teaching experience worked for Japanese instructors at Philippines, Singapore, Malaysia and Korea where we had a privilege to teach.

Keywords: *Maritime English, Maritime Department, STCW, KOSEN Colleges*

Introduction

Maritime officers are specialists handling ship navigation and maritime engineering. As for international maritime officers, a deep knowledge of theory, operating skill and maintenance for the ship is a very important requirement for them. Aside from that, they should speak English for internal or external communication between ship to ship or ship to shore. Actually, in practice, almost of all seafarers have different nationalities.

All Japanese teaching staffs focus on how to teach maritime English effectively. All training in maritime technology departments like the course 'Boat Handling, Experiments and Practice' and Onboard Training are conducted in the Japanese language, but actually they should speak English for internal communication on merchant ships in the future. There is no doubt about that.

The maritime technology departments in the five National Institute of Technology (NIT) colleges which means KOSEN Colleges in Japan have been working together to enhance the motivation and ability of the students to be international maritime officers and ship managers at sea [1]-[6]. We decided to bring the Japanese students to NTMA in the Philippines for short-term English training. The purpose is to experience the importance of English by living with Filipino students of the same age who are strongly aiming to be seafarers. NTMA promotes the standards in maritime education based on a variety of teaching methods delivered by highly qualified faculty members. We, Japanese instructors were given several chances to give lectures to Filipino students who are involved in maritime technology. It is very important for Japanese teachers who are non-native English speakers to practice teaching maritime technical subjects in English. It must be connected with students' motivation for English studying. This paper reviews how the English training and teaching experience worked for Japanese students and instructors at NTMA.

For the second step, one of the NIT colleges, Oshima College decided to send a faculty to Singapore Maritime Academy (SMA) of a partner school in Singapore based on the faculty exchange program. The faculty was requested to conduct the technical educational program in English based on STCW (*Standards of Training, Certification and Watchkeeping for seafarers*). A survey questionnaire was conducted when the program was over amongst the Singaporean students, and analyzed about the invited foreign instructor depending on each year and course. The results reflect how we should prepare course information and understandable topics as well as teaching skills by using the active learning style.

This study will measure on how the teachers could enhance their English competency using a global approach on Maritime schools in Japan. It is based on their experiences of teaching with the use of English as a medium in teaching. Teachers are going to teach technical subjects in foreign countries such as Philippines, Singapore, Malaysia and Korea in which English language will be the required language. It will help to measure how can a teacher manifest teaching effectively with the use of English language effectively.

Photo 1: Lecturing view at NTMA

Results and Discussion

Teaching experiences at NTMA

NYK-TDG Maritime Academy (NTMA) in the Philippines promotes standards in maritime education through a competency-based and maritime industry-driven curriculum that employs a variety of teaching methods delivered by highly qualified faculty members.

During the first half of the stay, the Japanese instructors had a chance to be a school inspector sitting in the classes, and Japanese students acted as temporary participants. Photo 1 shows the lecturing view at NTMA. A non-native English speaker, NIT instructor gave lectures in maritime technical subject such as Marine Auxiliary Machinery engineering in English at regular classes. Also a NIT instructor gave a presentation of Japanese culture and geography in English for all NTMA students. They listened intently to the class discussion, and there was an exchange of ideas. They raised questions and participated in the class discussion.

At NTMA, the classes were conducted in various ways, such as students' discussion, presentation and exercises with the instructor. During most of the classes, the instructors give their lectures using visual methods such as Powerpoint, Video, etc. to raise the students' understanding on the subject matter.

How to teach in English on technical subjects

We have accepted the model of Robert M. Gagne [7] for planning the instruction to enhance English competency of teachers. Table 1 shows the Nine Steps of Instruction Sheet presented by him. The procedure is as follows:

First, write the lesson plan in this sheet in detail. At the same time, be prepared to create an opportunity to draw out questions from the students' side, and to include an active learning method at a suitable time. During the lesson, keep the sheet handy and check the flow of lesson. After the lesson, check the time allocation and the inputs of learning, and reflect it on the next planning sheet.

Table 1: Nine steps of instruction presented by Robert M. Gagne

1	Gain attention
2	Tell the learners the learning objective
3	Stimulate recall of prior learning
4	Present the stimulus
5	Provide learning guidance
6	Elicit performance
7	Provide feedback
8	Assess performance
9	Enhance retention and transfer to other contexts

Questionnaire to the Filipino students on how they evaluate the invited lecturer from NIT

The question lists are as follows:

Q1. Is the lecturer's teaching well-organized?
Q2. Are you interested in the topics of the lecturer?
Q3. Have you understood the content of lecture?
Q4. Are you completely satisfied with the lecture?
Q5. Is the lecturer's English effective?
Q6. Is the lecturer's attitude (gesture, posture, and eye contact) effective?

For the feedback on the lecture at NTMA, we asked the Filipino students to select one number from a scale of one to five (see below) for each question:

1 = very disagreeable
2 = disagreeable
3 = neither disagreeable nor agreeable
4 = agreeable
5 = very agreeable.

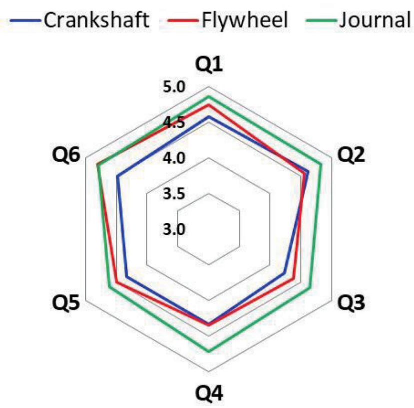


Figure 1: Average values to each question at NTMA

Figure 1 shows the average values for each question. A NIT instructor gave lectures three times for each of classes in Crankshaft, Flywheel, and Journal. They were all 3rd year students and 81 students in total. The class Journal got the highest score while the Flywheel got the middle score, and the Crankshaft got the lowest score. This means that the NIT instructor (lecturer) had become used to teaching in English in the classes. The lowest score shows in the Q3 as shown in the figure. That is why the students do not completely understand the content of lecture. Overall, they gave high values to the invited lecturer.

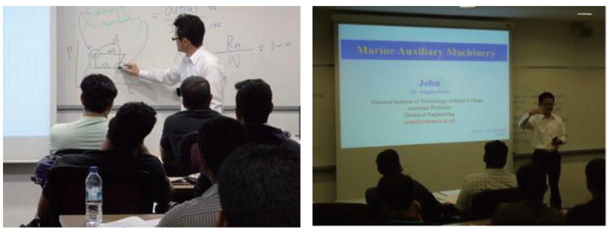


Photo 2: Lecturing view at SMA

English proficiency using a global approach in SMA

For the second step, one of the NIT colleges, Oshima College decided to send a representative to Singapore Maritime Academy (SMA) of a partner school in Singapore based on the faculty exchange program (see Photo 2). The faculty was requested to conduct the technical educational program in English based on STCW (*Standards of Training, Certification and Watchkeeping for seafarers*). He was also a non-native English speaker like the other Japanese teachers, so English was the only means of communication in the class. The students were able to identify the maritime technical professional words used in every subject, and to determine the meaning of the maritime terminology and their functions in the classes. For speaking comprehension, students were assigned to do a group activity where they have to make a plan on what to do.

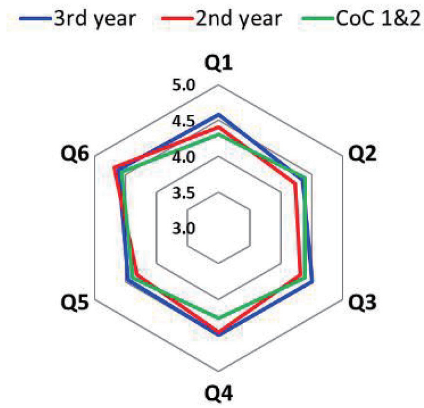


Figure 2: Average values to each question for the invited lecturer at SMA

They had to speak in English and use some maritime terms correctly while doing the task.

