Innovation in Education for Global Business

Universiti Malaysia Sabah
Kota Kinabalu, Sabah, Malaysia

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# Innovation in Education for Global Business

## Table of Contents

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction of Education System and New Challenges in Kobe City College of Technology</td>
<td>1</td>
</tr>
<tr>
<td>Comparative Analysis of Course Outcome Between Student Perception And Student Grade Achievement in Environment and Sustainability</td>
<td>8</td>
</tr>
<tr>
<td>Continuous Quality Improvement- Assessing Students’ Satisfaction</td>
<td>18</td>
</tr>
<tr>
<td>On the Topological Indices of Molecules and Molecular Compounds Associated with Fullerenes</td>
<td>23</td>
</tr>
<tr>
<td>Review of Symbolic Equation Solving for Engineering Problems</td>
<td>39</td>
</tr>
<tr>
<td>Thermal Oxidation Characteristic of Boron-Doped Diamond (BDD) Films</td>
<td>46</td>
</tr>
<tr>
<td>A Real-time Positioning System Based on BLE Beacon in Children’s School Vehicles</td>
<td>48</td>
</tr>
<tr>
<td>Incorporating Highway Information Modelling (HIM) in Capstone Highway Design Project for Undergraduate Level Studies: A Case Study</td>
<td>64</td>
</tr>
<tr>
<td>A Qualitative Study on the Creative Making Activities Using 3D Printer in Middle-High School and College Students Between Korea and Japan</td>
<td>67</td>
</tr>
<tr>
<td>Perception of Universiti Malaysia Sabah Civil Engineering Students Towards KA40102 Traffic Engineering Course</td>
<td>76</td>
</tr>
<tr>
<td>An international approach to improving the English proficiency of teachers in Japanese Maritime Colleges</td>
<td>87</td>
</tr>
<tr>
<td>Collaboration of international English Educational Programs to Train International Ship Officer in Maritime Colleges in Japan</td>
<td>97</td>
</tr>
<tr>
<td>Development of Accident Expert System Manager (AESM) As A Learning Tool for Students</td>
<td>110</td>
</tr>
<tr>
<td>Wiping Gravure Printing Method for Realizing Trench Pattern in Printed Electronics</td>
<td>130</td>
</tr>
<tr>
<td>A Study on Printability of WPOP Method According to Physical Properties of Paper</td>
<td>132</td>
</tr>
<tr>
<td>A Case Study of Online Assignment Submission for Engineering First-Year Students at Curtin University Malaysia</td>
<td>135</td>
</tr>
<tr>
<td>International Joint Education for Student Interaction in the Field of Electronics and Information Technology</td>
<td>152</td>
</tr>
<tr>
<td>Cultivating Well-rounded Students -The Importance of STEAM in Engineering Education-Learning through Teaching Programs of Science and Technology for University Students</td>
<td>157</td>
</tr>
<tr>
<td>Introduction to WISET and Women Included Engineering Education Program of PKNU in Republic of Korea</td>
<td>175</td>
</tr>
<tr>
<td>Practical Engineering Education Program Based on Forefront Technologies Accompanied with Students before Starting Graduation Studies -Superconducting Materials and Fabrication-</td>
<td>181</td>
</tr>
<tr>
<td>A case in action learning on basic programming course</td>
<td>183</td>
</tr>
<tr>
<td>Effect of Design Related Engineering Activity on Engineering Design Competency</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td>196</td>
</tr>
</tbody>
</table>
A Case Study of Exploring the Direction of Woman Engineering Education by the Analysis of Learner’s Recognition 208
On the Enhanced Wax Patterning Offset Printing for the manufacturing of Printed Electronics 210
A Survey on Students’ Readiness to Adopt Blended-Learning at Faculty of Engineering, UMS 214
Introduction of Education System and New Challenges in Kobe City College of Technology

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ABSTRACT
This paper introduces the unique education system and the new challenges in Kobe City College of Technology (KCCT). Students of KCCT start the engineering education from 16 to 20 years old. The education period is 5 years, and the starting time is in very young age. This education system includes both of the fundamental education in high school and the engineering education in university. Recently, the new topics of Medical welfare, Aerospace, Robotics are added in this education system. These new fields are the new growth industry in Kobe City. Our college collaborates with local industries very closely. I introduce the latest information of engineering education from Japan.

Keywords: The College of Technology in Japan, early consistency education, new growth industry

1. Introduction
The Kobe City College of Technology (KCCT) [1] was founded as unique type of higher level education institution in 1962. The same style of colleges is called “KOSEN” [2], and there are 56 colleges throughout Japan. “KOSEN” provides junior high school graduates with a 5-year program of study (fundamental course), by which they can attain the same educational level as engineering university students. Especially, the KCCT is governed by Kobe City, and the KCCT realizes a particularly unique education system among Technical Colleges. Fig. 1 shows the school guide of KCCT in web page [1].

In 1998, advanced courses, which provide an additional 2-year program for graduates of the fundamental course, were established allowing students to earn a bachelor’s degree in engineering.

The school campus has a bright and open atmosphere, with a square, a courtyard, modern school buildings and other facilities with a beautiful view of the surrounding area. It has state-of-the-art equipment and facilities, including an IT Center, high tech electronic microscopes and language laboratory, a “Clean Room” and various
2. Early consistency education system

Fig.2 shows the schematic diagram of the education system in the college of technology (KOSEN). Almost junior high school graduates (98.8%) go to the next stage of education grades in Japan. They have two routes, one is senior high school and another is KOSEN (a). KOSEN has 5-year education program, and the most distinctive feature of KOSEN is that there is no university entrance examinations. In the current state of education in Japan, the study of entrance examinations for university is regarded as important in senior high school educations. On the other hand, students in KOSEN can start to study the high specialized engineering education from early stage, whose age is 16 years old. After graduate KOSEN, students can select three routes. First is employment for a company (b), second is to go to the advanced course in KOSEN (c) and third is to enter a university (d). At the time of graduation, students of KOSEN have same level of the knowledge and skills as university students. Furthermore, after graduating from the advanced course in KOSEN, students get the bachelor’s degree of engineering, and they are get an employed by companies (e) or go to a graduate school in university (f).

On the other hand, second and third year students will take general courses like any normal Japanese high school students. These required classes include math, chemistry, physics, history, Japanese, English, information technology art, music, health and fitness. At first general studies dominate their schedules with only a few specialized classes for their major. Gradually, the number of specialized classes takes over, giving students more and more hands on experience in their fields. Experiments and laboratory work will eventually fill their schedules in their fourth and fifth years while only a few general science electives and required classes remain available to them. Besides English communication classes which are required throughout their time at KOSEN, they can choose between other electives such as humanities, philosophy, environmental awareness, geology, Chinese, Korean, German to name a few.
3. Departments in the Kobe City College of Technology

KCCT consists of 5 departments and 6 classes. One class has 40 students, the department of mechanical engineering has two classes, and the other departments have one class. The number of students in one grade is 240 students, and the total number of students in KCCT including the advanced course is about 1,500, which is the largest KOSEN in Japan.

3.1 Department of Mechanical Engineering

The Department of Mechanical Engineering (Fig.3) in KCCT has two courses. One is the Robotics Design Course and another is the Energy system course.

Robotics Design Course: This course focuses on robotics production and machine control technology. A robot is a total mechanical system that brings together various technologies such as design technology, dynamics, various actuator (motor) technologies, sensing technology with various sensors, information processing (programming technology, image recognition, voice recognition, etc.) and control technology. The purpose of this course is to acquire mechanical engineering related knowledge and technology through learning by using robot as a subject.

Energy System Course: This course focuses on technologies related to aircraft, rockets and cars. Energy is the basis of all technologies and is closely related to environmental issues. In this course, students learn mechanical engineering related knowledge and technology through learning energy conversion and its effective utilization. Furthermore, it aims to learn about the technology to combine them and systematize.

3.2 Department of Electrical Engineering

The Department of Electrical Engineering (Fig.4) includes many fields from energy to information /communication. Fundamental subjects, including electrical and electronic circuit design, along with computer simulation technology are useful in contributing to an ecologically sustainable society as well as developing state-of-the-art electronic products. Some subjects use English textbooks based on "learning technology in English" and "learning English in technology study" simultaneously.

3.3 Department of Electronic Engineering

The Department of Electronic Engineering (Fig.5) provides a curriculum featuring Telecommunication, Information Processing, Electronic Measurements and Control, and Electronic Material. Specifically, for the study of Integrated Circuit (I.C.), the Device Engineering Laboratory has been established. Software Technology, Information Technology and
Computer Technology Laboratories are also provided for the studies of computers.

3.4 Department of Applied Chemistry
The Department of Applied Chemistry (Fig.6) produces chemical engineers for various industrial fields related to organic chemistry, inorganic chemistry, physical chemistry, chemical engineering, and biological engineering. The goal of the department is to have students acquire fundamental knowledge in each field and competence to apply the knowledge for solving real issues with the help of analytical equipment and computation.

3.5 Department of Civil Engineering
As for the Civil Engineering Department (Fig.7), education and research into five fields are accomplished. The curriculum includes studies in structure, materials, soil mechanics, hydrologic and city design planning. Disaster prevention and environmental technology such as earthquake, tsunami and geology are also considered. Many public work projects come out of civic necessity and happiness, and city design dreams are realized. Our department's engineers are contributing to society are educated about the lifeline such as traffic networks, air ports, harbors, power facilities, water and sewage services.

3.6 Advanced Courses
Advanced Course (Fig.8) is 2 year program after graduated Advanced courses, which follow the five-year technical college program in order to provide two more years of technical education were established in 1998. These courses have produced engineers with advanced and extensive knowledge who not only have the ability to develop technology and solve problems but also contribute to the development of the industries themselves. Students in advanced course can get the bachelor's degree of engineering, and they can go to graduate school of universities in all Japan.

4. New trial of the Growth Industries Engineer Education Programs
Growth Industries Engineer Education Programs (GIEEP) for growth industries was started in 2017 by Kobe City planning.
The purpose of GIEEP is to develop young engineers for the future industries in need of human resources by the year 2020. Three areas of growth industries were planned up by Kobe City.

The industries for seen to have the most growth are Robotics, Medical & Welfare and Aerospace. Three GIEEP courses were newly created corresponding to these areas in KCCT. GIEEP courses are special three year program for third year students to enter from the majors of Mechanical, Electrical and Electronic Engineering fields in KCCT.

Fig. 9 shows a schematic diagram of the education system in the department of mechanical engineering. There are two courses of the Robotics Design Course and the Energy System Course. The both courses have same core subjects. Especially, the four main dynamics subjects of Strength of materials, Hydrodynamics, Thermodynamics and Mechanical dynamics are very important. After the fourth grade, the subjects of the two courses become different contents clearly, and the education contents will be to enhance the specialty in each course. GIEEP class starts from third grade based on these expertise. In usual case, students decide the GIEEP courses of the robot, the aerospace and the medical welfare when they go to third grade.

Fortunately, they can learn the GIEEP aerospace course from the Robotics course, or, conversely, learn the GIEEP robot from the Energy-system course. In addition, GIEEP medical welfare can be leaned from either course.

5. Problems of GIEEP

Although there are several problems in GIEEP operation, two main points were reported in this paper.

First, the operation of GIEEP becomes a heavy burden for teachers. There are many works, such as preparation of a new subject, requesting a visiting lecturer, planning a factory tour and negotiating with the host. These GIEEP jobs are added to the ordinary work and require a lot of time. As a result, the burden on teachers is increasing so much. Table 1 shows the activity results of the Aerospace course in 2017. Fig.10 shows...
Table 1 Activity results of the Aerospace course in 2017.

<table>
<thead>
<tr>
<th>1. Intensive Lecture</th>
<th>Lecture English Conversation lounge</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 26 (Tuesday) 13:00 to 14:30</td>
<td>(1) Purpose Maintain an environment familiar with English conversation from everyday times.</td>
</tr>
<tr>
<td>October 11 (Wed) 15:00-16:30</td>
<td>(2) Part-time lecturer Kobe City University Graduate School Ng Yik Min (Ichi) teacher Zheng Yi Meng (Yong) teacher Li Ying (Sakura) teacher</td>
</tr>
<tr>
<td>November 22 (Wednesday) 15:00 to 16:30</td>
<td>(3) Opening date 16 times on Wednesday of the following schedule PM14: 50-15: 50 May 10, 17 June 14, 21 and 28 July 5, 12 October 4, 11 November 8, 15 December 13, 20 January 10, 17, 24 (May 10-June 28: Zheng Yi Meng (Imon) teacher) (July 5-November 15: In charge of Li Ying (Sakura) teacher) (Dec. 13-Jan. 24: Ng Yik Min (Ichi) teacher)</td>
</tr>
<tr>
<td>December 8 (Fri) 13:30 – 15:00</td>
<td>From this Activity results, there were five intensive lectures by the outside lecturer, two visit training to companies, and 16 times English conversation lounge. This work is added on the regular school work of teachers. Therefore, the burden on teachers is increasing.</td>
</tr>
<tr>
<td>December 13 (Wed) 15:00 to 16:30</td>
<td>The second is that despite the heavy work load for GIEEP, the number of students who can attend is small. Table 2 shows the number of students who have selected three courses.</td>
</tr>
</tbody>
</table>

Table 2 Number of students who have selected three courses.

<table>
<thead>
<tr>
<th>Courses</th>
<th>Number of students &amp; Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robotics</td>
<td>2019</td>
</tr>
<tr>
<td>Medical Welfare</td>
<td>10</td>
</tr>
<tr>
<td>Aerospace</td>
<td>14</td>
</tr>
</tbody>
</table>
6. Conclusions
1) The education system of technical college (KOSEN) was explained.
2) An explanation was given on early integrated education in Kobe City College of Technology (KCCT).
3) We explained the relationship between the new courses of Growth Industries Engineer Education Programs (GIEEP) and the conventional curriculum.
4) The problems of the GIEEP were explained.

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1) http://www.kobe-kosen.ac.jp/en/
2) https://www.kosen-k.go.jp/english/
COMPARATIVE ANALYSIS OF COURSE OUTCOME BETWEEN STUDENT PERCEPTION AND STUDENT GRADE ACHIEVEMENT IN ENVIRONMENT AND SUSTAINABILITY

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Abstract

In teaching and learning (T&L) quantification and qualification, the outcome of course achievement is important indicator for continuous quality assessment and outcome-based education (OBE). This educational process is based on achieving certain specified program outcomes in terms of individual student learning. One of the program outcomes is Environment and Sustainability, where students are expected to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge and need for sustainable development. This paper highlights on the measurement between student achievement quantified based on product output and own-self-perception scale. The correlation and effect of education strengthening strategies using project-based learning (PBL) on student’s effectiveness in knowledge understanding and technology skills on environment and sustainability were evaluated in this paper. Direct measurement of learner’s outcome and course grade performance of Civil engineering students from recent cohorts of Universiti Malaysia Sabah (n=73) were analyzed and quantified. The result reveals that grade achievement may not a specified accurate measure in learning attainment. It is also found that the student learning perception is more fitted for direct assessment especially in learning strategies such as Project Based learning (PBL). The outcome of Project Based Learning (PBL) implementation and improvement in the assessment method has resulted positive influence between learner’s appreciation and environmental application.

Keywords: course outcome, outcome-based-education, engineering education, environment and sustainability

1.0 INTRODUCTION

Since 2006, the accreditation of engineering degrees by Engineering Accreditation Council (EAC) of Malaysia has mandate and emphasize on the outcome-based education (OBE) academic approach. This has made OBE pioneered by engineering faculties in most universities in Malaysia. The Outcome-Based Education is an approach that focuses on outcomes, i.e. the achievements of students that are measurable, proven, and can be improve which inclusive in Continuous quality improvement CQI. The process of learning is student-centered rather than lecture-based as done in the conventional method. OBE is an organization of educational process that target to obtain the desired results by the students’ achievement evaluation (Spady, 1994) and/or work as principle that decisions about curriculum and instruction should be driven by the outcomes
students that show at the end of their educational experience (O’Neil, 1994). The definition of OBE is various (Yusoff et al, 2014) however in practice it is a process that involves the restructuring of curriculum, assessment and reporting practices with documented evidences in education to reflect the achievement of high order learning and mastery. OBE has gained prominence recognition internationally and has been implemented many countries such as Canada, USA, Australia, South Africa, New Zealand, Hong Kong and Malaysia (Akir et al, 2012).