Questionnaire for the invited lecturer from NIT at SMA

We conducted a survey questionnaire in the classes on how the Singaporean students evaluate the NIT lecturer. It is the same survey that we did in the Philippines. As shown in Figure 2, you can see a hexagon chart. Each year level is represented by the color blue of 3rd year, red of 2nd year, and green of CoC1&2 classes. Q1 to Q6 means questions 1-6. Inside of it is the score from 0 to 5. As you can see in the figure, the overall results of the survey from the students in all levels show that they are satisfied based on their learnings. In this figure, the overall result of Q1, shows that the 3rd year students from Singapore agreed that the lesson conducted was well-organized. On the other hand, Q2 shows that CoC 1&2 was interested with the given lecture at the same time. Q3 shows that 3rd year students have the highest result in which they agreed that the lesson was understandable. This means that during the lesson, the usage of the global approach in English as a medium in the classroom was effective. As for the given result, in Q5 displayed that all levels agreed on the effectivity of the lecturer's English competency as well as the lecturer's gesture that is given on Q6. During the lesson the students able to ask questions and participated well with activity.

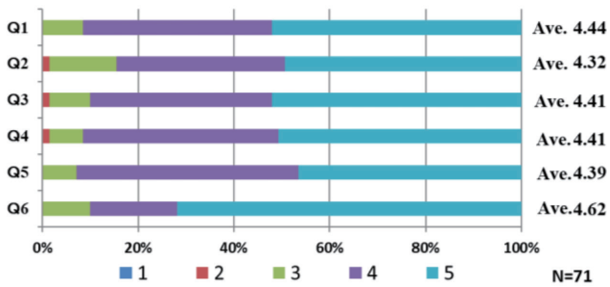


Figure 3: The results from all students at SMA

Figure 3 shows the average values for each question to the different way. For example, as for the Q1 (Is the lecturer's teaching well-organized?), the color of yellow green which indicates number 3 shares about 10%, the purple which indicates number 4 shares about 40%, and the sky blue indicating number 5 shares about 50% of 71 students in total. As a result, it is a fairly high score and a good indicator that NIT did well in the lecture. The Singaporean students generally gave high values on number 4 or 5 (means agreeable or very agreeable for the questions) of 90% in total number. The several students agreed on giving a lower score for Question 2 to 4 (means slightly not interested in the topics of the lecture). Q6 shows the highest value, 4.62. This means that the students do agree or very much agree with that the lecture's attitude such as gesture, posture, and eye contact. The lecturer's teaching skills were effective in the class. We learned a lot from the results as to how we should prepare the interesting and understandable topics as well as teaching skills by using active learning.

An international approach to improving the English proficiency

Figure 4 shows the total result which I have gathered since 2015 from the four countries [8]-[12]. The red color represents the Philippines and it obtained the highest score. Results in Q3 got the lowest score in Korea and Malaysia as compared to the Philippines and Singapore. Which means that the majority of the students didn't or has difficulty in understanding the given content of the lecture. On the other hand, Q6 in Korea got the highest score in which it corresponds to the teacher's gesture, posture and eye contact. This means, that during the lecture, the majority of the students were focusing on the lecturer's movement and not entirely on the given output of the lecture. They show different results depending on the countries. The students from the Philippines and Singapore like the lecture that we had. This will measure the effectiveness of the teacher's expertise based on their experiences of teaching English language.

Figure 5 shows what kinds of teaching methods are effective in the class. Students think the use of video is

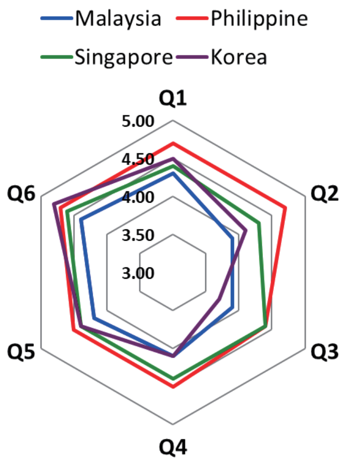


Figure 4: Average values to each question in the four countries

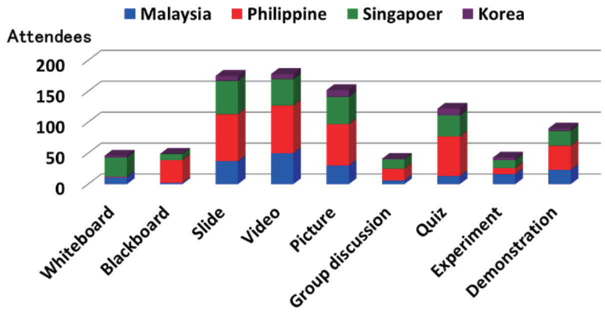


Figure 5: Effective teaching methods in the four countries

one of the most effective tools in teaching. They prefer a prepared visual presentation such as Slide, Video and Picture. The trend of preference of students on digital material or media is an indicator of people's fondness for social media. They also want some games or ice breaker to be incorporated in the lesson. That's why the quiz category ranked number 4. The demonstration is also chosen by the student because this activity involves people moving about and doing something in practice. Teachers don't have to use the same teaching methods all the time. For the purpose of variation, the teacher has to use different teaching methods so that students won't get bored in the class.

Conclusions

Through the International Maritime English Education in the classes, teachers could improve the management and teaching skills of professional subjects in English, and also students could learn professional Maritime English. The instructor had gained Maritime English Education experience in the countries where non-native English speakers are, so we were able to obtain mutual effects. The questionnaires for the training were reported to prove their comprehension about Maritime English [8]-[12].

However, the motivation to learn English passively cannot last a long time, and it disappears as time goes by. Only the learner's inner desire to improve is stimulated strongly, and this could be the real source of learning English. At the same time, teachers should, without doubt, meditate on the course information to fit students' needs.

Japanese people are not English native speakers and the medium of instruction in schools is not English. Exposure is important because it is one of the effective ways of applying and using the English language. Learning is an active process and is activated by the learners. The learners are the center or the key players in the teaching-learning process. All the activities or learning experiences should be Active Learning style to assist in teaching such as applying charts or tables, using videos, websites or computer simulators, and collaborative learning or peer tutoring etc. Consequently, Japanese students will gain the desire to learn English if they are willing to join the International Exchange

Activities and Internship programs that are now offered by each Japanese maritime college.

References

[1] Kanki Iwasaki. (2013). "Development of human resources training system with corporation between college and industry in maritime area - Overview of Maritime human resources developing project". *Proceedings of Education forum for all colleges in Japan*. AP4 3 1.

[2] Kyouko Ikeda and et al., (2013), *Surfing English - **Maritime college series***, 1st edition, Kaibunndou Publishing Co..

[3] Makoto Endou, (2013), "An approach to study method easy to understand and to fix in maritime department - all maritime college study method improvement project", *Proceedings of Education forum for all colleges in Japan*, AP4 3 2.

[4] C, Chirea Ungureanu. (2014), "Intercultural education, a response to contemporary multilingual societies and a new challenge for Maritime Education and Training (MET) Institutions", Procedia, 116, 4260–4263.

[5] Ahmad Fauzia, Patta Bundua, and Suradi Tahmira, (2016), "The Development of Maritime English Learning Model Using Authentic Assessment Based Bridge Simulator in Merchant Marine Polytechnic, Makassar", *International Journal of Environmental & Science Education*, 11, 10, 3231-3240.

[6] Ding Zi-hua, (2015), "The Existing Situation and Training about Maritime English Teachers in China", Journal of Shipping and Ocean Engineering 5, 266-270.

[7] Robert M. Gagne, Leslie J. Briggs and Walter W. Wager, (1992), "Principles of Instructional Design", Fourth Edition.

[8] Jongdoc Park and et al., (2016), "Educational Program for Maritime English with MAAP instructors adopted in Five NIT Maritime Colleges of Japan", International Symposium on Marine Engineering and Technology (ISMT) 2016, Busan Korea.

[9] Jongdoc Park and et al., (2017), "International Maritime Education and Training in Collaboration with Philippines Maritime Academy", Proceedings of the International Symposium on Marine Engineering (ISME), Tokyo, Japan, D20-201, pp 507-510.

[10] Jongdoc Park and et al., (2018), "The Practice of International Maritime English Education in the Classes", The 12th International Symposium on Advances in Technology Education (ISATE2018), IVE (Tsing Yi) Campus, Hong Kong, pp 1-6.

[11] Jongdoc Park and et al., (2018), "International Maritime English Education in the Classes Implemented by Japanese and Taiwanese Instructors", 30th International Maritime English Conference (IMEC30), Manila, Philippine, pp 1-13.

[12] Osami Yanagisawa and et al., (2018), "Implementation of an International Maritime English Educational program at Maritime Technology departments in five NIT in Japan", 30th International Maritime English Conference (IMEC30), Manila, Philippine, pp 1-13.

AUTHENTIC LEARNING FOR CYBER SECURITY: AN INDUSTRY PRACTICE PARTNERSHIP

James Tham[a], Mapel Yap[b]

[a] Republic Polytechnic, School of Infocomm, Programme Chair, Singapore
[b] Republic Polytechnic, School of Infocomm, Assistant Programme Chair, Singapore

*james_tham@rp.edu.sg, mapel_yap@rp.edu.sg

Abstract

Learning-by-doing is generally considered the most effective way to learn. This paper describes how learning-by-doing through the use of authentic use-cases is achieved at Republic Polytehnic through joint collaborations with industry partners. This paper describes one such collaboration in the area of cyber security incident response for students from a Infocomm Security Management programme. The role of industry in this programme and the use of technology-assisted authentic learning use cases are key features that will be elaborated in the paper. This paper will also highlight Singapore's Cybersecurity Strategy and how the collaboration effort supports the strategy.

Keywords: *Authentic Learning, Industry Engagement, Joint Collaboration.*

Introduction

Singapore's Cybersecurity Strategy, formulated by the Cyber Security Agency of Singapore (2016), aims to create a resilient and trusted cyber environment. The strategy is formulated with the intent of enabling Singaporeans to realise the benefits of technology securely and so secure a better future. There are four pillars that underpin the strategy. Firstly, the resiliency of critical information infrastructures will be strengthened. Secondly, safer cyberspace will be created for both citizens as well as businesses. Thirdly, a vibrant cybersecurity ecosystem will be developed. Last by not least, efforts will be stepped up to forge strong international partnerships.

As Singapore embarks to operationalise the Cybersecurity Strategy, it is challenged with an acute shortage of skilled cyber security professionals as reported by Lim (2016), Cheng (2018) and Ng (2018). Since 2015, Republic Polytechnic (RP) has been offering a three year full-time Diploma in Infocomm Security Management (DISM) to address this shortage. Much effort was put into designing the DISM curriculum to be authentic with regards use-cases, exercises, practicals that students engage in so that it reflects what security professionals face in the industry.

Authentic learning is learning designed to connect what students are taught in school to real-world issues, problems, and applications; learning experiences should mirror the complexities and ambiguities of real life as described by Lombardi (2007). Also described by Lombardi (2007), authentic learning typically focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities and case studies. Students work towards production of discourse, products, and performances that have value or meaning beyond success in school; this is learning by doing approach as described by Pearce (2016). Students say they are motivated by solving real-world problems. They often express a preference for doing rather than listening as described by Ambrose et al., (2010). At the same time, most educators consider learning by doing the most effective way to learn.

For years, authentic learning has been difficult to implement. Certain experiments are too dangerous, difficult, or expensive to conduct in the classroom; many are simply impossible to perform. With the emergence of technologies, students can be offered authentic learning based on action and experimentation as reported by Lombardi (2007). This can be done through joint-lab collaborations with the industry partners.

As such, DISM has collaborated with many security industry players such as RSA, Palo Alto Networks, Trend-Micro in the area of curriculum development, students' final year projects, etc, with the aim of bringing relevant and authentic learning to our students.

Joint-Laboratory Collaboration

RP-RSA's Security Operations Centre (RP-RSA SOC) laboratory is a joint collaboration effort between SOI and RSA for students from DISM. The lab is one of the many joint laboratories set up with industry partners to provide real-life learning experience. The RP-RSA SOC laboratory allows students to have hands-on practical experience in operating various SOC software, as well as experience the operations of a SOC in a simulated setting.

Figure 1. RP-RSA SOC Laboratory

The RP-RSA SOC Laboratory is set up for the delivering of the module C377 (Security Information Management) taken by students from the Diploma in Infocomm Security Management. The laboratory is equipped to simulate realistic cyber-attack scenarios. Figure 1 shows the interior of the RP-RSA SOC laboratory. This includes the Security Incident & Event Management (SIEM) software, host computers, servers, network switches, network taps, firewalls and traffic generator. Figure 2 shows the network diagram of the RP-RSA SOC Laboratory.

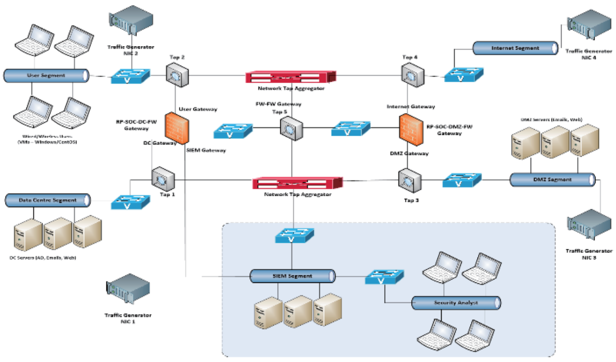


Figure 2. Network diagram of the RP-RSA SOC Laboratory

Authentic Learning Through Use Cases

Use cases are widely applied in the teaching of multiple disciplines as highlighted by Christensen (1981). Use cases allow for realistic, complex and context-rich scenarios. Teaching with use cases can help students actively engage in class participation and achieve positive learning outcomes. Within the context of a cybersecurity learning programme like DISM, we have incorporated real-world simulated industry cyber-attack use cases into the curriculum. Various use cases are re-created and simulated within the RP-RSA SOC laboratory environment. Some of these cyber-attack scenarios, which include Distributed Denial of Service (DDOS), Ransomware and Advanced Persistent Threats (APT), were created with the help of industry inputs from RSA. for the module, C377 (Security Information Management). Students investigate and work on these scenarios using industry standard software provided by RSA. Students are also taught the security incident response procedures as documented in the NIST Incident Handling Guide written by Cichonski, et al. (2012).

In C377 (Security Information Management), students were engaged in the investigation of seven cyber-attack use cases. In this paper, two use cases will be highlighted and discussed. The first use-case is related to the WannaCry ransomware attack that infected more than 230,000 computers worldwide as reported by Palmer (2018). The second cyber-attack use-case concerns a data breach incident.

The module C377 (Security Information Management) uses the Problem-Based Learning (PBL) pedagogy as the platform to apply authentic use-cases to engage students in their learning. The key learning activities of a typical PBL class is explained by Yew and O'Grady (2012) and shown in Table 1.

Learning Phase	Duration	Key Learning Activities
Learning Phase 1	1hour	Exploration of problem and learning issues
Learning Phase 2	1.5hours	Self-directed research, collaborative learning Lecturer's feedback/guidance, formulation of response to problem and overcoming learning obstacles
Learning Phase 3	2hours	Group presentation and critique Lecturer feedback and summary of learning issues Assessment of students' learning

Table 1. A typical day of a PBL class

In learning phase 1, the problem statement or scenario is the key to triggering students' learning and is scoped for the duration of the specific lesson. The problem statement or scenario serves to guide the students on an inquiry path to help them identify, search and investigate the scenario, work in teams, reason and justify to form opinions, apply known tools, convince others and reflect regularly on the investigation they do (Wang, Fong & Alwis, 2005).