The largest challenge in implementing OBE would be in evaluating qualitative and quantitively the input and outputs validation of the OBE overall process. Many program evaluations involve the analysis of outcomes using various forms of descriptive and inferential statistics, and such methods must meet the underlying assumptions of the assessment carried out correctly (Royse et al, 2016). Linking student performance with institutional effectiveness is probably one of the most important yet sensitive issues. Besides program structure and instruction while at studying at an institution, there are many other determinants of student learning and often these factors are beyond the institutional control such as student motivation, family influence, peer surrounding support system, financial status etc can all have impact on student achievement in their higher learning outcomes (Liu, 2009, Bolong et al, 2011). Furthermore, traditional instruction such as lecture-based session was one of the most effective ways to disseminate information although often allowed students to be passive in the classroom and relied on transcription, memorizing and repetition for learning (Kaliannan and Chandran, 2012).

Malaysia is member of Washington Accord; a recognition equivalence in the accreditation of qualifications for engineering programme. At the intuitional, the OBE assessment includes three types of outcomes/objective: first is the Course Outcomes (CO) which assessed during taught semester. Secondly, the Program Outcomes (PO); assessed at the end of the semester. The third outcome is Program Educational Objectives (PEO) assessed after 3 to 5 years after graduation. Though PEO is somehow beyond control of the institution and influenced by duration of career experience (Makinda et al, 2011) which another interesting subject of study.

Various methods of assessment have been implemented to assess the OBE achievement at higher learning institution. Due to better control and access data of students up until graduation, Course Outcome (CO) and Programme Outcomes (PO) are more conducive assessment and therefore received more attention and better expectations in accreditation process (Estes & Ressler, 2007). The evaluation of CO and PO may indicate how much students have learned or grasped during their learning period. Even though, several studies highlighted the issues of procedural, validity and reliability of outcomes assessment implementation and vague assessment method that failed to concrete continual quality improvement (Mohammad & Zaharim, 2012). However, implementation of OBE has resulted very useful especially for academic, attitudes and instructions not only due to capability in measure learners’ performance through course instructions but also promotes competitiveness among students, clear direction of learning, increase school activities and responsiveness (Angelica, 2016).
The twelve (12) (PO(i) to PO(xii)) attributes that are expected for Malaysian engineering graduates that relate to the skills, knowledge, and behavior of students are described in EAC manual (EAC, 2017). For this paper, we focus on the attainment of Environment and sustainability—in the ability for understanding and evaluating sustainability and impact of professional engineering work in the solutions of complex engineering problems in societal and environment contexts (PO7). Two common approaches used are direct and indirect assessment methods. These methods lead to triangulation of results and expected to provide better judgment on the degree of achievement of the courses' learning processes and outcomes.

2.0 Research Method and data analysis

The model of PO assessment on the attainment of Environment and sustainability is based on indicators set in the course assessment. Students were enrolled in environmental engineering course; one of the compulsory courses for the Civil Engineering program in the Faculty of Engineering, Universiti Malaysia Sabah (UMS). The course outcomes and assessments for the taught subject were aligned as shown in Table 1. The measurement method is categorized into two types which are 1) direct method which is based on evaluator’s marks input that contribute 100% of the total grade and 2) indirect method that consist of self-perception and individual feedback survey which quantified based on rubric criteria and Likert-scale.

Table 1 summaries the PO assessment whereas Figure 1 illustrates the PO assessment model and improvement (CQI) process conducted during the learning process. Improvement were only included in direct method especially for formative assessment (Project Based Learning Report and group assignment) however course CQI were also evaluated at end of the course for next coming course implementation.

The assessment and quantification for each performance indicator are normalized to 100 percent or indicated as tabulated in Table 2 to simplify comparison of attainment on Environment and Sustainability (PO7).
Table 1 The five main performance indicators used in measuring the Environment and Sustainability attainment (PO7) for Civil engineering Environmental Engineering Course.

<table>
<thead>
<tr>
<th>Method of measurement</th>
<th>Performance indicator</th>
<th>Course outcome (keyword)*</th>
<th>Pedagogy used</th>
<th>Measurement tool and parameter</th>
<th>Quantified unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>Course assessment</td>
<td>CO1</td>
<td>Lecturing</td>
<td>Final exam and tests</td>
<td>Marks score (percentage) (65%)</td>
</tr>
<tr>
<td>Direct</td>
<td>Course assessment</td>
<td>CO2</td>
<td>Tutorial</td>
<td>Group assignment</td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>Course sustainability project</td>
<td>CO3</td>
<td>Project Based Learning</td>
<td>Group report</td>
<td>Rubric and marks (35%)</td>
</tr>
<tr>
<td>Indirect</td>
<td>Course affective</td>
<td>CO3</td>
<td>Fieldwork</td>
<td>Self-reflection report</td>
<td>Rubric (1-4)</td>
</tr>
<tr>
<td>Indirect</td>
<td>Course perception survey</td>
<td>CO1, CO2, CO3</td>
<td>Online survey</td>
<td>Individual CO feedback</td>
<td>Likert scale (1-4)</td>
</tr>
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*CO1: Ability to identify and describe environmental problems (water, air, noise and waste disposal)  
CO2: Ability to evaluate the fundamental pollution issues and distinguish responsible solution  
CO3: Ability to Organize and value civil engineering problems on the environment/community sustainability

Fig. 1 PO assessment model for sustainability and environment for civil engineering at UMS (environmental engineering course)
Table 2 Description for Percentage marks in accordance to Point achievement indicator

<table>
<thead>
<tr>
<th>Scale point</th>
<th>Marks (%)</th>
<th>Indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.00</td>
<td>80 - 100</td>
<td>Very good</td>
<td>Learning outcome fully achieved</td>
</tr>
<tr>
<td>3.00</td>
<td>60 - 79</td>
<td>Good</td>
<td>Learning outcome is achieved</td>
</tr>
<tr>
<td>2.00</td>
<td>40 – 59</td>
<td>Fair</td>
<td>Learning outcome satisfactorily achieved</td>
</tr>
<tr>
<td>1.00</td>
<td>20 - 39</td>
<td>Poor</td>
<td>Learning outcome not achieved</td>
</tr>
<tr>
<td>0.00</td>
<td>0 - 19</td>
<td>Very poor</td>
<td>Learning outcome completely not achieved</td>
</tr>
</tbody>
</table>

3.0 RESULT AND DISCUSSION

3.1 Gender and entry education background

The total number (n=73) and the distribution between male and female of student studied in this paper is illustrated in Fig.2 (a) whereas in Fig. 2 (b) displays the percentage of enrollment categories of the students or their previous education experience before enrollment in civil engineering programme. It is anticipated that the characteristic of gender may have little influence on the quantification on the learner’s outcome as the distribution is quite balance. In spite of gender differences and various categories of previous education, the group work and learning activities approach ensures them to work cooperatively in a team.

![Fig. 2 Student background distribution (n=73) based on (a) gender and (b) education enrollment type](image)

From Fig 2. (b) Majority (53%) of the students are from Malaysian Higher School Certificate (STPM) education background and 22% from civil engineering diploma whereby these 2 categories may be few years older and has working experience than the other students from science foundation/matriculation (20%) and international students (5%). Since this is a final year subject, equal learning performance is considered unbiased after three years of studies (Bolong et al, 2011)
3.2 Course grade achievement

From the direct measurement result shown in Fig. 3, the lowest grade attained by the student in the course is grade C at 3% while 18% achieved A. This achievement is based on total marks from the direct measurement stated previously in Table 1. The values of grade were then equated with scale point as shown in the distribution achievement to complement the course outcome results.

The resulted values were 10% of scale point 2, 72% of scale point 3 and 18% attain scale point 4. The comparison of the attainment based on grade and the course outcome (CO) is shown in Fig. 4 (a-c). As expected, the course grade scale point did not represent well all the three COs because it is the cumulative of the three COs. Unfortunately grade result did not specified which learning outcome student has not achieved which make teaching and learning improvement indistinct. Furthermore, other researchers also have indicated that grades are not necessarily an accurate measure of learning (Arum & Roksa, 2011) even though it’s been highly used in measuring academic achievement (York et al, 2015).

As shown in Fig. 4 (a-c), CO1 has slightest standard deviation (ranges from 1.4 to 7.7) compared to CO2 and CO3 which are 1.4 to 41.7 and 1.4 to 14.9 respectively. This attributed to CO1 has the largest contribution marks of the grade (50%). Whereas for CO2 and CO3, it contributes 15% and 35% of the total marks respectively. Hence, CO2 and CO3 did not fit well the CO grade and shall not considered as outcome achievement of CO2 and CO3. The ratio of Total Course Outcome (50:15:35) did not appropriately fit the respective course outcome achievement and thus may mislead the continual quality improvement (CQI) strategies in Teaching and learning.

![Fig. 3 Percentage distribution of course attainment based on grade](image-url)
3.3 Course achievement and student perception

The student achievement quantified in accordance to product output (COs) and own-self-perception were resulted in Fig. 5 (a-c). The direct measurement (COD) shows quite large gap with the student perception or indirect measurement (CO(P)) except for CO3. For CO1, the std deviation (σ) ranges from 5.9 to 13.1, CO2: range from 5.5 to 23.5 whereas for CO3, the σ ranges from 0.5 to 3.5. The perception survey for CO3 has been found to be more fitted with their marks achievement due to the nature of the Project Based Learning (PBL) learning that may has built better confidence or understanding of the subjects learnt and it is a student-centered instructional approach (Dolmans et al, 2016). The PBL implementing community engagement has provide the teaching reformation and development in learning that reflected in the student perception. Furthermore, PBL provide students with the possibility of achieving sustainable and transferable skills, while at the same time exposing them to the complexities of global and cultural issues (Lehmann et al., 2008).
Additionally, the feedback from students on the course implementation and assessment were also compiled in the student perception survey. The responses were categorized as positive and negative/need improvement feedback and several examples are summarized in Fig. 6. More than half or 77% of the students enjoyed and responded positively to the course teaching and learning process; however, 23% has no comment or requires improvement for the course especially on the tutorial exercises, reading materials, and time and venue of the lecture hall. The positive feedbacks were primarily from the PBL implementation. PBL is an effective teaching and learning as it begins with problem analysis and followed with self-directed learning (Yew and Goh, 2016) and able to outperform the learning and foster conceptual change (Loyens et al, 2015). These feedbacks are important for the course continuous improvement for next semester such as by improving the learning facility comforts, time of lectures, and increase cognitive tutorial activities.

Fig. 6 Learners Feedback from course perception survey

CONCLUSION

In summary, the study analyzed and compared the direct measurement of grades, learning outcomes achievement and indirect measurement of student perception and feedbacks. It is concluded that the course grade is not directly equivalent to course learning outcome scale measurement which is not representing the course outcome and CQI evaluation as resulted in this case study. The direct measurement of learning outcome may differ to student perception due to variability of learners confidence and assessment criteria. Finally, it is also observed that perception survey is an important tool to assist educators to get feedback and improvement for the course learning strategies. It is recommended that measurement learning outcome either direct or indirect has more specific target for CQI improvement than student grade achievement.
Acknowledgement

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Continuous Quality Improvement- Assessing Students’ Satisfaction

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Abstract

Continuous quality improvement (CQI) is an important principle that can be used to improve any process including teaching and learning. One important aspect of CQI is to obtain, assess and evaluate feedback from stakeholders or customers. In teaching and learning, students are the main customers. Thus, their views on the quality of teaching and learning process is important. Each student at University Malaysia Sabah is required to fill-in an online evaluation form at the end of each semester. The form has five categories and each category has several questions. The student response is on Likert scale from 1 to 5. The analysis of the Faculty of Engineering students’ feedback for two semesters is reported. It was found out the average score for all courses given in a semester by each program is above 4. In addition, the percentage of courses where the average score was less than 80% was 6.9% and 6.5% for semester 1 and 2 respectively. Thus, it can be concluded that the students are satisfied with the teaching and learning process.

Keywords: Outcome-based education, stakeholders’ feedback, engineering education

Introduction

The accreditation of Engineering Programs is a very important issue to institutions of higher learning (IHL) because it affirms the quality of the degrees they offer. In Malaysia, The Board of Engineers, Malaysia (BEM) is the body entrusted with the accreditation of all undergraduate engineering programs through the Engineering Accreditation Council (EAC Manual, 2017). The EAC put a strong emphasis on continuous quality improvement (CQI). In the EAC accreditation manual 2017, for example, the term CQI was mentioned 38 times and it is highlighted in all seven criteria used for accreditation. In addition, it is stated in the manual that “the objective of accreditation is to ensure that Continual Quality Improvement (CQI) is being practiced by IHLs” (EAC Manual, 2017). Given the importance of CQI to a successful accreditation and thus the reputation of the academic programs offered by IHLs, CQI should become an essential part of the culture in IHLs (Carole, 2007). However, according to (Park, 2013) while “continuous improvement has become commonplace and well-documented in other industries, such as healthcare and manufacturing, little is known about how this work has manifested itself in education”. According to (ana, 2009) “While there is a consensus on the importance of service quality issues in IHLs, the identification and implementation of the right measurement instrument
is a challenge that practitioners who aim to gain a better understanding of the quality issues of students’ experiences face”.

Park (2013) defined continuous quality improvement as “the act of integrating quality improvement into the daily work of individuals in the system.” It involved three aspects: 1) the frequency of quality improvement work; 2) the depth and extent of its integration at different levels of the organization; and 3) the extent of contextualization within a system of work processes. Another term used for CQI in industries is Total Quality Management (TQM). The main principle and driving force in TQM is basically founded on the importance of customer satisfaction (i.e., customer-centered culture), leadership and continuous improvement effort by all involved within the system. The EAC manual encourages IHLs to meet with all stakeholders as this would give an indication of the stakeholders’ involvement in the CQI process of the program.

But in academia, who is the customer? Khosravi et al. (2013) stated that students are the customers and that “addressing the demands and needs of students is critical for higher educational institutions if they want to be competitive”. However, Yeap (2008) argued that by satisfying students, institutions might risk compromising the needs of society as a whole. Some authors preferred a process that modelled a fitness centre where students define their long-term goals and the institution prescribed the program for meeting those goals. However, others believed that both students and businesses needed to be treated as customers and they employed the concept of co-production that required the involvement and cooperation of educators, students, parents or businesses to achieve the quality outcome of the educational service. Yeap (2008) perceives students as both customer and employee. We believe that students are customers and products. They are customers because they want an education and the university is providing this service. However, they are a participating customer. Thus, the quality of the service they obtain from the university depends, to a certain extent, on their willingness and ability to receive the service. They are also products for the industries where they will be employed and the society at large because they will be part of that society.

In this paper, we focus on assessing the students’ satisfaction with the services provide by the university, specifically, the Faculty of Engineering. This paper is organized as follows: in the next section, the method used to collect the students’ responses will be explained. This is followed by discussing the results obtained from the data collected from the students and finally, the paper will conclude.

**Materials and Methods**
At the end of each semester, every student is required to fill-in a form, called PK07 shown in Figure 1, for each course they have studied during that semester. The form has 22 questions divided into 5 categories. The first category is called preparation, has 3 questions which deal with briefing for the students regarding the course which is normally carried out at the beginning of the course. The second section called, delivery of lectures, also has 3 questions that deal with how the lecturer delivered his lecture. The third section also has 3 questions that assess the learning outcomes while the fourth section, called facility, has 3 questions that assess the facility where the course was carried out. The last section, called soft skills, has 7 questions that assess the effect of the course has on the student’s soft skill. Students are required to give a value on a Likert scale from 1 to 5 for each question, 1 being the lowest value and 5 is the highest. The average for each section as well as the overall average is calculated from all the students taking a given course. Figure 1 shows a snapshot of the PK07 report generated for each course.

Results and Discussions

The analysis of all the PK07 reports for semester 2 session 2017-2018 and semester 1 session 2018-2019 will be reported in this paper. For semester 2 session 2017-2018, only 10 courses out of a total of 145 courses offered by the five programs achieved an overall percentage students’ satisfaction of less than 80%. That is only 6.9% of all courses have a percentage satisfaction rate of less than 80%. Similar results were obtained for semester 1 session 2018-2019 whereby only 9 courses out of 140 courses achieved an overall percentage satisfaction of less than 80% that is only 6.43% of the courses offered.
Figure 2 shows the percentage of courses with less than 80% satisfaction for each program for two semesters. As can be seen from Figure 2, there is only one program which has maintained almost a constant percentage for both semesters while another program percentage drops from around 7 to 0 while another increases from 0 to 15%. The performance of the other two programs either drops or increases. Thus, there is no trend that can be drawn. Only two programs can be seen as improving their performance, thus, they might be following the CQI process if this trend continues.