During learning phase 2, well-designed scaffolding is provided to guide them towards developing a comprehensive response to the problem statement or scenario. Soft scaffolding occurs more dynamically in class through the skillful facilitation of the lecturer and through team discussions, while hard scaffolding is pre-planned in the form of laboratory worksheets and resources that accompany the problem statement or scenario as highlighted by Saye & Brush (2002).

In learning phase 3, students are required to present and defend their solution to the problem statement or scenario in front of their classmates and lecturer.

1. **Cyber Attack Use Case:** WanaCry Ransomware Attack

Problem Statement:

One of the student's laptop in SureAce University was infected with an encryption-based ransomware known as "WannaCry" after opening an attachment from an email (see figure below). The case is escalated to RP's SOC for *further investigation and an incident with severity level 1 has been logged.*

WannaCry Ransomware Message

As a security analyst, you are required to investigate and respond to the incident.

At the beginning of the class, the lecturer will generate a simulated WannaCry Ransomware attack on a virtual machine. For learning phase 1 of the PBL approach, the students analyze the articulated problem scenario (in this case, the WannaCry Ransomware) and also discuss the detection strategy for such a cyber-attack.

Worksheets are provided to the students as hard scaffolds. The questions raised in the worksheet are carefully designed to help students explore the nature of ransomware attacks. For this particular problem, students are required to research and explain the concept of cryptoviral extortion which is the foundation and genesis of all ransomware attacks. The worksheet questions helps the students to move from exploring to a basic understand of the nature of ransomware attacks to the methods of detecting such attacks. Students are required to apply the NIST Incident Handling Guide and start investigating the alerts triggered on the SIEM monitoring dashboards to verify the incident (see Figure 3). After confirming the incident, students will perform containment on the infected computers based on the analysis from the Endpoint Threat Detection and Response Dashboard as shown in Figure 4.

Figure 3. Student investigating on the alerts

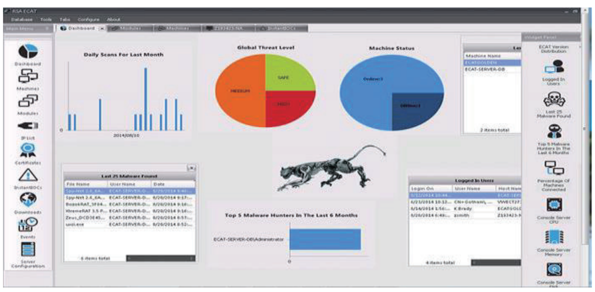


Figure 4. Endpoint threat detection and response dashboard

Further analysis on the network traffic and endpoint behavioural analysis is done to identify the malware behaviour on an infected laptop as shown in Figure 5.

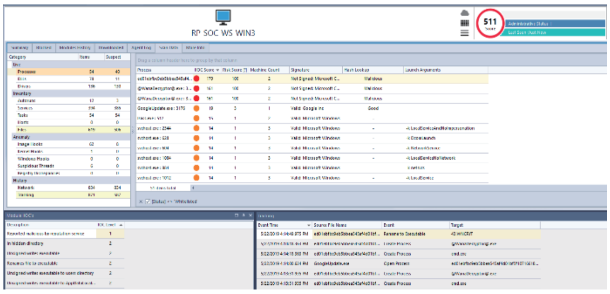
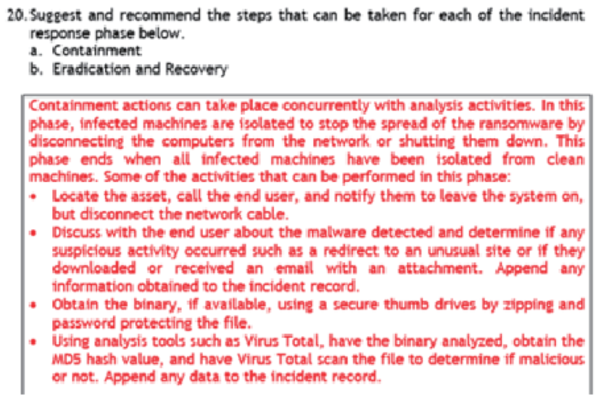


Figure 5. Other data analyzed as part of the problem solving process

Solutions and recommendations on the recovery steps are proposed by the students based on the analysis from the network traffic and logs.



20. Suggest and recommend the steps that can be taken for each of the incident response phase below.
a. Containment
b. Eradication and Recovery

Containment actions can take place concurrently with analysis activities. In this phase, infected machines are isolated to stop the spread of the ransomware by disconnecting the computers from the network or shutting them down. This phase ends when all infected machines have been isolated from clean machines. Some of the activities that can be performed in this phase:

- Locate the asset, call the end user, and notify them to leave the system on, but disconnect the network cable.
- Discuss with the end user about the malware detected and determine if any suspicious activity occurred such as a redirect to an unusual site or if they downloaded or received an email with an attachment. Append any information obtained to the incident record.
- Obtain the binary, if available, using a secure thumb drives by zipping and password protecting the file.
- Using analysis tools such as Virus Total, have the binary analyzed, obtain the MD5 hash value, and have Virus Total scan the file to determine if malicious or not. Append any data to the incident record.

Figure 6. Sample solutions proposed by students

2. Cyber Attack Use Case: Data Breach

Problem Statement:

This morning, Jason the security analyst attended the shift handover briefing. After the briefing, while performing a routine check, he noticed that the monitoring system had triggered many alerts. He suspected that there is a possible security *breach and immediately reported the case.*

Based on an initial investigation on the alerts, a data breach is detected. An incident has been created and you are to assist Jason in the investigation. In your investigation, you are required to document all findings and to recommend for any containment, eradication and recovery processes based on your investigation.

Just like the Wannacry Ransomware attack scenario, the lecturer will generate the data breach scenario at the beginning of the class. During learning phase 1, students will explore and discuss the problem scenario and discuss the detection strategy for this cyber-attack.

Worksheets are again used as hard scaffold for this problem statement. Students are to recap on the concept of the Cyber Kill Chain methodology as described by Hutchins, Cloppert and Amin (2011) which was covered in the previous specialisation module (C332 – Intrusion Detection & Prevention Systems). Recapping this methodology is important as the students are required to map Cyber Kill Chain phases to the various attack activities. The worksheet also provide students with the necessary resource to understand the MITRE ATT&CK framework as described by Strom et al. (2018). Students will learn to map the attacker's activities to the appropriate MITRE ATT&CK tactics and techniques. Each team start with investigating on the alerts triggered on the SIEM monitoring dashboards to verify the incident as shown in Figure 7.

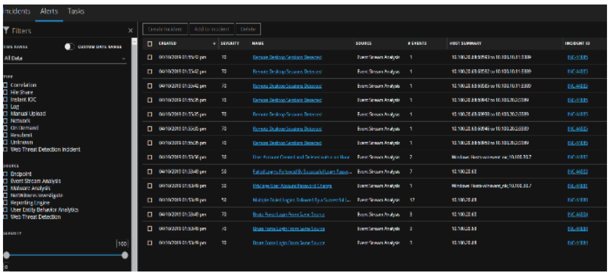


Figure 7. SIEM alerts monitoring dashboards

Students are to follow the NIST Incident Handling Guide to further analyse the network traffic and logs to identify the source of the attack and the various attack vectors used by the attacker based on the Cyber Kill Chain methodology and MITRE ATT&CK Framework shown in Figures 8 & 9.

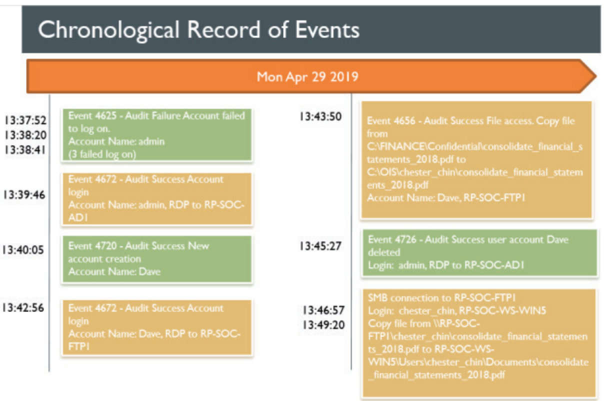


Figure 8. Reconstructing events based on investigation

Cyber Kill Chain Process	
Phase	**Related Activities**
Reconnaissance	• Brute-force admin password • Enumerating user account, user group and account information from Active Directory (RP-SOC-AD1) (using NET USER command) • Attempt to access confidential files in a share drive \\RP-SOC-FTP1\confidential\consolidate_financial_statements_2018.pdf
Delivery	• Direct Remote Desktop Protocol (RDP) used to access the server RP-SOC-AD1 and RP-SOC-FTP1
Exploitation	• Exploiting weak admin password
Installation	• Created new user account "Dave" • Assign "Dave" with administrative rights (privilege escalation)
Actions on Objectives	• Exfiltrated the file consolidated_financial_statements_2018.pdf with the use of the administrative account "Dave"

Figure 9. Mapping to the cyber kill chain methodology

Each team will need to propose or recommend the necessary eradication and recovery steps after analysis. Figure 10 shows sample solutions proposed.

20. Identify the **MITRE ATT&CK TECHNIQUES** based on the various activities performed by the attacker.

Tactics	Techniques	Activities
Initial Access	• Valid Accounts	• Credential dumping (enumerate accounts)
Persistence	• Create Account	• account "dave" created
Privilege Escalation	• Valid Account	• compromised "admin" account used to create a new user "dave" with administrative privilege
Credential Access	• Brute Force	• Brute-force user "admin"
Discovery	• Network Share Discovery • File and Directory Discovery • Password Police Discovery • Permission Groups Discovery	• Attempt to access the files in \\RP-SOC-FTP1\Confidential • Attempt to access the confidential pdf file • Net user and net account on the domain to retrieve account information
Lateral Movement	• Remote File Copy • Remote Desktop Protocol	• RDP to RP-SOC-AD1 and RP-SOC-FTP1 via remote desktop • Copy files from RP-SOC-FTP1 to own computer
Collection	• Data from Network Shared Drive	• Copy files from RP-SOC-FTP1 to own computer
Exfiltration	• Exfiltration Over Command and Control Channel	• Copy files from RP-SOC-FTP1 to own computer
Command and control	• Remote File Copy	• Copy files from RP-SOC-FTP1 to own computer

21. Based on your investigation; suggest the incident response steps below.

Incident Response Procedures	
Containment:	• Change the passwords for the user account admin or disable user account admin • Disable user account chester_chin • Disable remote desktop service on RP-SOC-AD1 • Seize chester_chin's computer for memory forensic investigation
Eradication:	• Set account lockouts after 3 failed logins • Create individual user accounts for authentication, non-repudiation and accountability instead of using a shared administrator account • Enforce strong password policy • Remove everyone from the ACL in the Confidential Folder and allow List access to only recommended users. • Perform vulnerability assessment checks on all servers in the network • Apply security patches and update OS patches
Recovery:	• Restore the file from latest backup (in case of any changes made) • Monitor the files in the confidential folder for any unauthorized accesses

Figure 10. Sample solutions proposed

Module Survey

A student survey to gather feedback on this module and the use of authentic learning with industry partnership was conducted. The questions are shown in Table 2 and the outcome of the survey are shown in Figure 12. On the whole, the survey rated an average of 4.5 out of 5, for all questions.

Q1	The lessons are designed to help me find my own resources.
Q2	The lessons are designed to encourage sharing of ideas.
Q3	The learning activities helped me think about my learning approach.
Q4	The lessons provided opportunities for me to help my classmates learn.
Q5	The lessons provide opportunities to learn from my classmates.
Q7	I find the module relevant to the job I may undertake in future.
Q7	There is a variety of learning activities to engage me in my learning.
Q8	My overall rating of module delivery is…

Table 2. Module Survey Questions

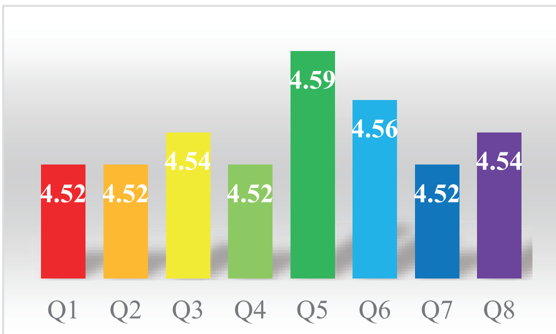


Figure 12. Survey Result for Q1 – Q8

Most of the students found the lessons interesting and engaging. Students appreciated the use of authentic learning in the curriculum and they have noted the benefits of applying theory and knowledge to real-world practical problems.

Industry Study Visits

Besides collaborating with industry on use cases, industy study visit is also one of the point of collaboration. The purpose of study visits is to allow students to see theory being applied in practice and the opportunity for students to enquire of the security professionals on site their specific issues/challenges on the ground which can enrich and complement their classroom learning. During the course of the module C377 (Security Information Management), a visit to the Thermo Fisher Asia Pacific SOC was organised for the DISM students (see Figure 11). The SOC provides incident monitoring, incident alerting and incident response/management for Thermo Fisher Scientific in the APAC region. In the visit, the professionals shared how they response to various security incidents. This allowed the students to relate what they learnt in the classroom to that of the industry practices.

Figure 11. Visit to Thermo Fisher APAC SOC

Conclusions

The practice of authentic learning for cyber security has yielded a number of benefit for both the institution and students. The use of industry real-world cyber attack scenarios in the lessons brings authenticity and relevance to the cyber security curriculum where students ability to apply the knowledge and skills gained has seen students being more engaged and enthusiastic with their learning. This is evident from the positive module feedback received at the end of the semester. The use of industry real-world cyber-attack scenarios also exposes students to the operations of a SOC in a safe and controlled environment so that they will be better equipped and ready to fulfil job functions of a SOC security analyst. Industry study visits further expose students to the experiences of SOC practitioners where they will hear first hand ‘stories from the trenches’ and also learn about the issues and challenges on the ground.

References

Singapore Cybersecurity Strategy (2016). Retrieved from https://www.csa.gov.sg/news/publications/singapore-cybersecurity-strategy

Lim, L. (2016). *Singapore’s cybersecurity skills shortage: Why it matters*. Retrieved from https://www.channelnewsasia.com/news/singapore/singapore-s-cybersecurity-skills-shortage-why-it-matters-7762864

Cheng, K. (2018). *Data scientists, cyber-security specialists among top emerging jobs in Singapore: LinkedIn Report*. Retrieved from https://www.todayonline.com/singapore/data-scientists-cyber-security-specialists-among-top-emerging-jobs-spore-linkedin-report

Ng, R.J. (2018). *Cybersecurity industry sees large salary increases amid talent crunch*. Retrieved from https://www.sgsme.sg/news/cybersecurity-industry-sees-large-salary-increases-amid-talent-crunch

Chia, Lianne (2018). *All primary schools to set up applied learning programmes by 2023: Ng Chee Meng*. Retrieved from: https://www.channelnewsasia.com/news/singapore/all-primary-schools-to-set-up-applied-learning-programmes-by-10014282

Pearce, S. (2016*). Authentic learning: What, why and how?* Retrieved from: http://www.acel.org.au/acel/ACEL_docs/Publications/e-Teaching/2016/e-Teaching_2016_10.pdf

Ambrose S.A., Bridges M.W., DiPietro M., Lovett M.C., Norman, M.K., (2010), *How Learning Works – Seven Research Based Principles for Smart Teaching*, San Francisco: Jossey Bass.

Lombardi M.M., *Authentic Learning for the 21st Century: An Overview* Retrieved from: https://www.researchgate.net/profile/Marilyn_Lombardi/publication/220040581_Authentic_Learning_for_the_21st_Century_An_Overview/links/0f317531744eedf4d1000000.pdf

Cichonski, P., Millar, T., Grance, T. & Scarfone, K., (2012). *Computer Security Incident Handling Guide*, National Institute of Standards and Technology.