Figure 3 shows the percentage of courses with less than 80% satisfaction by category. As can be seen from Figure 3, the delivery and facility sections have the lowest satisfaction rate while the preparation section has the best satisfaction rate. In the spirit of CQI, it is expected that the satisfaction rate for each section should improve in every semester. However, as evident from Figure 3, the satisfaction rate for almost all categories decreases. The reasons for this should be investigated and remedial actions be taken to continuously improves the students’ satisfaction rates.

**Conclusion**

Students’ satisfaction with the services provided to them by their IHL is very important if the IHL wants to continuously be respected by students, parents, and the community at large. Thus,
having a system that continuously assess, evaluates and improves the satisfaction rate by students. In this paper, students’ satisfaction rate for five categories for two semesters were evaluated. It was found, only 6.9% and 6.43% of the courses obtained less than 80% satisfaction rate. Out of the five categories, the delivery and Facility sections have the lowest satisfaction rates.

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On the topological indices of Molecules and Molecular Compounds associated with Fullerenes

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1. Abstract

In this research\textsuperscript{1}, we study four degree based topological indices, the atom bond connectivity (ABC) index, the fourth version of the atom bond connectivity index, the geometric-arithmetic (GA) connectivity index and the fifth version of the geometric-arithmetic connectivity index of chemical graphs associated with molecules and molecular compounds of fullerenes. For fullerene networks and carbon nanotube networks, these indices were studied by M. Baca, J. Horvathova, M. Mokrisova and A. Suhanyiova. We calculate the four indices for the dimer and the linear \( n \)-polymer of the

\textsuperscript{1} This research was done as the “Final Year Project 2018 - 2019” in the educational program “Malaysia Japan Higher Educational Program.”
fullerene $C_{60}$.

**Keyword:** fullerene, molecules and molecular compounds of fullerenes, topological indices, graph theory

## 2. Introduction

Molecules and molecular compounds often can be modeled by chemical graphs. A chemical graph is a representation of the structural formula of a chemical compound in terms of graph theory. So graph theory has provided chemists with a variety of useful tools, such topological indices. For example, the atom-bond connectivity (ABC) index which is one of a most important topological index can be used for modeling thermodynamic properties of organic chemical compounds (cf. Estrada 2018, Estrada et al. 1998, and Gutman et al. 2012).

The purpose of this research is to analyze the topological indices of molecules and molecular compounds associated with fullerenes. In particular, we treat $C_{60}$. We calculate and analyze well-known connectivity topological descriptors which are the ABC index, the fourth version of the ABC index, the geometric-arithmetic (GA) index and the fifth version of the GA index. We first consider $C_{60}$ and its dimer $(C_{60})_2$. We also generalized the results of them to the case of the linear $n$-polymer $(C_{60})_n$.

## 3 Literature Reviews

### 3.1 Fullerenes

A fullerene is a molecule of carbon in the form of a hollow sphere, ellipsoid, tube, and
many other shapes. Fullerenes is also known as a form of carbon having a spheroidal molecule consisting of a hollow cage of sixty or more atoms, of which Buckminsterfullerene $C_{60}$ was the first known example. The fullerene $C_{60}$ and its derivatives are main objects in this paper. In this research, $C_{60}$ was modeled by Origami and this model was very helpful to our calculations. See Figure 1 below.

![Figure 1: An origami model of fullerene $C_{60}$](image)

### 3.2 Oligomers of Fullerene $C_{60}$

From the point of view of polarizability, the fullerene dimer $(C_{60})_2$ and some oligomers of $C_{60}$ were studied by D.S. Sabirov (Sabirov 2013). The polarizabilities have been found to be efficient parameters for the design of nanostructures with desirable behavior. He have performed the first density-functional theory study on the polarizability of fullerene
derivatives \((C_{60})_n\) \((n=1,2,3,4,5)\) to elucidate how their structures affects the polarizability.

![Figure 2: Oligomers of fullerene C\textsubscript{60} \(n=1,2,3,4,5\) (from Sabirov 2013)](image)

**3.3 Graph Theory**

Formally, a graph \(G\) is a pair of sets \((V,E)\), where \(V\) is the set of vertices and \(E\) is the set of edges, formed by pairs of vertices. For a graph \(G\), the degree of vertex \(v\) is defined to the number of edges incident to \(v\) and denoted by \(\text{deg}(v)\). For the terminologies and notations in the graph theory, refer to West 2003.

In chemical graphs, the vertices of the graph correspond to the atoms of the molecule, and the edges represent the chemical bonds.
3.4 Topological Indices

A graph can be recognized by a numeric number, a polynomial, a sequence of numbers or matrix which represent the whole graph, and these representation are aimed to be uniquely defined for that graph. A topological index is a numeric quantity associated with a graph which characterize the topology of graph and is invariant under the graph auto morphism. There are some major classes of topological indices such as distance based topological indices, degree based topological indices and counting related polynomials and indices of graph. Among these classes degree based topological indices are of great importance and play a vital role in chemical graph theory.

Let $G$ be a chemical graph. One of the well-known degree based topological indices is the atom-bond connectivity (ABC) index of $G$ defined by

$$ABC(G) = \sum_{uv \in E(G)} \sqrt{\frac{\deg(u) + \deg(v) - 2}{\deg(u) \deg(v)}}.$$  \hspace{1cm} (1)

The fourth version of the atom-bond connectivity index was introduced in Ghorbani et al. 2010. It is defined by

$$ABC_4(G) = \sum_{uv \in E(G)} \frac{S_u + S_v - 2}{S_u S_v}.$$  \hspace{1cm} (2)

where $S_u$ is the sum of degrees of all vertices adjacent to $u$. That is, $S_u = \sum_{v \in N_G(u)} \deg(v)$ where $N_G(u) = \{v \in V(G) \mid uv \in E(G)\}$.

Another well-known index is the geometric-arithmetic (GA) index which is defined in Vukicevic et al. 2009. It is defined to be

$$GA(G) = \sum_{uv \in E(G)} 2 \sqrt{\frac{\deg(u) \deg(v)}{\deg(u) + \deg(v)}}.$$  \hspace{1cm} (3)
The fifth version of GA index was proposed in Graovac et al. 2011 and defined as

\[ GA_5(G) = \sum_{uv \in E(G)} \frac{2 \sqrt{S_u S_v}}{S_u + S_v}. \]  

(4)

We consider these topological indices in this research.

4 Methodology

In this section, we calculate the four topological indices introduced in Section 3, for chemical graphs of fullerene \( C_{60} \) and its derivatives.

4.1 Fullerene \( C_{60} \)

We first consider the fullerene \( C_{60} \). Let \( G_{60} \) be its chemical graph. The chemical graph \( G_{60} \) is a planar, 3-regular and 3-connected graph, twelve of whose faces are pentagons and any remaining faces are hexagons. See Figure 3 below.

![Figure 3: The chemical graph \( G_{60} \) of the fullerene \( C_{60} \) (from Wikimedia Commons, https://commons.wikimedia.org/wiki/Fullerene_graphs?uselang=ja)](image)

It follows from Figure 3 that \( \text{deg}(v)=3 \) and \( S_v=9 \) for \( \forall v \in V(G_{60}) \). It is also well known that \( \#V(G_{60})=60 \) and \( \#E(G_{60})=90 \). Using these datum, we easily obtain
\[ ABC (G_{60}) = 90 \times \sqrt{\frac{3 + 3 - 2}{3 \times 3}} = 60, \]
\[ ABC_4(G_{60}) = 90 \times \sqrt{\frac{9 + 9 - 2}{9 \times 9}} = 40, \]
\[ GA(G_{60}) = 90 \times \frac{2\sqrt{3 \times 3}}{3 + 3} = 90, \]
\[ GA(G_{\frac{5}{60}}) = 90 \times \frac{2\sqrt{9 \times 9}}{9 + 9} = 90. \]

4.2 The Fullerene Dimer \((C_{60})_2\)

In this subsection, we consider the fullerene dimer \((C_{60})_2\). Let \(G_{120}\) be the chemical graph of \((C_{60})_2\).

The chemical graph \(G_{120}\) is shown as Figure 5 below. It is known that the total number of edges of \((C_{60})_2\) is \(#E(G) = 182\) (resp. \(#V(G) = 120\)). On the other hand, the number of vertices for \((C_{60})_2\) is \(#V(G) = 120\).
4.2.1 The ABC index of $G_{120}$

The degree of each vertex of $G_{120}$ follows from Figure 5 as

$$\text{deg}(v_i) = \text{deg}(v_j) = \text{deg}(u_i) = \text{deg}(u_j) = 4, \text{deg}(v_i) = \text{deg}(u_j) = 3 \text{ for } i \neq 1,2, j \neq 1,2.$$  \hfill (5)

By (5), we have the following three values for the terms in the definition of ABC index:

$$\sqrt{\frac{\text{deg}(u) + \text{deg}(v) - 2}{\text{deg}(u) \cdot \text{deg}(v)}} = \begin{cases} \sqrt{\frac{6}{4}} = \frac{\sqrt{6}}{2}, \\ \sqrt{\frac{15}{5}} = \sqrt{3}, \\ \frac{2}{3} \end{cases},$$  \hfill (6)

For the edges $v_1v_2, v_1u_1, v_2u_2, u_1u_2$, we have the first value $\frac{\sqrt{6}}{4}$ in (6) (resp. the second one $\frac{\sqrt{15}}{5}$ in (6)). On the other hand, the third value $\frac{2}{3}$ in (6) occurs for the other 170 edges. Consequently, we have
\[ ABC(G) = \frac{\sqrt{6} \times 4 + \sqrt{15} \times 8 + 2 \times 170}{3} = \frac{3\sqrt{6} + 4\sqrt{15} + 340}{3}. \]

### 4.2.2 The fourth version of ABC index of \( G_{120} \)

Next we calculate the fourth version of ABC index. It also follows from Figure 3 that the following datum:

\[ S_{v_1} = S_{v_2} = S_{u_1} = S_{u_2} = 14, \]
\[ S_{v_3} = S_{v_4} = S_{v_5} = S_{u_3} = S_{u_4} = S_{u_5} = S_{u_6} = 10, \]
\[ S_{v_7} = S_{u_7} = 9 \quad \text{for the other vertices}. \]

So we have the following four values of the terms in the definition of the fourth version of ABC index:

\[
\begin{array}{c}
\sqrt{S_u + S_v - 2} \\
\sqrt{S_u S_v}
\end{array} = \begin{cases} 
\frac{\sqrt{26}}{14}, \\
\frac{\sqrt{770}}{70}, \\
\frac{\sqrt{170}}{30}, \\
\frac{4}{9}
\end{cases}
\]

The first value \( \frac{\sqrt{26}}{14} \) in (7) occurs for the four edges \( v v, v u, v u, u u \). The second one \( \frac{\sqrt{770}}{70} \) occurs for the eight edges \( v v, v v, v v, v v, u u, u u, u u, u u \). The third one \( \frac{\sqrt{170}}{30} \) occurs for the sixteen edges \( v v, v v, v v, v v, v v, v v, v v, v v, u u, u u, u u, u u, u u, u u, u u \). We also have the fourth one \( \frac{4}{9} \) for the other one hundred fifty four edges. Consequently, the fourth version of ABC
index is obtained as
\[
ABC_4(G_{120}) = \frac{26}{14} \times 4 + \frac{\sqrt{770}}{70} \times 8 + \frac{170}{30} \times 16 + \frac{4}{9} \times 154 = \frac{2}{7} \sqrt{26} + \frac{4}{35} \sqrt{770} + \frac{8}{15} \sqrt{170} + \frac{616}{9}.
\]

### 4.2.3 The GA index of \(G_{120}\)

Here we consider the GA index for \(G_{120}\). It follows from (5) that
\[
\frac{2 \deg(u) \times \deg(v)}{\deg(u) + \deg(v)} = \begin{cases} 
1, \\
\frac{4}{3}, \\
\frac{19}{6}, \\
\frac{35}{6}, \\
\frac{1}{19}.
\end{cases} \tag{8}
\]

For the edges \(v_1v_2, v_1u_1, v_2u_2, u_1u_2\), we have 1 in (8). For the edges \(v_1v_2, v_1v_3, v_2v_3, u_1u_2, u_1u_3, v_1u_3, v_2u_3\), the value \(\frac{4}{3} \sqrt{7}\) in (8) occurs. We can also check that 1 in (8) occurs for the other 170 edges. Hence, we have
\[
GA(G_{120}) = 1 \times 4 + \frac{4 \sqrt{3}}{7} \times 8 + 1 \times 170 = 174 + \frac{32 \sqrt{3}}{7}.
\]

### 4.2.4 The fifth version of GA index of \(G_{120}\)

We consider the fifth version of GA index for \(G_{120}\). Similar to the case of the fourth version of ABC index, we have
\[
\frac{2 \sqrt{S_u S_v}}{S_u + S_v} = \begin{cases} 
1, \\
\frac{\sqrt{35}}{6}, \\
\frac{\sqrt{10}}{19}.
\end{cases} \tag{9}
\]

The first value 1 in (7) occurs for the four edges \(v_1v_2, v_1u_1, v_2u_2, u_1u_2\). The second one
occurs for the eight edges \( v_1v_3, v_1v_6, v_2v_4, v_2v_5, u_1u_2, u_1u_3, u_6u_4, u_6u_5 \). The third one

\[
\frac{\sqrt{35}}{6}
\]

occurs for the sixteen edges \( v_3v_7, v_3v_8, v_4v_9, v_4v_{10}, v_5v_{11}, v_5v_{12}, v_6v_{13}, v_6v_{14} \). We also see that 1 occurs in (9) for the other one hundred fifty four edges. Hence, the fifth version of GA index for \( G_{120} \) follows from these datum as follows:

\[
GA_{5}(G_{120}) = 1 \times 4 + \frac{\sqrt{35}}{6} \times 8 + \frac{6\sqrt{10}}{19} \times 16 + 1 \times 154 = 158 + \frac{4\sqrt{35}}{3} + \frac{96\sqrt{10}}{19}.
\]

4.3 The linear \( n \)-polymer \((C_{60})_n\)

As the generalization of the fullerene dimer \((C_{60})_2\), we calculate the four indices of the fullerene linear \( n \)-polymer \((C_{60})_n\). Let \( G_{60n} \) be its chemical graph (see Figure 6).

![Figure 6: The chemical graph \( G_{60n} \) of the fullerene linear \( n \)-polymer \((C_{60})_n\)](image)

Note that we have \#V\((G_{60n}) = 60n\) and \#E\((G_{60n}) = 90n + 2(n-1) = 92n-2\).

4.3.1 The ABC index of \( G_{60n} \)
For a vertex $v$ of $G_{60n}$, its degree is 4 or 3. So, by the same argument as in 4.2.1, we can see that the values of the terms in (1) are also given by (6). The number of edges which attain the value $\frac{\sqrt{6}}{4}$ (resp. $\frac{\sqrt{15}}{6}$) in (6) is $4(n-1)$ (resp. $8(n-1)$). The other $10(8n+1)$ edges attain $\frac{3}{2}$ in (6). So we have

\[
ABC (G_{60n}) = \frac{\sqrt{6}}{4} \times 4(n - 1) + \frac{\sqrt{15}}{6} \times 8(n - 1) + \frac{2}{3} \times 10(8n + 1) + \left( \frac{4}{\sqrt{6}} \right) \left( \frac{\sqrt{15} + 160}{3} \right)(n - 3\sqrt{6} + 4 \sqrt{5} - 20).
\]

### 4.3.2 The fourth version of ABC index of $G_{60n}$

For a vertex $v$ of $G_{60n}$, the value of $S_v$ is one of 14, 10 and 9. By the same argument as in 4.2.2, the values of the terms in (2) are also given by (7). Note that the numbers of edges which attain the values $\frac{\sqrt{26}}{14}$, $\frac{\sqrt{770}}{70}$, $\frac{\sqrt{170}}{30}$ and $\frac{4}{9}$ in (7) are $4(n-1)$, $8(n-1)$, $16(n-1)$ and $2(32n+13)$ respectively. It follows that

\[
ABC \left( G_{60n} \right) = \frac{\sqrt{26}}{14} \times 4(n - 1) + \frac{\sqrt{770}}{70} \times 8(n - 1) + \frac{\sqrt{170}}{30} \times 16(n - 1) + \frac{4}{9} \times 2(32n + 13)
\]

\[
= \left( \frac{26}{7} \sqrt{26} + \frac{\sqrt{770}}{35} + \frac{8}{15} \sqrt{170} \right)(n - 1) + \frac{8}{9}(32n + 13).
\]

### 4.3.3 The GA index of $G_{60n}$

For $G_{60n}$, the values of the terms in (3) is also given by (8). The numbers of edges which attain the values 1 and $\frac{4\sqrt{3}}{7}$ in (8) are $2(42n+3)$ and $8(n-1)$ respectively. Hence,

\[
GA(G_{60n}) = 1 \times 2(42n + 3) + \frac{4\sqrt{3}}{7} \times 8(n - 1) = \left( 84 + \frac{32 \sqrt{3}}{9} \right)n + \left( 6 - \frac{32 \sqrt{3}}{9} \right).
\]
4.3.4 The fifth version of GA index of \( G_{60n} \)

The values of the terms in (4) is also given by (9), in this case. The numbers of edges which attain the values \( \frac{\sqrt{35}}{6} \) and \( \frac{6\sqrt{10}}{19} \) in (9) are \( 2(34n+11) \), \( 8(n-1) \) and \( 16(n-1) \) respectively. Consequently, we have

\[
GA_5 (G_{60n}) = 1 \times 2(34n+11) + \frac{\sqrt{35}}{6} \times 8(n-1) + \frac{6\sqrt{10}}{19} \times 16(n-1)
\]

\[
= \left[ \frac{68 + \frac{4\sqrt{35}}{3} + \frac{96\sqrt{10}}{19}}{n} + \left\{ \frac{22 - \frac{4\sqrt{35}}{3} - \frac{96\sqrt{10}}{19}}{n} \right\} \right].
\]

5 Findings

Here we summarize the computational results obtained in Section 4.