Wang, J., Fong Y.C. & Alwis, W.A.M. (2005). *Developing professionalism in engineering students using problem-based learning*. Paper presented at the 2005 Regional Conference on Engineering Education, Johor, Malaysia.

Saye, J.W., & Brush, T. (2002). Scaffolding critical reasoning about history and social issues in multimedia-supported learning environments. *Educational Technology Research and Development*, 50(3), pp 70-76.

Yew, E., & O'Grady, G. (2012). *One -Day One-Problem: An Approach to Problem-based Learning* (pp 4-5). New York: Springer.

Hutchins, E.M., Cloppert, M.J., Amin, R.M. (2011). *Intelligence -driven computer network defense informed by analysis of adversary campaigns and intrusion kill chains.* Retrieved from https://www.lockheedmartin.com/content/dam/lockheed-martin/rms/documents/cyber/LM-White-Paper-Intel-Driven-Defense.pdf

Strom, B.E., Applebaum, A., Miller D.P., Nickels, K.C., Pennington, A.G., Thomas C.B. *MITRE ATT&CK: Design and Philosophy*. Retrieved from https://www.mitre.org/sites/default/files/publications/pr-18-0944-11-mitre-attack-design-and-philosophy.pdf

Presenters Index

A

Last Name	First Name	Title	Page
A Rahim	Noor Faridah	AN INNOVATIVE MICRO-LEARNING APPROACH THAT ADDRESSES INDUSTRY KNOWLEDGE AND WORKPLACE RELEVANCY FOR INDIVIDUALS AND CORPORATES	248
Akiba	Sadahiro	EFFECT OF CAREER EDUCATION USING THE TRAINING SHIP AND CONSIDERATION OF TEACHING TECHNOLOGY	455
Ang	Jayden	AUGMENTED REALITY IN CHEMISTRY: EFFECT ON LEARNERS' ACADEMIC ACHIEVEMENT AND LEARNING EXPERIENCE	159
Aoto	Masahiko	INTRODUCTION OF “LIBERAL ARTS DISCOURSE MEETING”AT NATIONAL INSTITUTE OF TECHNOLOGY, YONAGO COLLEGE	224
Arakawa	Hironori	HOW TO FOSTER GLOBAL MINDSETS AMONG FIRST YEAR KOSEN STUDENTS -FROM A SEVEN-YEAR SURVEY OF THE “KOREA JOINT STUDY TOUR” PROGRAM	589
Asami	Yoshiko	DEVELOPING RESILIENT MINDSETS IN STUDENTS FOR NATURAL DISASTERS BY ENGAGING THEM IN THE DEVELOPMENT OF POCKET MAPS AND GUIDES	559

C

Last Name	First Name	Title	Page
Cai	Linghua	ONLINE COLLABORATIVE LEARNING: STUDENTS' PERCEPTION AND LEARNING EXPERIENCE - A MIXED METHODS STUDY	109
Cheah	Sin-Moh	TEACHING STUDENTS SELF-DIRECTED LEARNING TO SUPPORT EDUCATION FOR SUSTAINABLE DEVELOPMENT	379
Cheung	Calvin	VIRTUAL AND AUGMENTED REALITY LEARNING FOR LIFT MAINTENANCE - SUBSTANTIAL ADVANCEMENT IN LIFT MAINTENANCE TRAINING	66
Cheung	Tommy	BENEFITS OF MENTORING RELATIONSHIPS FROM THE PERSPECTIVE OF THE MENTOR IN ENGINEERING EDUCATION	220
Chua	Samuel	A STUDY OF THE CHANGES IN DELIVERY METHODS OF A STATISTICS MODULE	190

D

Last Name	First Name	Title	Page
Doi	Shigeo	**DEVELOPMENT OF IOT CAR EXPERIMENT TEACHING MATERIALS IN THE K-SEC PROJECT**	206

F

Last Name	First Name	Title	Page
Fujii	Shunsuke	**INTRODUCTION OF TRINITY OF SCINCE: PHYSICS, EXPERIMENT AND MATHEMATICS FOR INTERNATIONAL STUDENTS**	149
Fujishima	Noriaki	**EFFECTS OF STEP-BY-STEP ACTIVATION LEARNING IN A PRIMARY COMPUTER PROGRAMMING CLASS**	79
Fujiwara	Shigeyasu	**ENHANCING PHYSICS EDUCATION USING INTERACTIVE ELECTRONIC BOOKS FOR DIFFERENTIAL AND INTEGRAL CALCULUS, MECHANICS AND AN LMS**	61
Fukuda	Noboru	**PEDAGOGICAL SUGGESTION FOR THE CREATION OF STUDENT'S/TEACHER'S BELIEFS AND JAPANESE LANGUAGE CURRICULUM AIMED AT INTERNATIONAL STUDENTS AT KOSEN**	569
Fukukawa	Kazumi	**ACTIVE LECTURE: "COMMUNITY AND ENGINEERING"**	332
Futamura	Akira	**CURRICULUM DESIGN BASED ON UNIVERSAL MARITIME EDUCATION**	278

G

Last Name	First Name	Title	Page
Goh	Kai Song	**MINING MAJOR PROJECT REPORTS FOR INSIGHTS**	412

H

Last Name	First Name	Title	Page
Haraguchi	Osamu	LIBERAL ARTS AS A LEARNING MOTIVATOR FOR NIT STUDENTS	200
Higa	Marshall K	USING EYE-TRACKING EQUIPMENT TO IMPROVE READING STRATEGIES ON STANDARDIZED TESTS	95
Higashino	Adriana	TEACHING TRADITIONAL JAPANESE ARCHITECTURE: HOW THE CONSTRUCTION OF AN OKOSHIE CAN LEAD THE STUDENTS TO A BETTER SPATIAL UNDERSTANDING	129
Hirai	Nobumitsu	EDUCATIONAL PROGRAM FOR FUTURE GLOBAL ENGINEERS IN NIT, SUZUKA COLLEGE	343
Hirano	Masashi	AN INTER-DEPARTMENTAL COLLABORATIVE PROGRAM TO MOTIVATE FIRST-YEAR KOSEN STUDENTS TO LEARN ENGLISH	579
Hirose	Yasuyuki	DISASTER PREVENTION EDUCATION PROGRAM IN COOPERATION WITH PREFECTURAL AREA IN JAPAN	574
Hoshuyama	Teruo	IMPLEMENTATION OF THE REMOTE CLASSES BETWEEN MARITIME COLLEGES (TAKING THE SHIP HEALTH SUPERVISOR "SPECIAL LECTURE" AS AN EXAMPLE)	299
Hung	Benson	STUDENT PERCEPTIONS AND EXPERIENCES OF CO-TEACHING IN A PROJECT-BASED SUBJECT	322

I

Last Name	First Name	Title	Page
Ichikawa	Yuko	ANALYSIS OF CORRELATION BETWEEN CLASS ACTIVITY AND STUDENTS' ATTENTION IN ACTIVE LEARNING CLASS FROM BIOLOGICAL VIEWPOINT	99
Ikematsu	Mineo	DEVELOPMENTAL TRANSFER OF JAPANESE LANGUAGE TO ENGLISH SKILL FOR JAPANESE ADULT LEARNERS OF ENGLISH	316
Itakura	Kazuhiro	NURTURING 'GLOBAL ENGINEERS' THROUGH INTERNATIONAL EXCHANGE ACTIVITIES: AN ATTEMPT BY NIT NARA COLLEGE WITH THE GECEP PROGRAM	540
Ito	Takeshi	ACTIVITY OF SCIENTIFIC EXPERIMENT CLUB BASED ON REMOTE ISLAND ENGINEERING	564

J

Last Name	First Name	Title	Page
Jin	Jing	EVALUATING A LABORATORY LESSON CONDUCTED FOR SUPPLY CHAIN STUDENTS USING KOLB'S EXPERIENTIAL LEARNING CYCLE	174

K

Last Name	First Name	Title	Page
Kairisto-Mertanen	Liisa	MAKING THE CHANGE – APPLYING FIVE MODELS OF ACADEMIC DEVELOPER PRACTICE	338
Kajimura	Yoshihiro	STUDENTS` EMOTIONS ANALYSIS USING A REFLECTION SHEET DEVELOPED FOR A PBL TYPE COURSE AND COMPARED WITH A PROG TEST ANALYSIS	402
Kakuda	Naoki	DEVELOPMENT AND PRACTICE OF ULTRAVIOLET SENSOR TEACHING MATERIAL FOR IMPROVING ANALYSIS SKILLS FOR SELF-STUDY	504
Kato	Tatsuya	EFFECT OF PBL ON REMOTE CONTROLLED ROBOT COMPETITION FOR PRACTICAL ENGINEERING EDUCATION	476
Kato	Fumitake	IMPLEMENTATION OF ENGINEERING CLASSES IN KOSEN AND POLYTECHNICS IN MALAYSIA	599
Kawasaki	Koji	A PROPOSAL OF A STUDENTS' VOLUNTARY IMPROVEMENT CYCLE METHOD BY VISUALIZATION OF GENERIC SKILLS	364
Khiang	Jason	ETC LAB. – AN INTERDISCIPLINARY CENTRE FOR COLLABORATIVE DESIGN AND RESEARCH TO CREATE SOCIAL IMPACT AND CHANGE	470
Kikuchi	Akio	ACTIVE LEARNING BASED ON TOURISM AND CULTURE – CONTENTS TOURISM AS TEACHING MATERIAL	268
Kobayashi	Toshiro	VERIFICATION OF THE APPLICATION OF A PARTICIPATORY AND DELIBERATIVE ENERGY EDUCATION POGRAM IN TECHNICAL COLLEGE	184
Kobayashi	Yohei	DEVELOPMENT OF A NEW EDUCATIONAL PROGRAM BASED ON LOCAL ISSUES IN THE MAIZURU KOSEN	376
Kobayashi	Hideyuki	INVESTIGATING THE EFFICIENCY OF FOSTERING BASIC SOCIAL SKILLS BY ACTIVE LEARNING USING AN OBJECTIVE ASSESSMENT	466

Last Name	First Name	Title	Page
Kobayashi	Mio	IMPLEMENTATION OF GLOBAL MIND TRAINING CAMP FOR KOSEN STUDENTS IN JAPAN	623
Koh	Noi Sian	THE EFFECTIVENESS OF BITE-SIZED TEACHING APPROACH FOR ADULT LEARNERS	169
Komura	Ryotaro	MATCHING EDUCATIONAL PROGRAMS WITH SKILL OF STUDENTS IN INFORMATION SECURITY EDUCATION	126
Kontio	Juha	THE BIG PICTURE OF QUALITY ENHANCEMENT @TUAS	293
Kor	Andrew	COLLABORATIVE PARTNERSHIP WITH STUDENTS FOR EFFECTIVE ENGINEERING SERVICE LEARNING PROJECTS	489
Kosaka	Hiroaki	COMPARISON OF HANGEUL LEARNING METHODS FOR JAPANESE LEARNERS FOCUSING ON VOWELS AND CONSONANTS	122
Kuramashi	Yasuhiro	THE EFFECTIVENESS OF A LANGUAGE PROGRAM FOR KOSEN STUDENTS IN THE PHILIPPINES	408

L

Last Name	First Name	Title	Page
Law	Tracy	DEVELOPMENT OF AN AUTHENTIC ASSESSMENT FOR AN ELECTIVE MODULE IN DIPLOMA IN CIVIL ENGINEERING COURSE	397
Lee	Andy	A BLENDED REMOTE LEARNING APPROACH IN ELECTRONICS TECHNOLOGY MODULE	116
Lee	Kim Sung	SCENARIO-BASED LEARNING IN BIOINFORMATICS: THE USE OF INFECTIOUS DISEASE OUTBREAK	450
Lee	Sze Hung	EVALUATION OF STUDENT FEEDBACK ON EXCHANGE PROGRAMMES FOR CONTINUOUS IMPROVEMENT	612
Lei	Kangbin	JOINT ENGLISH TRAINING PROGRAM IN THE PHILIPPINES	544

Last Name	First Name	Title	Page
Leinonen	Esa Tapani	BUILDING LIFE CYCLE BASED MODEL IN CIVIL ENGINEERING EDUCATION – BETTER CO-OPERATION WITH WORKING LIFE	309
Leong	Peter	TEACHING AI TO ADVANCE SUSTAINABLE DEVELOPMENT GOALS	287

M

Last Name	First Name	Title	Page
Matsuda	Kanaho	SURVEYS ON CAREER AND GLOBAL EDUCATION FOR PROGRAM TO DEVELOP LEGAL MIND	618
Matsumura	Toshie	PROGRAMMING COURSE FOR ELEMENTARY AND JUNIOR HIGH SCHOOL STUDENTS	594
Morimune	Taichiro	CREATIVITY EXPERIMENT INCORPORATING ORGANIC LIGHT EMITTING DIODE FABRICATION	243

N

Last Name	First Name	Title	Page
Nakamura	Yoshimichi	SELF-DIRECTED RESEARCH UNDER A QUARTER SYSTEM: HOW THE UNIQUE RESEARCH CURRICULUM IMPLEMENTED, IMPROVED?	348
Nakamura	Susumu	INTERACTIVE EDUCATIONAL EXCHANGES BETWEEN NAGAOKA KOSEN AND ADTEC MELAKA BASED ON PROJECT-BASED LEARNING	550
Ng	Tsz Wang	A PROJECT-BASED LEARNING APPROACH IN DEVELOPING STUDENTS' CROSS-DISCIPLINE ENGINEERING SKILLS	429
Nihashi	Sohey	A TRIAL OF COOPERATIVE EDUCATION PROGRAM BASED ON PBL WITH LOCAL COMMUNITIES AT NATIONAL INSTITUTE OF TECHNOLOGY (KOSEN), TOMAKOMAI COLLEGE	515
Nishiguchi	Hiroshi	PRACTICAL COMMUNICATION CLASS WITH A "USA" THAT IS LOCATED TEN MINUTES FROM KOSEN	163

Last Name	First Name	Title	Page
Nishii	Yasuhiro	DEVELOPMENT OF ESD STUDENT-CENTERED DELIVERY CLASS	483
Nishimura	Shunji	TYPING DURING LECTURES AS AN ALTERNATIVE FOR BLACKBOARD WRITING	196
Niwa	Takahiro	THE IMPORTANCE OF FACE-TO-FACE DISCUSSION – AN ATTEMPT TO USE “CONCEPTUAL THINKING ENCOURAGING MATERIALS” IN ELEMENTARY PHYSICS EDUCATION	263

O

Last Name	First Name	Title	Page
Ogawa	Taiji	ENGINEERING EDUCATION AS CITIZENSHIP EDUCATION BY P4C	326
Ohya	Makoto	DESIGN OF THE CONSTRUCTION ENGINEER EDUCATION FOR i-CONSTRUCTION AND ITS APPLICATION FOR THE RECURRENT EDUCATION PROGRAM	145
Okada	Akira	THE IMPORTANCE OF BUILDING COLLABORATIVE PARTNERSHIPS WITH INBOUND AND OUTBOUND PARTNERS	425
Okuma	Chiharu	FOSTERING GLOBAL LEADERS THROUGH THE "INTERNATIONAL SEMINAR ON TECHNOLOGY FOR SUSTAINABILITY"	434
Okuzaki	Mariko	A CLASSROOM STUDY OF TOEIC E-LEARNING INVOLVING FOURTH-YEAR KOSEN STUDENTS AT NIT, HAKODATE COLLEGE	216
Ong	Wai Sing	GENESIS@BME: AN INTEGRATED APPROACH TO TECHNOLOGY EDUCATION IN BIOMEDICAL ENGINEERING	495