5.1 Topological indices of the dimer \((C_{60})_2\)

The topological indices of the dimer \((C_{60})_2\) are listed in Table 1 below.

<table>
<thead>
<tr>
<th>Topological index</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ABC(G_{120}) )</td>
<td>( \frac{\sqrt{3} + 4\sqrt{5} + 340}{3} )</td>
</tr>
<tr>
<td>( ABC_4(G_{120}) )</td>
<td>( \frac{\sqrt{7} + 26 + \frac{4\sqrt{770}}{35} + \frac{8\sqrt{70}}{15} + \frac{616}{9}}{7} )</td>
</tr>
<tr>
<td>( GA(G_{120}) )</td>
<td>( 174 + \frac{32\sqrt{3}}{7} )</td>
</tr>
<tr>
<td>( GA_5(G_{120}) )</td>
<td>( 158 + \frac{4\sqrt{35}}{3} + \frac{96\sqrt{10}}{19} )</td>
</tr>
</tbody>
</table>
5.2 Topological indices of the linear $n$-polymer $(C_{60})_n$

The topological indices of the linear $n$-polymer $(C_{60})_n$ are listed in Table 2.

<table>
<thead>
<tr>
<th>Topological index</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ABC(G_{60n})$</td>
<td>$\left(\sqrt{6} + \frac{4\sqrt{15} + 160}{3}\right)n - \frac{3\sqrt{6} + 4\frac{1}{3} - 20}{3}$</td>
</tr>
<tr>
<td>$ABC_4(G_{60n})$</td>
<td>$\left(\frac{2\sqrt{26}}{7} + \frac{4\sqrt{770}}{35} + \frac{8\sqrt{170}}{15}\right)(n-1) + \frac{8}{9}(32n + 13)$</td>
</tr>
<tr>
<td>$GA(G_{60n})$</td>
<td>$\left(\frac{32\sqrt{3}}{3}\right)n + \left(6 - \frac{32\sqrt{3}}{7}\right)$</td>
</tr>
<tr>
<td>$GA_5(G_{60n})$</td>
<td>$\left(\frac{68}{3} + \frac{4\sqrt{35} + 96\sqrt{10}}{19}\right)n + \left(22 - \frac{4\sqrt{35} - 96\sqrt{10}}{19}\right)$</td>
</tr>
</tbody>
</table>

Substituting $n=2$ to the each value of topological indices in Table 2, we obtain Table 1. This fact implies that the results in Table 2 are the generalizations of those in Table 1.

6 Conclusion

Fullerenes are carbon which will formed polyhedral cages with bond structures identically as the planar cubic graphs which comprised of hexagons and pentagons faces. From the topological indices calculated throughout the research, the number of
chemical properties of a fullerene is comprised to be derived from its plane graph theory. In addition, the number of topological indices of the fullerenes can be used in chemical fields to identify the chemical reaction of a fullerene by using the fullerene’s mathematical properties which is the number of the topological indices of fullerene.

From the mathematical properties of fullerene, simple yet beautiful solutions can be found while many interesting chemical and mathematical problems in the field remains open. From this research, the number of topological indices of the fullerene can be calculated yet the significant meaning behind those numbers of topological indices is still remained imperceptible. However, it can be assured that the number of topological indices of the fullerenes not only can bring beneficial impact in chemistry field which related to the chemical reaction of the atomic bond generally nevertheless in the mathematical fields itself.

**Reference**


REVIEW OF SYMBOLIC EQUATION SOLVING FOR ENGINEERING PROBLEMS

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Abstract: Selected software packages capable of symbolically solving mathematical equations were reviewed for suitability in being used for engineering applications and education. As test cases, an ideal gas equation and a statics example problems that were derived from standard textbooks were solved using these selected packages. These software packages were Matlab, Mathematica, Octave, Maxima and Sagemath. The solution of the ideal gas equation demonstrates equation solving and 3D plotting. The statics problem solution demonstrates the solving of simultaneous equations and 3D graphics of vectors. The code fragments which were the results of the solutions can be used as a skeleton of typical programs for engineering applications which were lacking in tutorial and help files supplied by these software packages. Software is important if they are easy to use or program so these aspects were reviewed by the author who rarely use these packages especially the symbolic functionality. Commercial packages such as Matlab and Mathematica were the most complete and have less inconsistencies so were preferable for commercial use. The free software packages have less functionalities and more inconsistencies, Maxima has innovative Units modules that were easy to use and should be emulated but it lacks tools to solve other problems despite its powerful symbolic functionality. Octave has more support with tools but its symbolic functionality is add-on, in common with Matlab. Symbolic solving of mathematical equations for applications and education in engineer is well developed but still need further improvements.

Keywords: Computer Algebra Systems, Engineering education, Symbolic processing, Vector algebra

Introduction

Computer Algebra System(CAS) allows programmers to enter equations as normal algebraic notations and solve them immediately, resulting in solutions in symbols instead of numerical values. It is also called symbolic computing and this term is widely used in available software systems.

Wikipedia (Wikipedia 2019a) describes the Computer Algebra System. This crowd source encyclopaedia states that the earliest CAS appeared in the 1960s. The Schoonschip by Martinus J. G. Veltman was one of the earliest. For a more scholarly description, please refer to (Cole & Wolfram 1981). For a list of available CAS,
(Wikipedia 2019b) provides an almost comprehensive list except for Octave, by the time this article is written.

**Literature Review**

(Wikipedia 2019a) mentioned the use of CAS for education based on various references. (Tokpah 2008) wrote that his Doctor of Philosophy research results indicated that students exposed to CAS were likely to perform better than their peers taught using non-CAS instruction if both groups were given a common mathematics exam.

Reports as early as 1979 in (Stoutemyer 1979) promotes computer symbolic mathematics. Symbolic mathematics should not be confused with the use of computers for learning mathematics numerically. Computer Assisted Instruction such as described in (Suppes & Jerman n.d.) is the use of computers to teach subjects such as mathematics using the numerical results of the programs.

By 2019, especially with the development and availability of free Computer Algebra System that can solve mathematical equations symbolically, such as (Maxima 2019), more widespread education related uses of CAS as shown in (Velychko et al. 2019).

Engineering textbooks such as (Cengel & Boles 2015), comes with a Limited Academic Version of EES (Engineering Equation Solver) software with scripted solutions to selected text problems. However EES solves them numerically and therefore cannot handle units directly.

**Methodology**

**Software Packages**

This article restricts the reviews to five major mathematical software that can solve engineering problems symbolically at the moment of writing this article. They were the commercial Matlab 2019a (The MathWorks 2019) and its free clone Octave 5.1.0 (Eaton 2019) which were natively numerical but can load packages to handle symbolics processing. Sagemath 8.6 (sagemath.org 2019) was also a free natively numerical package buts its symbolic package was pre-loaded. Maxima 5.42.2 (Maxima 2019) is a free CAS that is natively symbolic but can do numerical computations. Maxima was based on the commercial Macsyma (Symbolics 2019) but it was no longer in active development compared with Maxima. Mathematica (Wolfram 2019) is a commercial software that was based on Macsyma but is still actively developed, and probably the most advanced of the CAS in 2019. Mathematica competes with Matlab in providing high level computation packages which motivated Mathematica to call itself for technical computing, instead of just computer algebra.

**Reasons for Choices**
This review is not meant to be comprehensive. Only the most easily available packages in Malaysia were chosen. Matlab in various versions and toolboxes was already widely used in Universiti Malaysia Sabah and courses had been conducted on some aspects of Matlab but so far, none on its symbolic toolbox. Mathematica has recently been made available though the internal cloud, which led to the interest in symbolic computing in Universiti Malaysia Sabah. However, Mathematica is too expensive and only a limited quantity was available so there is a need to find alternative programs, which Maxima provides. Unfortunately, it lacks a few critical functions for image processing so other programs were investigated which led to the choices of Octave and SageMath.

**Engineering Objective**

The objective of the review is to allow engineering students and professionals to select CAS that were suitable for the problems that they face. To help in making such choices, there was a need to find typical engineering problems with proven solutions. Test codes were then written using the selected CAS.

One source file is to solve the ideal gas equation derived from the textbook (Cengel & Boles 2015). It demonstrates the solution of an equation with three variables. A 3D plot of the three variables were used to investigate a range of values for the three variables, P, V, T. This file is called SolvePlotGasEq.

Another source file is to solve the statics problem derived from Example 5.17 of the textbook (Hibbeler 2010). It demonstrates a solution to a statics problem involving the equilibrium of forces acting on a rigid body. It requires a cross product of vectors in three dimensions and a solution of a set of simultaneous equations. The resultant vectors were then displayed using labelled 3D graphics. This file is called VectorDraw3DStatics.

**Only Symbolic Functionalities**

The symbolic functionalities were utilised for each one of them. Units and Physical Constants were used where available. Timing codes were inserted to give an estimate of the execution time. No detailed profiling was done to make the codes the most efficient. They were written based on styles that were the easiest to understand styles.

Formatted texts and pictures were inserted where possible. Comments and line continuation were inserted just to test their functions although alternative modes of entry were available.

**Results and Discussions**

**Execution**

For each software package, the two source files were written according to the syntax required by each package, to demonstrate the capability of each package to solve problems that were required for each of the source file.
The sources were run and debugged until they can show similar results. The execution times of all packages in executing the VectorDraw3DStatics were recorded. The prices were determined from online searches on 28/Mac/2019 for Malaysia. The machine where the timing data was determined was a Lenovo Thinkpad Workstation W520 with an i7-2720QM CPU and 16 Gb DDR3 RAM running on 64-bit Windows 10 1809. All the data and results are tabulated in Table 1.

**Lack of Standardisation**

What can be observed is the lack of standardisation. The commercial software were much faster except for SageMath. Sagemath is fastest but it does not have proper documentation of its features. The line continuation character is supposed to be \text{ ... }: but it did not work for the 8.6 version for 64-bit Windows. Of special note is the availability of some Engineering Tables for Mathematica. Engineering Tables are just an extension of Physical Constants which are supplied by most packages except the free Octave and SageMath. They are just databases of engineering data that are publicly available.

For engineering solutions and presentations, it will help engineers a lot if standardised ways of reading the data can be shared instead of entering and writing the users’ own databases and data sets.

**Unique Features of Maxima**

Maxima is a free software and yet it has an innovative way of entering and converting units. Unfortunately Maxima has a weak image processing ability. SageMath is supposed to have better image processing but its documentation is not updated and its GUI (Graphics User Interface), jupyter, does not have a pulldown menu for its functions. Maxima, via its GUI, wxMaxima is the best in this respect, not even Mathematica has. Mathematica has a real-time suggestions of functions but not easy to choose the correct one.

**Help Files**

All packages have built-in help files but browser searches are much better. Maxima is best because its reference manual is actually part of the help file and searches can be restricted to the reference manual only, unlike SageMath that will virtually search all possible matches, that offer more irrelevant choices than browser searches using Google.com. On the whole, commercial packages have better support and functionalities than free packages.

**Conclusion**

Free but powerful and easy to use CAS, Maxima, SageMath and Octave were available so can be used for educational purposes. However, commercial CAS, Matlab and Mathematica offer more functions and better documentation that will determine the efficiency in solving engineering problems in competitive commercial environments or post graduate research programs.
The dream of having CAS that is affordable and can solve the most complex engineering problems as easily as writing mathematical equations is still far from being achieved but we are getting closer to this dream. By learning and competing among the various CAS implementations, future developments can be speeded up.

References


Velychko, V.Y. et al., 2019. USE OF COMPUTER ALGEBRA SYSTEM MAXIMA IN THE
PROCESS OF TEACHING FUTURE MATHEMATICS TEACHERS. , 69, pp.112–123.


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Thermal Oxidation Characteristic of Boron-Doped Diamond (BDD) Films

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Keywords, Boron-doped diamond (BDD) film, Chemical vapor deposition, Thermal Oxidation, TGA analyzer

ABSTRACT: Boron-doped diamond (BDD) thin films are an excellent electrode materials with a large potential window in aqueous solutions and low background current. The wider potential window and lower background currents make BDD material very attractive for electrochemical analysis experiments. Furthermore, BDD exhibits high chemical stability and electrochemical stability, which makes the material suitable for various applications such as bio-electrochemical applications and water disinfection. However, BDD is low in heat resistance and has a large difference in resistivity and diamond quality depending on the content of boron doping.

In this study, boron-doped CVD diamond thin films were fabricated by hot filament chemical vapor deposition process. The optimum condition of the boron doping with the lowest resistivity was established and the characteristics of the diamond and the deposition rate were investigate according to the boron content. In addition, the anti-oxidation test was performed on the deposited diamond film to investigate the thermal oxidation characteristics.

In the diamond deposition process, the CH\textsubscript{4} / H\textsubscript{2} concentration was fixed at 2\% and the B\textsubscript{2}H\textsubscript{6} / CH\textsubscript{4} concentration was varied from 0.01 to 0.05\%, and the boron doped diamond film was deposited for 4 hours. At this time, the temperature of the filament was 1700 °C to 2400 °C, and the substrate temperature was measured at about 850 °C to 950 °C. In addition, the distance between the filament and the substrate is 0.2 to 2 centimeters. The oxidation temperature was experimentally measured at from 600 °C to 750 °C in a box furnace and TGA analyzer. The oxidation start temperature of the diamond thin film was measured in an atmospheric air condition, and the morphology and weight reduction rate were measured precisely to determine the oxidation resistance respectively. The boron-doped diamond film was compared with the Non boron-doped diamond film and the crystallinity, deposition rate, resistivity and thermal stability of the diamond film were compared and analyzed. Cyclic voltammetry of boron-doped CVD diamond films was also measured and analyzed.

References


A Real-time Positioning System Based on BLE Beacon in Children’s School Vehicles

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Abstract
In this paper, we proposed a real-time positioning system based on the Bluetooth low energy (BLE) beacon in children’s school vehicle capable of recognizing if they are in the dangerous area of school vehicle. The system provides the child positioning and the traffic information functions. The configuration of proposed system consists of the mobile beacon module (MBM), the fixed beacon modules (FBMs), and the child positioning platform (CPP) in indoor of children's school vehicle. In the future, the proposed system will be upgraded to a prototype for practical use after cooperating with company.

Keywords: BLE Beacon, Positioning, Vehicle, Safety, Child Positioning Platform, GPS.

I. Introduction
In recent years, accidents of children's school vehicles have become frequent and a big social problem. Every year, repeated safety accidents of children's school vehicles indicate that it have more than functional aspects for schooling. Although the number of accidents is gradually decreasing year by year, the number of child deaths is similar or increasing, so it is necessary to take countermeasures. Korea is especially the country with the highest number of children’s car accidents among OECD countries [1].

The purpose of a children’s school vehicle is simply for commuting, but it is more important for a child to move safely. It is analyzed that 62.5% of children’s vehicle accidents for schooling occurred due to non-safety driving duty, 75% of fatalities due to no finding pedestrians, or children did not check safety when boarding or getting off. This means that a systemized operating system is more than merely requiring the driver to pay attention during operation. Costs of 2 million dolor are used to enhance the safety of children's vehicles, but most of them emphasize external functions such as headlights, rear camera and paint, and do not provide system safety functions to children on board [2-4].

In this paper, we proposed a real-time positioning system based on the Bluetooth low energy (BLE) beacon in children’s school vehicle capable of recognizing if they are in the dangerous area of school vehicle. The most important function of the proposed system is to detect instantly whether a child is in a dangerous area around the vehicle that ran right before departure when the child got off the vehicle.

II. System Design

2.1 Design Philosophies
When a beacon periodically transmits an ID and a received signal strength indicator (RSSI) signal, the child wearing the beacon module enters the distance of the signal, the coordinator beacon module recognizes it and transmits the information to the positioning platform via internet. The platform uses this information to estimate the child's location in real-time [5-6]. In-vehicle positioning can only be done by detecting the presence or absence of a child on board the vehicle. Therefore, only the minimum coordinator beacons module in the vehicle are installed. When a child leaves the vehicle, the child's safety is basically determined by estimating whether or not the child is in a certain area around the vehicle after getting off the vehicle.
2.2 System Design

The configuration of proposed system consists of the mobile beacon module (MBM), the fixed beacon modules (FBMs), and the child positioning platform (CPP) in indoor of children's school vehicle as shown in Figure 1(a). If each FBM receives the RSSI values from MBM, it will transmit the values to the CPP to estimate the location of MBM. Thus, the location of MBM is transmitted to smart phone or server in real-time via wireless network and Internet.

Finally, a parent of a child in a children’s school vehicle can check in real-time through his smartphone app to see if his or her child is in the vehicle and is doing well. In addition, system operators of children's school vehicles can monitor the safety and operation status of the vehicles in real-time.

2.2.1 Child Positioning Function Design

The hardware for MBM and FBM for child positioning function are manufactured as a prototype by purchasing commercial BLE beacons. When a child carrying a MBM boarded the vehicle, the FBM accesses the MBM to detect of the child on board, checks the child's ID, and transmits the name and boarding time information to the CPP. The CPP transmits the information to the server via the network. The CPP estimates if the child is apart from the vehicle sufficiently before departing to the next stop after the child has left the vehicle.

The FBM measures the RSSI from a MBM held by a child who has been or is sufficiently apart from the distance between the child and the vehicle before departing from the next stop after getting off the child. Based on this, the CPP estimates the distance after applying various filtering techniques according to the situation. If everyone who gets off does not stay above the distance set from the vehicle, the CPP notifies the driver of the strong alarm.

The FBMs are mounted on the front, rear, and sides of the vehicle, so that the child knows whether he is located inside or outside the vehicle. The number of FBM is basically four, but the size and condition of the vehicle may be changed according to the size of vehicle or operation situation.

2.2.2 Traffic Information Function Design

The traffic information function is performed entirely by the CPP. The hardware for the CPP can be replaced with a smart phone for efficiency, and the related software modules are executed in the form of apps. The CPP receives the position coordinates using the built-in GPS receiver when the vehicle is in operation, estimates the position, and transmits it to the server connected to the Internet through the wireless cellular or Wi-Fi networks.

The traffic information service app for children receives the position information of the moving vehicle from the server and provides information on the estimated time of arrival of the vehicle and the current position of the vehicle to a child waiting for the vehicle. The child information received from the CPP is delivered to the server via the network and then provided to parents of child who boarded on the vehicle.

2.3 Algorithm on the Real-time Child Positioning Function

Figure 1(b) shows the sequence flows for operation on the real-time child positioning function in a school vehicle until the child enters the school safely. When a child boards a school vehicle, the child wearing MB periodically sends the RSSI value to the FB. A plurality of FBs are installed in the vehicle. If there are five FBs, each FB receives the RSSI value of the MB. When the RSSI value received from several FBs is transmitted to the CPP, the CPP calculates the distance value between the MB and each FB using all received RSSI values. Values with very large deviation among these values are corrected by the filter and then transmitted to the fingerprint (FP) map.

The child positioning algorithm of the development system is designed using the fingerprint-based DIFFERENCE-MEANS (FDM) algorithm. The FDM algorithm consists of two phases such as the fingerprint learning and the indoor localization phases. The indoor localization phase is executed by Eq. (1), where the DMS is a value of DIFFERENCE-MEANS to be obtained in the current reference point (RP). n is a number of measured RSSI information, is an index of the RP in fingerprint map.
database, $\text{FP}_{\text{AVR}}^{\text{RSSI}}(i,j)$ is an average value of the RSSI of $j^{th}$ FBM in $i^{th}$ RP of fingerprint map database, and $\text{RSSI}(j)$ is the RSSI value of $j^{th}$ measured RSSI information [7].

$$\text{DMS} = \text{MIN} \left( \sum_{j=1}^{n} \text{IFP}_{\text{AVR}}^{\text{RSSI}}(i,j) - \text{RSSI}(j) \right)$$  \tag{1}

Figure 1. Configuration (a) and Algorithm (b) of Proposed System.

2.4 MBM, FBM and CPP Prototypes

The MBM and FBM were manufactured as a prototype after incorporating a protocol suitable for the environment of a children's school vehicle after purchasing a BLE beacon (see Figure 2 (a)). In addition, the CPP was built as a prototype by incorporating a child positioning function developed in the embedded hardware module Raspberry Pi 3 Model B + (see Figure 2 (b)). In Figure 2 (b), CPP stands for the module on the left of the two modules and indicates that it is being tested by connecting it to the FBM on the right for performance testing.

Figure 2. Configuration of MBM, FBM Prototype (a) and CPP Prototype (b).

3. Experimentation and Performance Metrics

3.1 Experimental Environments

In order to verify the performance of the proposed system, we 1st installed a fixed/mobile beacons and a child positioning platform developed by a mobile technology laboratory of a graduate school on a university campus, and then executed an indoor experiment. We are currently preparing a 2nd field test to verify the performance of these devices after installing them in actual children's school vehicle.

3.2 Performance Measuring Metrics

The performance measuring metrics of the proposed system are defined in Table 1. Performance tests will be conducted for the items 1-5 defined by the Korea Marine Equipment Research Institute (KOMERI), a nationally recognized testing institute, in May of this year. For items 6-7 of the performance metrics, we will actually be conducting surveys on parents of children, children using
school vehicles, and children. The results of these seven items will be used as indicators for future performance improvement.

Table 1. Performance Measuring Metrics

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<tr>
<td>2</td>
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<td>3</td>
<td>Average accuracy of children's risk recognition</td>
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<tr>
<td>7</td>
<td>Traffic safety service satisfaction</td>
<td>%</td>
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IV. Conclusion

In this paper, a real-time positioning system based on BLE beacon for the safety and information services of children's school vehicle is proposed. We will examine the results from KOMERI, an accredited testing institute, and analyze the results to complement the problems soon. In addition, all experimental results and analysis results obtained through laboratory experiments, field experiments and certified tests will be released through the second paper. Further study of this paper is whether children are located indoors or outdoors when riding a children's school vehicle. At present, it is very difficult to recognize the situation accurately, because the variation of the RSSI signal strength is very weak when the BLE beacon is used. In the future, a real-time positioning system in children’s school vehicle will be upgraded to a prototype for practical use after cooperating with company.

Acknowledgement

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References

Incorporating Highway Information Modelling (HIM) in Capstone Highway Design Project for Undergraduate Level Studies: A Case Study

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Abstract:
Highway design is a multi-disciplinary and multi-dimensional undertaking that requires great coordination between different stakeholders to optimize alignment design and minimize wastage. There have been many instances where poor alignment design has brought about cost and safety implications. Highway Information Modelling (HIM) was introduced into infrastructure road project delivery to address these problems by improving design coordination and optimizing cost. HIM is an extension of the BIM concept from building structures, whereby, all project information is represented digitally in the form of a 3D model and shared with the project team (Abdullah et al, 2014). HIM has already been used to deliver benefits on several highway projects such as the E10 Avvakko-Lappeasuando highway in Sweden (AECOM). Adoption of HIM comes in several levels from 0 through to 4, depending on the amount of collaboration. Current project delivery trends show that it is inevitable that HIM will lead the future for highway construction and thus imperative that students are exposed to the design environment associated with it. This paper looks to summarize the incorporation of HIM into a capstone design project for final year undergraduate students of the civil engineering program. For the purposes of this trial implementation, the level of HIM adoption will be set at the equivalent of BIM Level 1 whereby there will be 3D modelling with information but limited digital collaboration. The findings will be compared against other projects carried out in the industry. The key challenges in implementation were identified and strategies proposed to enable for Level 2 adoption in future projects.

Keywords: Highway Information Modelling, HIM, highway design, education, capstone project.
1.0 Introduction

1.1 Background on BIM

Building Information Modelling (BIM) is a process of generating and managing digital representations or models of buildings and infrastructure. Contrary to the conventional project delivery method where project drawings, data, and specification are all presented separately, BIM models contain all these information. BIM will also change the way teams run a project; from the current fragmented nature to an integrated as shown in Figure 1.1.

![Figure 1.1 Comparison conventional structure and BIM](image)

BIM is a way of digitizing the construction industry to increase effectiveness and reduce waste at all stages of construction by getting it right the first time. BIM use is one of the drivers in the construction industry in line with the 4th Industrial Revolution, or IR 4.0 (King, 2017).

Benefits of BIM include:

- Capturing reality – model can include aerial imagery, digital elevations and laser scans of extg. infra.
- Minimizing waste – less duplication of work and early conflict detection
- Improving collaboration – sharing information/drawings much easier via digital workflow
- Simulate and visualize – sunlight, energy performance

Implementation of BIM comes in several levels, from the lowest Level 0 to Level 3 and beyond, summarized below:

- Level 0 – 2D CAD with no collaboration.
- Level 1 – 3D CAD for concept work but 2D drafting and submission. Some form of electronic data sharing.
- Level 2 – 3D models developed individually and shared via common file format to form a federated model. Developing building information in collaborative environment.
Level 3 – Not fully defined but likely to include single, collaborative, online models that incorporate cost, construction programming and lifecycle information.

BIM adoption has reached close to 50% in most developed countries such as the UK, US, Australia, Singapore and some parts of Europe. Some governments have also mandated compulsory BIM compliance for certain project procurements.

1.2. Adoption of HIM on highway projects

Highway Information Modelling (HIM) is an offshoot of the BIM concept when applied to infrastructure projects. It integrates BIM with geographic information science (GIS), which is a digital map that contains attributes of the geographic terrain. HIM is used to carry out optimal highway alignment design based on multiple, overlapping criteria.

The current conventional method of doing the alignment in 2D is often inefficient compared to 3D, and often leaves other important aspects such as the geotechnical design to latter stages.

HIM has been successfully employed to model the 786km Pan Borneo Highway Sarawak in Malaysia ("Pan Borneo Highway Sarawak HIM Nearing Completion," 2018) and the E10 Avvakko-Lappeasuando in Sweden. The widening of the M25 motorway in the UK carried out in 2012 using HIM has also won Autodesk’s BIM Award.

1.3. Capstone design project

Capstone design projects are a common method for institutions of higher learning to gauge the effectiveness of taught modules throughout the duration of an engineering or technological design degree programme. In addition, the capstone design project course allows student to simulate the design and management processes of a real-life project by carrying out a large-scale design exercise that required application of knowledge and skill elements previously
gained. It adopts an open-ended approach to problem solving by giving students freedom integrating classroom lectures with laboratory work. An important aspect of a capstone design project is the complex engineering problems and complex engineering activities element whereby Accreditation bodies for engineering degree courses programmes such as the Engineering Accreditation Council (EAC) (Council, 2017) in Malaysia required the use of modern tools found in the industry such as HIM to deliver the project.

1.4. Description of capstone design project
This paper looked at a capstone design project carried out by students of the civil engineering programme at a public university located in the city of Kota Kinabalu in Malaysia. The project involved designing an access road to connect a new hospital premises building to an existing highway. The students had to carry out the design based on specification and criteria set out by in the project brief. The design process would span from initial feasibility study to the detailed design stage and would last one semester which is equivalent to 14 academic weeks. For the feasibility study, as in real practice, the students were required to propose several road alignments, one of which has to include widening of an existing carriageway. The new highway would have to be complemented with all the ancillary design components such as drainage, retaining structures, bridges and ground improvement. All these design aspects would have to be properly coordinated to ensure it is free from conflict and build-able. The design of a highway is a multi-disciplinary exercise which BIM can bring a lot of benefit to.

![Figure 1.2 Location of new hospital and proposed alignments](image)

During the course of the design, students will identify and plan the tasks required to achieve individual objectives. One of these objectives were to implement the equivalent of BIM level 1 in delivering the project. BIM level implementation on a highways project will mandates the following:

i. To develop modelling and drawing standards as a group and produce plan to carry out modelling

ii. To model the highway in a 3D with embedded information (Level 1).
iii. To ensure design coordinated with ancillary structures such as drains, culverts, bridges and retaining walls.

iv. To produce tender level drawings with cut and fill quantities volumes.

And Optionally;

v. To develop information exchange process and collaboration strategy to coordinate models.

vi. To develop 3D visualization of highway.

1.5. Course facilitators

There are a total of five course facilitators administering this course. The main course coordinator and designer of the capstone project is Lim Chung Han, a chartered professional engineer and lecturer with the university. Two fellow lecturers assisting with the course are Lillian Gungat and Mohd. Azizul bin Ladin, whose research specialism are highway pavement and traffic and transportation respectively.

In addition to the lecturers, there are also two industry professionals, namely Han Shee Kwang and Chidambaram Ramanathan, who were invited in as course assessors and spoke on specific technical design aspects.

2.0 Objective

The aim of this research is to establish the effectiveness of limited (Level 1) HIM implementation in a capstone design project course involving final year undergraduate students undertaking a bachelor’s degree course in civil engineering.

To achieve the aim, the following objectives were assessed against the result:

a) Determine the background BIM/HIM knowledge of respondents.

b) Determine the level and effectiveness of HIM implementation undergraduate degree capstone design project.

c) Determine the degree of collaboration carried out in the capstone design project.

In addition to the objectives above, the research will also seek for identify shortcomings in the implementation so that subsequent courses can be improved with higher level of BIM adoption.

3.0 Methodology

The case study was conducted using a combined mix of observation of a classroom/workshop environment and questionnaire survey from students in that class.

The questionnaire survey was carried out face to face to maximize the response rate.

3.1 Sampling

The respondents were all students in their fourth and final year of a bachelor’s degree course in civil engineering at a university located in the
city of Kota Kinabalu, Malaysia. There were 72 registered students in the course, made up of 68 home (Malaysian) and four international students. The response rate achieved was 87.5% with one response rejected. A majority of the respondents have not had formal experience of the construction industry except for a 10-week industrial internship at the end of their third academic year. Most did their internship with either a consultant firm (48%) or engineering contractor (35%), whilst a small minority went to property developer (14%) and research/education (3%).

3.2 Format
The first part of the questionnaire survey was intended to establish the level of industrial experience of the respondents as well as level of BIM awareness prior to this project course. It also established whether they have had BIM/HIM exposure whilst engaged with the industry. The second part of the questionnaire collected feedback from the respondents as to how the modelling work was carried out and to establish the level of HIM adoption. It will also assess the effectiveness of HIM adoption in reducing workload and improving efficiency at design stage. The third and final part delved into the level of collaboration used in the administration of the design process.

3.3 Timeline
The questionnaire survey was carried out toward the end of the course, prior to final submission of the drawings.

4.0 Results and Discussions
4.1 Background
At the commencement of the survey questionnaire, the respondents were queried on their current awareness and background knowledge of BIM and as well as HIM/CIM. The results are summarized in Figure 5.1 below. It shows that there is a clear definitely better awareness on BIM than HIM in the class, with only 1 student reporting that they are not aware of BIM versus 27 students who have not heard of HIM/CIM. A total of 7 respondents have at least some manner of training or practical working experience in BIM whilst none of them has had any in HIM.

![Figure 5.1 Level of awareness of respondents](image-url)
The respondents also reported that during their industrial internship, most employers (87%) do not incorporate any form of BIM whilst the remaining observed BIM being used in a limited capacity (Level 1 adoption).