P

Last Name	First Name	Title	Page
Park	Jongdoc	ENHANCED ENGLISH COMPETENCY OF TEACHERS USING GLOBAL APPROACH FOR MARITIME COLLEGES IN JAPAN	627

R

Roslöf	Janne	DEVELOPMENT OF THE CAPSTONE INNOVATION PROJECT COURSE - ANALYSIS OF PROJECT ASSIGNMENTS AND STAKEHOLDERS	523

S

Last Name	First Name	Title	Page
Sakimura	Ritsuo	A RECURRENT EDUCATION FOR A GRADUATE FROM THE TECHNICAL COLLEGE THROUGH A COLLABORATIVE RESEARCH	534
Sakuma	Ikko	FEASIBILITY STUDY OF ENGLISH PROGRAM BASED ON COMMUNICATION USING STANDARD MARINE COMMUNICATION PHRASES (SMCP)	303
Shirahama	Naruki	AN INTERNATIONAL HACKATHON WITH THE THEME OF DISASTER PREVENTION COLLABORATING WITH INDUSTRY	605
Shomura	Ryo	INTRODUCTION OF THE “INTEGRAL ENGINEERING CLASS” AT TSURUOKA KOSEN: BACKGROUND, DESIGN, AND FUTURE DIRECTION	271
Siu	Chun Ho	INNOVATIVE STEM WORKSHOPS FOR ENGINEERING EDUCATION	230
Sochi	Nobuyuki	GROUP LEARNING WITH THE ELEMENTS OF THE GAME	55
Sow	Samantha	EXPLORATORY LEARNING ANALYTICS: TRANSLATING SHAPES OF EDUCATIONAL DATA INTO EARLY INTERVENTION WARNING SIGNALS IN YEAR ONE COURSE	418

T

Last Name	First Name	Title	Page
Takagi	Natsuki	ESTABLISHMENT OF GLOCAL EDUCATION AND RESEARCH CENTER FOR AGRICULTURAL ENGINEERING IN NIT (KOSEN), MIYAKONOJO COLLEGE - EDUCATIONAL TRIALS FOR LOCAL CONTRIBUTION AND INTERNATIONAL ACTIVITY -	385
Takada	Taku	AN ONLINE-BASED EDUCATIONAL FRAMEWORK FOR KOSEN SPACE ACADEMY: THE FIRST YEAR’S RESULTS (2018)	85
Takeda	Naho	EFFECTIVENESS OF THE PBL APPROACH IN CIVIL ENGINEERING TO DEEPEN STUDENTS’ UNDERSTANDING	134
Takehara	Shinya	DEVELOPMENT OF COMMUNITY BASED LEARNING PROGRAM AS AN ENGINEERING EDUCATION FOR REGIONAL REVITALIZATION	180

Last Name	First Name	Title	Page
Tan	Tiong Wei	PILOT STUDY: THE EFFECTIVENESS OF SMARTBOOK FOR FLIPPED CLASSROOM LEARNING IN SCIENCE	70
Tan	Irene	THE IMPACT OF DISTRIBUTED PRACTICE ON STUDENTS' ACADEMIC ACHIEVEMENTS IN DATABASE SYSTEMS MODULE	461
Tang	YewFei	INVESTINGATING NUDGE EFFECTS WITH SPACED REPETITION ON CONTEMPORARY LEARNER'S MOTIVATION AND PERFORMANCE IN LEARNING DATA COMMUNICATION AND NETWORKING	257
Tang	U-Liang	INTEGRATING PYTHON PROGRAMMING INTO CURRICULUM FOR SPECIALIST DIPLOMA COURSES IN DATA SCIENCE	274
Taquet	David	DEVELOPING CROSS-CULTURAL AWARENESS IN PROVINCIAL HOKKAIDO BY CONNECTING EXCHANGE STUDENTS AND KOSEN JAPANESE STUDENTS	519
Tay	Jin Wei	HIGH STAKE E-ASSESSMENT IN ENGINEERING	440
Teoh	Florence	LEARNER-CENTRIC BLENDED LEARNING PLAN FOR AN ENGINEERING MODULE	235
Tham	James	AUTHENTIC LEARNING FOR CYBER SECURITY: AN INDUSTRY PRACTICE PARTNERSHIP	632
To	Kelvin	NURTURING SMART CITY PROFESSIONALS THROUGH STEM PROJECT OF UNMANNED ELECTRIC ROVER	213
Tokutake	Shiho	DEVELOPMENT OF AN EDUCATIONAL SYSTEM TO PROVIDE FOR VIRTUAL LABYRINTHINE STREETS BASED ON LINES DRAWN ON A PAPER	360
Tsukazaki	Kaori	EMPOWERING WOMEN IN STEM: COLLEGE STUDENTS AND SCHOOL PUPILS	91

U

Last Name	First Name	Title	Page
Uesugi	Yuko	EXPLORING THE RELATIONS BETWEEN THE INTERNATIONAL EXCHANGE EVENTS AND THE ENHANCEMENT OF STUDENTS' MOTIVATION	555
Uesugi	Yuko	THE EXPOSURE IS THE KEY: SIMILARITIES AND DIFFERENCES BETWEEN THE MALAYSIAN AND THE JAPANESE ENGLISH EDUCATION SYSTEMS Yuko UESUGI	585
Usuda	Yoshiyuki	DEVELOPMENT OF A TASK-BASED ONLINE SELF-LEARNING SYSTEM USING LMS	283

V

Last Name	First Name	Title	Page
Vedamuthu	Andrew	PRELIMINARY DEVELOPMENT OF A SELF-DIRECTED LEARNING INDEX FOR POLYTECHNIC STUDENTS	392

W

Last Name	First Name	Title	Page
Wan	Mark	USING THE EVIDENCE-BASED REFLECTIVE PRACTICE TOOL TO ENHANCE PROFESSIONAL PRACTICE	369
Wong	Kin Ming	PARTNERSHIP BETWEEN VOCATIONAL TRAINING COUNCIL AND OVERSEAS UNIVERSITIES IN OFFERING TOP-UP ENGINEERING DEGREES IN HONG KONG	529

Y

Last Name	First Name	Title	Page
Yagyu	Hotaka	EXAMINATION OF THE EFFECT OF INDIVIDUALIZED MASTERLY LEARNING BASED ON EXTERNAL ASSESSMENT	352
Yamada	Keisuke	A CLASS FOR HUMAN RESOURCE DEVELOPMENT CAPABLE OF CORRESPONDING TO DIVERSIFICATION OF ENERGY	500
Yamashita	Satoshi	ON THE SUPPORT SYSTEM KETCINDY FOR CREATING MATHEMATICS TEACHING MATERIALS USING TEX	155
Yanagisawa	Osami	INTERNATIONAL EXCHANGE PROGRAM FOR DEVELOPMENT OF GLOBAL HUMAN RESOURCES AND JOINT RESEARCH	509
Yeou	Eddie	USING LEARNING ANALYTICS TO ACHIEVE BETTER STUDENT LEARNING OUTCOMES IN BUSINESS STATISTICS	479
Ying	Kai Chi	ANALYSIS OF THE STUDENT PERFORMANCE IN ENGINEERING MODULES BY APPLYING FLIPPED CLASSROOM CONCEPT	139
Yokota	Miyo	THE APPLICATION OF PRACTICAL ACTIVITIES IN SCIENCE AND ENGINEERING TO KOSEN ENGLISH CURRICULUM	446
Yu	Arthur	COMPETITION-DRIVEN LEARNING FOR IOT TALENTS	355

Z

Last Name	First Name	Title	Page
Zhang	Huiyu	ICT IN TECHNICAL TEACHING TO ENGLISH AS FOREIGN LANGUAGE LEARNERS	103
Ziemba	Tomek	ENCOURAGING MULTIMEDIA AND DIGITAL LITERACY FOR COLLEGE STUDENTS IN RURAL JAPAN WITH PRESENTATIONS AND VIDEO EDITING	76