The students were then given a brief introduction about BIM at a conceptual level and then queried to get their viewpoints on the relevance and importance of BIM. A majority agreed that BIM should be used for construction project delivery and be made mandatory only for large and complex projects such as healthcare facilities. It was perceived that BIM adoption mostly benefits from the 3D model that is able to accurately represent the design intent (47%) and also from reducing wastage arising from building activities and indirectly the construction cost. Only a small majority sees the benefit of simulation, 4D cost control or the improved collaboration that BIM brings.

![Figure 5.2 Perceived benefits from BIM implementation on construction projects](image)

A lot of countries worldwide have published a national roadmap for BIM adoption. The UK for example has mandated adoption of BIM Level 2 from 2016 onward. In Malaysia, there is a policy whereby public projects over RM100 million has had to implement BIM Level 2 by 2019 and the Construction Industry Development Board (CIDB) in its roadmap (Building Information Modelling Roadmap for Malaysia’s Construction Industry: Workshop Report (Series 2)) has outlined various initiatives such as the establishment of myBIM satellite centres to develop competency in the area. Based on the questionnaire response, most students were not aware of the existence of such a roadmap (71%) whilst the rest were aware but without intimate details of it. However, after the course facilitator shared information regarding the national roadmap with the students, the students felt that working knowledge of BIM will bring additional value to students of civil engineering in the jobs market with half of them believing it will make them stand out amongst their peers whilst another half feeling that it will give them an edge over graduates from better universities.

### 4.2 Effectiveness of HIM in Capstone Design Project
Most students carried out both alignment study and detailed design using 3D model but were still reliant on 2D CAD for some draughting work. 2D CAD appears especially indispensable at feasibility stage almost all students were reliant on it at one manner or the other.

A small number of students had produced their alignment using purely 2D CAD whilst a similar amount ventured into full 3D modelling without reliance on 2D CAD for detailed design stages.

The project being a multi-disciplinary required coordination between the different aspects such as highway alignment, the drainage, retaining structures and bridges. A majority of respondents reported that either no coordination was carried out or coordination was done by federating the separate models into a single common file. A small portion of respondents coordinated their design by using hardcopy drawings or sketches. Two respondents have reported that they managed to carry out coordination in real time via a single model.
To obtain the cut and fill quantities from their highway design, close to half the respondents (42%) rely on a mix of both automatic generation from the software and calculation from 2D CAD sources. Only 35% were able to automatically generate all the cut and fill volumes whilst another 15% had to employ a third party software to fully generate these values. 8% reported that they use manual approximate measurement from hardcopy drawings.

Software training aside, the respondents were also asked to gauge as to whether the current highway design course offered by the university was pre-requisite enough for them to transition to HIM without any re-training. The results are summarized in Figure 5.6. Just under half (45%) respondents claimed the current highway design syllabus is sufficient whilst a third says the course syllabus is not sufficient but can be supplemented by other courses that they have undertaken un the university. 23% says that the transition to HIM requires additional knowledge not obtainable within the university.

The improvement to level of efficiency in modelling brought about by the implementation of BIM in this capstone project are summarized in Figures 5.7 and 5.8.
Half of the respondents reported that implementation of HIM has both marginally improved the design process by reducing the amount of task (50%) and also marginally shortening the duration for modelling (50%) when compared against the conventional method. Meanwhile another 40% managed to significantly improved the design process by greatly reducing amount of task and at the same time significantly reduce the time required for modelling. The remainder reported that HIM implementation has either no bearing on the efficiency of the design process or has been a detrimental effect to it.

Autodesk appeared to be the main choice of software provider selected by most of the respondents. The most popular of these are AutoCAD, Civil 3D and Infraworks. Meanwhile, on the other end, there was only one adopter of Bentley software, who is one of the main competitors of Autodesk in the market today. This phenomenon may be due to the accessibility of free educational versions of the software. Other popular software used to deliver the project, that was not listed in the questionnaire, were Google Earth Pro for ground contour and satellite photos, TCX Converter to translate GPS data from handheld devices and Autodesk 3ds Max for visualization.
4.3 Levels of Collaboration

In the third and final part of the questionnaire, the respondents were asked about the amount of collaboration that and design coordination carried out in the capstone project. Collaboration is often an integral part of any civil construction project due to the multi-disciplinary nature and typically large scale. This means that the design and modelling work would often be segmented and shared amongst several parties and some form of standardization and information sharing protocol would need to be established. Levels of collaboration could typically vary from simple direct peer to peer communication such as use of email or instant messaging services for smaller scale projects to use of cloud-based portals that handles document control, design integration and even review and approval processes for larger undertaking.

The modelling and design processes would then have to be standardized to ensure the federation process of merging all the models together can be carried out seamlessly and also to ensure consistency in presentation. Even back in the days hand draughting, there were established principles for drawing presentation such font types and sizes, pen thickness and arrangement of views. For the conventional digital CAD and BIM, the importance of standardization becomes more apparent as there are strict modelling guidelines that have to be complied with to ensure inter-operability between the different software that when the models had to be federated. Standardization can be achieved either by having a single modeller to carry out all the work or by having a pre-agreed set standard that everyone follows.

In the capstone project, a large majority of respondents (69%) reported that there is only one modeller responsible for the modelling tasks at one given time. This is an inefficient way of working as the modelling task may be subjected to critical path. This explained why 29% of the respondents achieved standardization by having one dedicated modeller. Another 21% responded that there were no standardization in the
modelling at all. The remaining half had set up pre-agreed modelling standards as a guideline for the duration of the project.

In addition to standardization, the models from all parties would need to be fully coordinated to ensure there are no conflicts and in accordance to design criteria. The way coordinate is carried out is related to the level of BIM implementation. Almost half the respondents (47%) reported that coordination was carried out by federating the models from all parties which was similar to Level 1 implementation. A small portion managed (3%) to carry out coordination in real time whilst modelling is in progress, which is equivalent to Level 2. 13% carried out coordination using either 2D or hardcopy drawings whilst a worryingly a large number (37%) have carried out no coordination at all.

Figure 5.10 Amount of standardization carried out in capstone project

Figure 5.11 Level of coordination carried out in capstone project
Only a handful of respondents (29%) have set up a dedicated online cloud based portal such as googledrive or onedrive to share project information whilst most respondents (71%) preferred to share project information using direct peer to peer such as emails or forms of direct messaging.

Figure 5.12 Level of information sharing
5.0 Conclusion and Recommendations

5.1 Conclusions

Highway planning and design is always complex due to the multi-variate nature of field.

Based on the results in section 4.0, the following conclusions can be drawn:

The level of awareness on BIM and HIM amongst undergraduates of civil engineering is at an acceptable level given that there still has not been any formal courses in the subject. Most graduates have at least some conceptual understanding of BIM but less on HIM. Meanwhile in the industry, the respondents reported that a majority of employers within the construction sector have not implemented BIM of any form within their organisation.

In terms of HIM implementation for modelling on the capstone project, most respondents managed to achieve better than Level 0 but fell short of required Level 1 adoption. Only a small handful of respondents have achieved either Level 1 or better. The respondents attributed this to the lack of exposure and training on the software. It has also been reported that the software most widely employed, Autodesk Civil 3D, is quite demanding on computing power and requires fast CPUs when either the contour or project scale gets large.

Most also reported that HIM had either marginally or significantly improved efficiency in the design and modelling of highway compared to conventional methods taught during their undergraduate course.

The findings were similar in terms of collaboration where only half of respondents have established common standard of working and coordination. There appears to be an alarmingly high rate of unstandardized and uncoordinated design of over one quarter.

5.2 Recommendations

Based on the conclusion it appears HIM implementation in a capstone design project is certainly feasible as it has shown to improve efficiency but there are certainly room for improvement.

First and foremost, future students undertaking the capstone design project should undergo a prerequisite course in BIM as preparatory.

The university should also invest in newer desktop PCs and perhaps set allocation to trial in order to facilitate a better experience for the students.

Finally, in order to enable full digital collaboration, some further research will be required to establish the infrastructure requirements and trial the system.
References

*Building Information Modelling Roadmap for Malaysia's Construction Industry: Workshop Report (Series 2).* Retrieved from
A QUALITATIVE STUDY ON THE CREATIVE MAKING ACTIVITIES USING 3D PRINTER IN MIDDLE-HIGH SCHOOL AND COLLEGE STUDENTS BETWEEN KOREA AND JAPAN

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The Maker movement continues to gain momentum on various field with the emphasis on the fourth industrial revolution. The making activities are highly emphasized in the area of education like a science, technology, engineering, and mathematics. In many middle-high school and college, educational programs using digital equipment like a 3D printers have been developed and is applying in education systems. In this study, we observed examples of creative making activities between Korea and Japan’s middle-high school and college students. As a result, creative making activities show that middle-high school and college students between Korea and Japan improve the Maker mind-set and motivation factor in the learning process.

Keywords: Making activities, Maker mind-set, motivation, 3D printer, Qualitative study.

1. Introduction

The fourth industrial revolution is the word that emerges as a major issue in recent years. The fourth industrial revolution is the edge technology such as the internet (IoT), robotics, AI, Big Data, (Cyber-physical system) is a social structural revolution that led to production (Han Dong-young, 2016), which has developed into convergence technology of biotechnology (BT), information technology (IT) and cognitive science (CS). The fourth paradigm of education and industry has emerged in line with the increasing trend of the 4th Industrial Revolution, and the supply of various digital equipment such as 3D printer, laser processing machine and CNC is rapidly proceeding. Based on this, the ability to support and utilize equipment and space for the implementation and production of ideas for revitalizing the manufacturing and manufacturing technology industries is emphasized, and the construction of platforms in various manufacturing spaces is spreading throughout society.

Among them, the use of 3D printers is most active in the area of the industry, and attempts are made to introduce 3D printers in the field of education and to utilize them in a variety of ways. Therefore, this study aims to examine the use of 3D printers, which are most important for creating a maker's ecosystem, at the educational sites of elementary, middle, high schools and universities in Korea and Japan, and to examine the changes in the manufacturer's tendencies and motives.
2. Background

2.1. Maker eco-system and 3D printer

The maker is a newly emerging concept with the advent of the fourth industrial revolution. Though defined differently by scholars, in general, ordinary people can be defined as those who seek pleasure and pleasure in making things using various materials, techniques and tools, free from the blind expenditure of established products made by businesses or experts and share knowledge through the Internet.

[Table 1.] Definition of Maker

<table>
<thead>
<tr>
<th>Research</th>
<th>Definition of Maker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make magazine (2005)</td>
<td>People who enjoy complex projects or make things using cheap materials, including household goods</td>
</tr>
<tr>
<td></td>
<td>A person who wants to incorporate science and technology into DIY (Do It Yourself) activities</td>
</tr>
<tr>
<td>Chris Anderson (2012)</td>
<td>Web Generation with features that are designed with computers, prototypes using desktop manufacturing machines, and instinctively sharing their own creations</td>
</tr>
<tr>
<td>Dale Dougherty (2013)</td>
<td>People who enjoy science and technology, who want to learn about science and technology constantly</td>
</tr>
<tr>
<td>Kalil (2013)</td>
<td>Everyone who instinctively creates and worries about things, solves problems, finds new directions, and shares value with them.</td>
</tr>
<tr>
<td>Mark Hatch (2014)</td>
<td>It is not tied to the existing maker categories such as inventors, craftsmen, engineers, etc.</td>
</tr>
<tr>
<td>Halverson &amp; Sheridan (2014)</td>
<td>Everyone who develops creative goods in everyday life and wants to share their own creations or development processes with others</td>
</tr>
<tr>
<td>Dixon &amp; Martin (2014)</td>
<td>A person or group who is creative and interested in making a product and solving a problem at hand, who is willing to learn constantly, and is willing to work with others who are sociable</td>
</tr>
<tr>
<td>Mingjie, Yongqu &amp; Ping (2016)</td>
<td>The masses who want to conceive and develop their own products, make ideas into actual products, and share their experiences and interact.</td>
</tr>
</tbody>
</table>

The fact that the maker activity has attracted new attention is a dramatic change in the way various products are produced with the advent of 3D printing, which also affects economically. If existing creation depends on the skills and skills of a small number of elite craftsmen, current production is easy and popular enough for anyone to innovate through the development of production tools and technologies and the utilization of open source (IT Industry Promotion Agency, 2017), utilizing 3D printers in various industrial areas and various programs for using 3D printer are also being developed for this purpose in the field of education.

2.2. Using 3D printer for education

In the constructivism, the characteristics of self-directedness, cooperative learning ability, and context-based learning environment are emphasized. In particular, maker education emphasizes learning in the making process, that is, when realizing ideas in the making process, students try hard to learn knowledge and skills to solve real-life problems, it is closely related to constructivism. The learning theory of constructivism sees that
knowledge is acquired not by the teachers but by communicating with other people (friends, colleagues, teachers) and acquiring them through a meaningful environment configuration using social contextual education tools (Vygotsky, 1980). Also, students who participated in maker education were asked to participate in project-based learning (Kang In-Ae et al., 2011), activity learning, problem-based learning (PBL), collaborative learning, digital tools such as 3D printers, and actual tools and environments for maker education. Papert(1991) believes that technologies such as the use of 3D printers in schools can be a powerful tool in shaping children's maker activities that re-awaken the maker's sense, not a way to facilitate past education.

3. Methodology

Eight elementary, middle, high schools, college, and university in Korea and Japan (Kagoshima) were selected and observed for this study. The observations were conducted from November 4, 2018, to December 27, 2018, with a total of six observations made and an average of two hours observing time. To supplement the observations, in-depth interviews were conducted after the observations were completed. Two students, one parent and one teacher who actively participated in the activity were interviewed. It took an average of one hour per person.

Also, elements of the maker mindset defined by Dougherty(2013) and synchronized strategies (MSLQ) for learning questionnaires developed by Duncan and Mckeachie (2005) were used for examining the effect of 3D printer activities on the maker. The developed checklist was reviewed and supplemented to confirm its validity by the manufacturer's experts and professors and was used to observe the activities of the 3D printer.

4. Result

4.1. Using 3D printer for education

The result of observation for activities of using 3D printer, elementary, middle, high school, and the university was shown different activities. Also, there are differences in educational methods and contents depending on the form of the maker space that can utilize the 3D printer. However, there are some differences between using 3D printers in Korea and Japan.

The use of 3D printers in elementary schools in Korea was mainly used to understand the principles of using widely used FDM-type 3D printers, as they mainly offer product-making experience using 3D pens. In elementary schools in Japan, rather than using printers, it was mainly done using various tools and materials to experience the activities of the makers. However, while 3D printer training is non-regular in Korea, in Japan, production-type curricula have been regularly opened and operated.

In the middle school, basic modeling training for using 3D printers is being conducted and experience of simple product output has been experienced, but it has been operated as a form of non-regular and one-time experience as in elementary school. In middle school, there was no difference in the form, purpose, and content of using a 3D printer between Korea and Japan.
### Table 2: Maker Mind-set Factors and Diagnostic question on Using 3D Printers for education

<table>
<thead>
<tr>
<th>Factor</th>
<th>Diagnostic question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mind-set</td>
<td>I am interested in the activities of the maker and try to participate.</td>
</tr>
<tr>
<td>Playful</td>
<td>He laughs more than once in his activities as a maker.</td>
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<td></td>
<td>There are various interactions during the activities of the maker.</td>
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<td></td>
<td>At the end of the activities of the manufacturer, check or wait for the schedule of the next manufacturer's activities.</td>
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<tr>
<td>Asset growth-oriented</td>
<td>Do activities that learn directly from the literature or the internet in relation to the activities of the maker.</td>
</tr>
<tr>
<td></td>
<td>Ask for direct advice or help in making activities through experts.</td>
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<tr>
<td></td>
<td>Do activities that help other makers with what they know.</td>
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<tr>
<td></td>
<td>He is active in finding and proceeding with new activities or tasks, thinking he or she can learn or do anything.</td>
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<tr>
<td>Failure-positive</td>
<td>During the activities of the manufacturer, the company conducts repeated explorations to solve the work's failure experience.</td>
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<td></td>
<td>Ask for expert help on difficult problems that cannot be solved.</td>
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<tr>
<td></td>
<td>Based on the experience of the failure of the manufacturer's activities, find and suggest various solutions.</td>
</tr>
<tr>
<td>Collaborative</td>
<td>During the maker's activities, he presents his opinions to others and gets help.</td>
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<tr>
<td></td>
<td>Work together with interest in other people's actions and words.</td>
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<tr>
<td></td>
<td>Talk about each role in the activities of the makers and proceed with the activities according to the roles.</td>
</tr>
</tbody>
</table>

### Table 3: Factors and Diagnostic question in Education 3D Printers for education

<table>
<thead>
<tr>
<th>Factor</th>
<th>Diagnostic question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>They coordinate the schedule of the manufacturer's activities or coordinate the number of participants to take active actions in participating.</td>
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<td></td>
<td>In the process of making a product, it does not delay the production process of a product to others, but does it directly.</td>
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<td>Among the manufacturer's activities, they offer suggestions on purchasing materials, meeting ideas and improving production activities.</td>
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<td>Self-regulate</td>
<td>Have an attitude to learn new things, including making activities, through the internet, books, and experts.</td>
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<tr>
<td>learning</td>
<td>Do activities that help others with the knowledge and skills they know.</td>
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<td>Self-efficacy</td>
<td>While working on the activities of the maker's products, it expresses expectations for participation in the competition or the actual application of the product.</td>
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<td>Satisfaction</td>
<td>I am satisfied with the results of the maker's work, smiling or expressing encouraging behaviors.</td>
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<td></td>
<td>They offer words of encouragement or praise to each other among the makers' activities.</td>
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<td>I am also trying to challenge the difficult contents.</td>
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<tr>
<td>Immersion</td>
<td>It is described that time passes quickly during the activities of the maker.</td>
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<td></td>
<td>I try to record all the activities of the maker.</td>
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<td></td>
<td>Being immersed in the activities of the maker is not aware of the circumstances surrounding it or of the changes in other people's behavior.</td>
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</table>
In the case of high school, there is no education to utilize 3D printer in the regular and non-regular curriculum, but it was operated in the form of utilizing 3D printer in scientific circles. And, 3D printer is used for modeling, printing, and producing products in Korea, but it is being used for personal purposes such as printing and using personal items for personal life in Japan. Especially high school in Korea, they have been using 3D printers for production or assembling 3D printers to understand the principles and structure of 3D printers.

The cases of college students, Both countries were using the 3D printer to produce their ideas or various products needed for classes at schools.

<table>
<thead>
<tr>
<th>[Table 4] Subject of study and activities</th>
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<tbody>
<tr>
<td>Purpose and goals for Education</td>
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<td>---------------------------------</td>
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<tr>
<td><strong>Elementary School</strong></td>
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<td><strong>Middle School</strong></td>
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<td><strong>High School</strong></td>
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<td>F</td>
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<tr>
<td><strong>College And University</strong></td>
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4.2. Maker mind-set and Motivation

The observations of the mind-set to see the tendency of the maker showed that the experience of education using 3D printer was the highest in playful in elementary school students, middle school, high school and university in maker mindset. And the part of asset growth-oriented was the highest in high school students, and the failure-positive was the highest in college students. Overall, there was little difference between Korea and Japan in maker mindset, but playful and collaborative showed more in Korean education than Japan, and asset growth-oriented and failure-positive were higher in Japan than in Korea.

| [Table 5] Observed Result of Maker Mind-set (Frequency of activities / 1hour) |
|-----------------|-----------------|-----------------|-----------------|---|
| Playful | Asset growth -oriented | Failure -Positive | Collaborative | Country |
| Elementary School | | | | |
| A | 1.69 | 0.63 | 0.45 | 0.92 | Korea |
| B | 1.13 | 0.67 | 0.53 | 0.69 | Japan |
And, Interviews on the maker mind-set "playful" in education using 3D printer show that students are excited and hope to participate in ongoing make-up activities as a hands-on class that touches and produces equipment, not traditional classroom classes, which are run around lectures and theories.

I thought it would be difficult to start a 3D printer at first, but I wanted to have a 3D printer because it was fun to make many things and do various 3D modeling.

I usually study only in your lectures and books at school, but I can use 3D printers to touch the machine and print out the things that I made. I think 3D printers are necessary and fun, so I hope there are many more of these classes.

The improvement of the student's 'Asset growth-oriented’ in 3D printing was felt more by the teacher than by the student. This can be seen and check more easily as a teacher knows and teaches the various aspects of students' daily lives than students themselves.

The best thing about educating the makers is that they have improved their spirit of the challenge. The children didn't want to challenge the difficult problem until the beginning of the semester. There was a strong tendency to want to solve easy problems and get high scores. But now students are turned into students who want to challenge difficult problems. They've always wanted to take on new projects because they've felt confident that they can solve any problems and have a sense of accomplishment when they publish their project output.

And while students are experiencing various failures using 3D printers, they create a positive 'failure-positive' attitude to overcome and resolve failures through efforts to resolve them.

When I was studying at school, my grades were falling or I was very depressed. But in 3D printer classes, the results often fail even if you work hard for an hour, and when you find a variety of solutions, you will not be afraid of failure, and you will be able to work with confidence even if you get stuck or wrong in studying.

Students are also increasing interaction and cooperation in educational activities using their 3D printers, such as exchanging and interacting information.

The most desired thing in learning 3D printer was to be active. The most important change is that students have been working together while making products and listening to their friends' opinions, and have been actively and cooperative in general life.
In addition, a result of observation for maker motivation by activities of using 3D printer, the self-determination and self-efficacy increased as the grade of the elementary school increased as the motivation for the 3D printer to use the 3D printer was the highest in elementary school students. Particularly, there was no difference between Korea and Japan in terms of participation motive as a whole, but in terms of satisfaction, Japan felt higher satisfaction than Korea.

| [Table 6] Observed Result of Motivation (Frequency of activities / 1 hour) |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Country                        | Self-regulate learning | Self-efficacy | Satisfaction | Immersion | Country         |
| Elementary School              | A 0.42          | 0.44           | 0.91          | 0.60        | Korea           |
|                                 | B 0.36          | 0.41           | 1.45          | 0.86        | Japan           |
| Middle School                  | C 0.75          | 0.61           | 0.66          | 0.58        | Korea           |
|                                 | D 0.54          | 0.83           | 1.26          | 0.81        | Japan           |
| High School                    | E 1.13          | 0.63           | 0.78          | 0.85        | Korea           |
|                                 | F 0.78          | 0.95           | 1.23          | 0.61        | Japan           |
| College And University         | G 1.34          | 0.77           | 0.78          | 0.88        | Korea           |
|                                 | H 1.12          | 0.94           | 0.97          | 0.86        | Japan           |

Interviews on the motives behind the maker activities of students attending the 3D printer education showed that students usually attend through recommendations from their parents, teachers, and colleagues. However, as students go to high school and university, they are self-determinedly participating in the making activities by using their ideas as a 3D printer by taking the initiative of students to create their own ideas.

My teacher is very meticulous and teaches me well. He introduced me to the making club activities and thought that he was learning something good, so I joined the club.

I live in a dormitory, and I thought that I could automatically check the entrance after seeing people fill out each student’s entry control with their hands. So I proposed an idea and learned the 3D printer in the club and used.

Also, while learning about the use of 3D printers in elementary and secondary schools did not appear much in the process of self-efficacy, students were found to feel highly self-efficacy by using 3D printers to produce their ideas and attending contests.

It’s fun when you make a product and work on it. It’s the most rewarding when you go to the competition with the product.

The use of 3D printers also requires various types of teaching methods, but by allowing participants to work around hands-on activities, it increases satisfaction with school life and provides motivation for making activities.

I thought it was difficult to make this pen. Because I did it a few times during art or creation time, but I didn’t want to do it because I always messed up. But after doing this, I like it.
because it looks like it's made just like a real pair. Other friends say they made a good job, and I think they will use it every day at school. I'm so satisfied.

The use of 3D printers makes students indulge in the process of making and learning and producing fun. In particular, it is creating an incentive to actively participate in school activities and interest in them.

Generally, I don't have much time in other classes. Then, you lose your concentration. I play with my kids, sleep, or do that. The 3D printer is so fun that I don’t know how much time is going on. My school life is fun.

5. Conclusion and discussion

The results of a study on Maker mind-set showed that students' 3D printer activities were active in all elements of playful, asset growth-oriented, fail-possessive, and collaborative, with the most significant improvement in Maker mind-set. This is a hands-on process in which 3D printers work directly with new technologies and experience output, which can be seen as a result of students' more enjoyable participation in activities. However, the factors of playful are decreasing and the number of failure-positive is increasing, indicating that long-term 3D printer activities are needed to have high Maker mind-set, as the higher the grade of 3D printer activity is, as compared to the 3D printer activity of lower grade students by teacher management and guidance.

In addition, research into maker motivation found that all four factors in self-regulate learning, self-efficiency, satisfaction and immersion can be enhanced through 3D printer activities, especially those in which self-regulate learning is a leading participant in activities using 3D printer.

The results of these studies indicate that long-term educational activities using 3D printers at elementary, middle, high schools and universities are very important to create and promote the ecosystem of makers.

It is meaningful that this study provides basic information on the utilization and education of 3D printers for the purpose of creating a sustainable maker ecosystem by researching the activities of 3D printers in Korea and Japan. In future studies, it is necessary to conduct research on various effects and effects other than the maker mind set and the motivation for 3D printer activities. It is also necessary to conduct a survey of many schools in Korea and Japan on 3D printer activities and utilization in a few more schools to ensure the reliability of their research results.

References

Perception of Universiti Malaysia Sabah Civil Engineering Students Towards KA40102 Traffic Engineering Course

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KA40102 Traffic Engineering course is offered to the fourth-year civil engineering major student in Universiti Malaysia Sabah (UMS). The present model is student would take traffic engineering as fundamental and practical in traffic engineering lab. It should, therefore, be evident that cooperative learning component, both of which are integral to its success to be a fundamental basis for the civil engineering student. Nowadays, many parties argue that graduates lack the necessary theoretical skills, training and managerial understanding. These inadequacies contribute to unemployment and the lack of advancement opportunity within their chosen careers. Besides, there is a need to examine the perceptions of students regarding course content before they go into industry. The aims of this research project are, to explore the course content offered in traffic engineering, and secondly to measure the levels of satisfaction of students towards this subject. Using an approach through a survey of 73 students, this study explores the course content and satisfaction levels based on study areas in traffic engineering. This paper concludes by presenting the subject satisfaction index tool that will contribute towards the improvement of the overall quality of the civil engineering academic programs and subsequently the employability of its graduates.

Keywords: Traffic engineering, Civil engineering, Student perception
INTRODUCTION

There is a debate that perception of students towards the difficulty of different subjects has occurred over many years in certain subjects’ area. Teachers and students’ perceptions of subjects may have an impact on which subjects’ students choose to study and whether other concern might interact with it. Several writing and articles have written that various factor might influence students’ perception towards the decision making process on subjects that they are enrolling in (Fossett, Dyke, & Maringa, 2004). These included the excitement of the subject, the perceived practical of the subject. Perceptions of usefulness may be one such factor, as it is likely that students will need to handle the trade-off between perceptions of subject difficulty and the usefulness of the end qualification. There are large number of school students that has high aspirations for their future (Baird, J.A. et al., 2012) and always overthinking about it. As well as being more motivated to further their education in enjoyable subjects, intrinsic motivation has also been linked with greater academic grade and performance, better learning curve, deeper understanding and enhanced memory. (Ryan, R.M., 1991)

In a writing paper in the year of 1996, Darling & Glendening stated that students may believe that their own internal views are the most important factor in decision making and the perception towards a subject. The views such as those of their teachers have also been shown to be an important deciding factor for a student (Jinn et al., 2011). This also included the subject difficulty (Brown et al., 2008). Teachers are likely to have their own perceptions of subject difficulty, which may shape the advice that they provide, and the way in which they constrain the choices available to students. It is important, therefore, to take into account their perceptions and behaviours, alongside those of students.

So, it is normal nowadays for higher education institutions to collect student feedback regarding the teaching, course efficiency, and quality (Aithal, P.S., 2015). The systems for evaluating teaching and course quality in higher education have long been created in many countries, including Malaysia. Although there are different style of student evaluations from country to country or from institution to institution, the ultimate purpose of evaluation is to ensure “accountability, benchmarking and continuous improvement” (Kifle, T. and Alauddin, M., 2016).
Although final course examination scores have been the primary criterion for establishing the validity of student evaluations, the scores reflect only a limited view of students learning outcomes. More comprehensive indicators of student learning would go beyond a single exam score, which typically reflects only the narrowly defined course objectives. Such indicators might include student perceptions of their increase in interest in the subject, critical thinking skills, interpersonal outcomes (e.g. cooperative abilities), intrapersonal outcomes (e.g. self-understanding) and other broad course outcomes (Koon and Murray, 1995). In fact, one study found that student perceptions of learning in a course correlated much higher with student ratings of instruction than did differences in pre- and post-test scores (Stark-Wroblewski et al., 2007). Ryan and Harrison (1995) and Cashin and Downey (1992) also found that student perceptions of learning were highly correlated with their overall ratings of perceptions. According to the Theory of Reasoned Action, human behaviours are shaped by perception (Montano, D.E. and Kasprzyk, D., 2015). The Technology Acceptance Model (Venkatesh, V. and Davis, F.D., 2000) further suggested that the perceived effectiveness of a technology for the tasks at hand determines the acceptance of the technology. O’Malley and McCraw (1999) added that the perceived effectiveness of an educational technology is dependent on the perceived characteristics of the technology, and the characteristics and background of students.

**METHODOLOGY**

University Malaysia Sabah (UMS) was established on 24th November 1994 (Seng, L.T. et al., 2018). His Royal highness the Yang Dipertuan Agong proclaimed the establishment of UMS under Section 6(1) of the Universities and University Colleges Act 1971. University Malaysia Sabah strives to achieve academic excellence in various fields by gaining international of the society and recognition through learning and teaching, research and publications, social services and a balanced specialization of knowledge and personality development of students resulting in high productivity and quality in context of the society and the nation.

The Faculty of Engineering (FKJ), formerly known as the School of Engineering & Information Technology (SKTM), offers various courses such as civil engineering, chemical engineering, electrical and electronic engineering, computer engineering,
software engineering and computer science. In this study, the Civil Engineering programme also known as HK01 is the scope of examination and concern. The Civil Engineering programme at UMS contains elements of theoretical and practical nature and designed to provide students with a sound basis for a professional career. Students learn among others, materials, structures, geotechnics, hydraulics, water resources, surveying, management and law, accounting and final year research project. The theoretical aspects are reinforced with practical hands on through laboratory sessions, design projects field works, industrial visits and training attachment. Some of the courses in HK01 are Civil Engineering Material, Engineering Geology, Statistic, Fluid Mechanics, Solid Mechanics, Hydrology, Traffic and Highway and Finite Element Method

Traffic Engineering course is a compulsory core subject for students in HK01 and is typically scheduled to be enrolled in the fourth year of the study. This course involves an extremely complex interaction of economic, behavioural, social, political, environmental and provide students with a solid introduction to the principles of traffic engineering with the focus on traffic analysis, urban traffic optimization and solution to traffic problem for construction and operation of highways. The outline of the course would be distributed to lecture, tutorial, case study, course assignment and examination. It accumulates up to 80 hours of study where 43.5 hours are lecture session while the remaining 36.5 hours are tutorial, lab work, and assignment work for the individual students. The course aims to have the students achieve the following objective by the end of their study:

1. The ability of Demonstrate complex knowledge of sustainable traffic management
2. Model and analyse traffic flow, speed, density and level of service (LOS)
3. Analyse urban traffic optimization
4. Apply contextual information for road traffic safety issues.

The course covers whole process of collecting data, analysis and applying the principles, fundamentals of traffic engineering and solving traffic problems. The limitation of the study would be the respondents with respect to knowledge, attitudes, beliefs and behaviours.
A total of 73 students from the HK01 programme in the year 2017 responded to the course evaluation form, PK07. PK07 is the standard course evaluation used by UMS to determine the satisfaction of students, and strive to improve the course content, facility, and assessment of a particular course. The PK07 is divided into six main categories which included:

(a) Preparation of Course  
(b) Delivery of Lectures  
(c) Assessment of Tasks  
(d) Learning Outcomes  
(e) Facility  
(f) Soft Skill

The rating will be a scale of 0 to 5, where 0 is bad and 5 is excellent. Then every category would have some questions for students to rate and the average of it would be taken into account.

**FINDINGS**

It showed that most of the students in HK01 were very satisfy with the preparation of the lecturer of this course. The result shows an average sum mean of 4.42 satisfaction. The course outline had been distributed to student even before the semester starts. At the same time, the lecturer had informed all the students to join schoology interactive education website where students could interact and communicate between each other’s as well as their lecturers. Hence, it is clearly showed that the quality of the lecturer is well top notch.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Briefing on course/syllabus at the start of semester</td>
<td>4.40</td>
</tr>
<tr>
<td>Written information on course implementation</td>
<td>4.45</td>
</tr>
<tr>
<td>Appropriateness of course content with learning</td>
<td>4.42</td>
</tr>
<tr>
<td>objectives/outcome</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Evaluation of Preparation
Next, PK07 required student to evaluate the delivery of the content from their lecturer. From table 2, we can see that the lecturer clearly has crystal clear delivery of the course content to his students.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of audio-visual aids by lecturer</td>
<td>4.44</td>
</tr>
<tr>
<td>Clarity in delivery of lectures</td>
<td>4.39</td>
</tr>
<tr>
<td>Ability of lecturer to attract and sustain students’ interest on subject</td>
<td>4.40</td>
</tr>
</tbody>
</table>

Table 2: Delivery of Lectures

The magnificent mean score show that majority of the student could easily understand this difficult technical subject. Other than that, students are required to evaluate in how their grade being assessed. From the statistic in table 3, it showed that students feel satisfy with their grades and how their hard works and efforts being assessed.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety of assessment methods</td>
<td>4.42</td>
</tr>
<tr>
<td>Appropriateness of marks allocate for each assignment or task</td>
<td>4.40</td>
</tr>
<tr>
<td>Feedback from lecturers regarding results of examinations and assignments</td>
<td>4.37</td>
</tr>
</tbody>
</table>

Table 3: Assessment

The structure of assessment was divided into 5% for attendances, 15% for test and quizzes, 10% for project works, 20% for program-based learning and finally 50% for the final exam. The ability of students understanding or take away skills were also evaluated in the PK07 where students would give rating based on this course outcome as shown in table 4.
Table 4: Learning Outcome

This score is high because the syllabus of study that outline in this course truly prepare students in different way where they could have solved the real-life problems where traffic congested happened in most urban areas. They also have gained the knowledge of how to evaluate the level of service of the traffic, methods on data collection for traffic junction, determination of conflict points as well as the futuristic traffic management system where engineering make it to be happen. Besides that, students also give rating on the facility standard in table 5.

Table 5: Facility

The score shown are reasonably high because UMS has been always striving to be one of the best eco campus university and provide the most comfortable places for the students enhanced learning. Therefore, every classroom is well prepared with air conditioning, top notch standard of table and chairs as well as leaning assistants’ tools such as projectors and speakers.
<table>
<thead>
<tr>
<th>Subject</th>
<th>Mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhancement of communication skills</td>
<td>4.2</td>
</tr>
<tr>
<td>Enhancement of critical thinking and problem-solving skills</td>
<td>4.37</td>
</tr>
<tr>
<td>Enhancement of teamwork skills</td>
<td>4.40</td>
</tr>
<tr>
<td>Enhancement of leadership skills</td>
<td>4.42</td>
</tr>
<tr>
<td>Enhancement of knowledge in moral, and professional ethics</td>
<td>4.35</td>
</tr>
<tr>
<td>Enhancement of life-long learning and information management ability</td>
<td>4.37</td>
</tr>
<tr>
<td>Enhancement of entrepreneurship skills</td>
<td>4.15</td>
</tr>
</tbody>
</table>

Table 6: Soft Skills

Lastly, students were required to evaluate the soft skill that they gained in this course which will be tabulated in table 6. The result shows that students have developed very good soft skills out of this course where they have been trained in leadership, teamwork, and ethics because the course has a lot of hands on project and group project where the problem-based learning required a team of students to finish the task. Overall statically, students think that the course is informative and increase their knowledge a lot with overall mean of 4.40 which is 88% indicating that they are exposed to lots of practical and academic knowledge.

As of 2017, the course has 98.25% passing rate which is in line with the PK07 evaluation form where students were well understood about the content. 10 students which is about 13.7% scored grade A while 48% of the students scored grade B, and 15.1% student of the students scored grade C and lastly only 1.75% of student which is only 1 person failed the subject. The y-axis of the graph is shown the percentage of the students and x-axis showing the grades of course.
CONCLUSIONS

This study showed that the students’ perceptions toward this course are extremely positive and the expectations of students were greatly achieved at the same time. This is surprisingly good given that the student has no experience or approach in this field before. The fourth year of student would be polishing up their final year skill to become a well-qualified engineer where they will work in the industry very soon. So, this study is responsive to the needs of the expertise in this country.

The finding also indicated that UMS provided top notch quality of lecturer and comfortable places for students to learn where it greatly improves the learning curve of the students. Indeed, it would increase exponentially the student’s absorption ability at the same time. This paper has given the insight view of the value of perception of the students in the traffic engineering the findings also indicate that the satisfaction level of the students was excellent.
REFERENCES


An international approach to improving the English proficiency of teachers in Japanese Maritime Colleges

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Abstract. The maritime technology departments in the five National Institute of Technology (NIT) colleges in Japan namely Toyama, Toba, Hiroshima, Yuge and Oshima College have been working together to improve the ability of Japanese students and instructors to use Maritime English without any trouble. 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” since 2015. We decided to join the project with Japanese students and instructors. Aside from the students’ English training, we, Japanese instructors, were given several chances to give lectures to Filipino students. This paper reviews how the English training and teaching experience worked for Japanese 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 Singaporien students, and analysed 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, STCW, NIT maritime 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 NIT 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]-[3]. 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 analysed 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.

**REVIEW**

**Teaching in English on technical subjects 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.

Photo 1: Lecturing view at NTMA
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.

**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 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.

Figure 2 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 purple which indicates number 4 shares about 25% and the sky blue indicating number 5 shares about 75% of 81 students in total. As a result, it is a fairly high score and a good indicator that NIT did well in the lecture. The Filipino students generally gave high values on number 4 or 5 (means agree or very agree for 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). There are only two colors in Q1 and Q5. This means that the students do agree or very much agree with that the lecture’s organization and the lecturer’s English was effective. 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.

**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. 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 3, 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 class. Q1 to Q6 means questions 1-6.

![Hexagon chart showing average values to each question for the invited lecturer at SMA](image)

**Figure 3: Average values to each question for the invited lecturer at SMA**
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.

An international approach to improving the English proficiency

Figure 4 shows the total result which I have gathered since 2015 from the four countries. 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
Figure 5 shows what kinds of teaching methods are effective in the class. Students think the use of video is 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 [7]-[11].

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


Collaboration of international English educational programs to train international ship officer in Maritime Colleges in Japan.

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Abstract. Most of Japanese international maritime company hires many foreigners as ship crew. Most of ship crew is form Philippines (19%) because of their English communication ability, then Indonesia (6%), China (6%), Turkey (5%) and so on in Japanese company. It is necessary for international maritime officer to have daily communication with foreign crew through one board for 6 months, not only to communicate with Standard Marine Communication Phrases based on the International Convention on Standard of Training Certification and Watchkeeping for Seafarers. The maritime technology departments in the five National Institute of Technology colleges in Japan namely Toyama, Toba, Hiroshima, Oshima and Yuge college have been developing English educational programs and shearing together to train Japanese international ship officer. “All maritime college study method improvement project” in 2006 - 2011, “Maritime Human Resources Development project” in 2012 – 2017 and “2nd phase of Maritime Human Resources Development project” in 2017 – 2019 supported by Japanese government have been carry out to achieve this goal. Abroad English educational programs which dispatch and accept
students have been carry out successfully with NYK-TDG Maritime Academy in Philippines as part of “NYK mirai project”, Singapore Maritime Academy, Kauai Community College and Emilio Aguinaldo College in Philippines. English teachers were invited to provide maritime English seminar from Maritime Academy of Asia and the Pacific in Philippines and have successfully educational results.

**Keywords**: Maritime English, STCW, NIT maritime colleges, NTMA

**INTRODUCTION**

The maritime technology departments in the 5 NIT colleges in Japan have challenges to improve from the classical maritime English education which focus on reading and writing typical in Japan to modern [1. 2. 3. 4] to enhance motivation and ability of students to be ship officer and manager at oversea as shown in Table 1. [5 - 16]

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>06</td>
<td>All maritime college study method improvement project, Japanese government[5]</td>
</tr>
<tr>
<td>07</td>
<td>MARP[9, 10, 11] Professional maritime English seminar, Textbook publishing[12]</td>
</tr>
<tr>
<td>08</td>
<td>Maritime human resources developing project, Japanese government[6, 7, 8]</td>
</tr>
<tr>
<td>09</td>
<td>Mirai Project NTMA[13, 14, 15, 16]</td>
</tr>
<tr>
<td>10</td>
<td>Next generation maritime human resources developing project[17, 18]</td>
</tr>
<tr>
<td>11</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
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<td>15</td>
<td></td>
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<td>16</td>
<td></td>
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<td>17</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. History of English education developing project in the 5 NIT colleges

Various international internships and English seminars are developed and carried out among the 5 NIT colleges as shown in Table 2[17, 18]. Same of them are suit for other department like information science. Program at NTMA have a best cost performance among these programs. MAAP and NKMUT English seminars give a chance to many students to study English without any extra personal cost. In this paper we focus on “The English study + international internship programs in NTMA” and “NIT hosting NTMA visit to Japan”.
Table 2 List of International internships and English seminars carry out in the 5 NIT colleges

<table>
<thead>
<tr>
<th>Place</th>
<th>Period Days</th>
<th>Price USD</th>
<th>Program</th>
<th>Number of participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTMA Philip-pines</td>
<td>11</td>
<td>700</td>
<td>Special English seminar Attend regular classes, Field Trip</td>
<td>4 9 10 11 23</td>
</tr>
<tr>
<td>Kauai Community College Hawaii</td>
<td>21</td>
<td>5000</td>
<td>English seminar Canoeing, Camp activity</td>
<td>10 16 12 11</td>
</tr>
<tr>
<td>Singapore Maritime Academy Singapore</td>
<td>14</td>
<td>3000</td>
<td>English Seminar On board ship training</td>
<td>16 13 8</td>
</tr>
<tr>
<td>AMA Computer University Philip-pines</td>
<td>14</td>
<td>1200</td>
<td>English Seminar</td>
<td>8</td>
</tr>
<tr>
<td>MAAP Japan</td>
<td>14</td>
<td>0</td>
<td>Professional Maritime English Seminar On board ship training</td>
<td>840 630</td>
</tr>
</tbody>
</table>

Table 2 List of International internships and English seminars carry out in the 5 NIT colleges

Class and evaluation

The English study + international internship programs were performed at NYK-TDG Maritime Academy (NTMA) in the Philippines as “NYK mirai project”.

Table 3 Number of participant of students and schools for the program in NTAM

<table>
<thead>
<tr>
<th>Year</th>
<th>Student</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hiroshima</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Yuge</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Oshima</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Toyama</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Toba</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Instructors</td>
<td>Hiroshima</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Yuge</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Oshima</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Toyama</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Toba</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 3 Number of participant of students and schools for the program in NTAM

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
<th>0500H</th>
<th>0800H</th>
<th>1200H</th>
<th>1300H</th>
<th>1700H</th>
<th>2100H</th>
<th>2200H</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Reveille (follow Cadet’s Daily Routine)</td>
<td>Attend classes of 3rd Year Cadets</td>
<td>Lunch with NTMA Cadets At Cafetorium</td>
<td>Attend classes of 3rd Year cadets</td>
<td>Attend English Oral Communication Activities</td>
<td>Administrative Time</td>
<td>TAPS (sleeping time)</td>
</tr>
<tr>
<td>1</td>
<td>Arrival</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Attend regular classes, Welcome party</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Attend regular classes, Special English seminar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Trip to Manila Old Down town</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Trip to Coconut Prantation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-9</td>
<td>Attend regular classes Special English seminar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Attend regular classes, Farewell party</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Departure</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Table 4 Day schedule of the program

Table 5 Time schedule of the program
An official agreement between NIT 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.

Buddy system which makes a pair between NIT and NTMA student was employed to take care NIT 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.

NIT students performed introduction presentation of themselves, school, training ship, club activities, town in English for all NTMA students. They participated in specialized maritime and also basic subject regular classes, ship maneuver simulator and engine trouble simulator training and so on taught in English with their buddy.

Special English seminar for NIT 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.

A non native English speaker instructor from NIT performed lectures of maritime technical subject, accessory machine in English at regular class in NTMA. A non native English speaker instructor from NIT performed a presentation of Japanese culture and geography in English for all NTMA students.

One day trip to Manila Old down town and Coconut plantation on Saturday and Sunday were provided. Students had very good communication in English. NIT students could understand Philippines culture and geography very well.
Questionnaire survey for NIT students for “English seminar & internship” in NTAM in 2018 was performed to evaluate enhancement of student motivation to study English and be seaman as shown at Table 6.

Just choose one number from listed below for each question.

1: Very false 2:False 3:Neither true and false 4:True 5:Very True

**About buddy**

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 your buddy?
Q. 1.4 Can you enhance your understanding for your buddy (personally)?
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

**About class**

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?

**Educational effect for the program**

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?

Table 6 Questionnaire for NIT students for the program in NTAM in 2018

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

Table 7 Questionnaire for NTAM students for the program in NTAM in 2018

NTMA 3rd grade students and instructors visited to NIT Toyama college (Toyama) for 4 days including visit to NYK head office in Tokyo in 2018 as “NYK mirai project”.

The buddy system was employed to take care NTMA students in Toyama. NTMA performed presentation of self-introduction, ship boarding history (only for instructors), Philippines culture and geography for student in Toyama.

NTMA students participated in specialized maritime and also basic subject regular classes, Ship maneuver simulator training, Kater (Japanese style lifeboat) practical training, English and so on. Unfortunately, some of classes taught in English but most of them in Japanese. In this point future improvement for teaching in English is needed.

NTMA students joined on board ship training to Toyama with 3rd grade navigation couse Toyama students for 3 days on Wakashio Maru. Role playing of “starting main diesel engine”, “starting diesel electric generator”, “departing port procedure”, “arriving port procedure”, etc. were done in this on board ship training.

Questionnaire survey for Toyama and NTMA students for the program especially for the introduction presentation and the on board ship training at Toyama in 2018 were performed as shown at Table 10 and 11 respectively.

<table>
<thead>
<tr>
<th>Year</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>Hiroshima</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yuge</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oshima</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toyama</td>
<td>O</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toba</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8 List of host college of NTMA visit to NIT

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Arrival</td>
</tr>
<tr>
<td>2</td>
<td>Attend classes Welcome party</td>
</tr>
<tr>
<td>3-4</td>
<td>On bord ship training to Takamatu</td>
</tr>
<tr>
<td>5</td>
<td>Vist to NYK H.O. and Tokyo Disney land</td>
</tr>
<tr>
<td>6</td>
<td>Departure</td>
</tr>
</tbody>
</table>

Table 9 Day schedule of the program in 2018
Photo 5 Introduction presentation of NTMA students at Toyama college in 2018

Photo 6 Dormitory life of NTMA students with Toyama students buddy in 2018

Photo 7 Departing port procedure of NTMA students on board ship training on Wakashio maru in 2018

Photo 8 Starting main engine of NTMA students on board ship training on Wakashio maru in 2018

About the presentation
Q. 1.1 Can you listen the presentation in English?
Q. 1.2 Can you understand the presentation?
Q. 1.3 Can you ask a question in English for the presentation?

Q. 1.4 Can you enhance your understanding for NTMA (personally) through the presentation?
Q. 1.5 Can you enhance your understanding for Filipino?
Q. 1.6 Can you enhance your understanding for Philippines culture?
Q. 1.7 Can you enhance your understanding for NTMA (school)?
Q. 1.8 Can you enhance your understanding for Philippines seaman?
About on board ship training
Q. 2.1 Is on board ship training good?
Q. 2.2 Can you communicate with NTMA [Toyama] students in English?
Q. 2.3 Can you perform training in harmony with NTMA [Toyama] students?
Educational effect for the program
Q. 3.1 Can you understand necessity to communicate with foreigner?
Q. 3.2-3.4 = Q. 3.2-3.4 in Table 6
Q. 3.5 Can you enhance your motivation to join the program in NTMA?
Table 10 Questionnaire for Toyama students for the program in Toyama in 2018

About buddy
Q. 1.1 Can you listen your buddy's English pronunciation?
Q. 1.2-1.7 = Q. 1.1-1.6 in Table 6
About on board ship training
Q. 2.1-2.3 = Q. 2.1-2.3 in Table 10
Q. 4 Can you get support for on board life from your Toyama student buddy?
Q. 5 Can you get support for training from your buddy?
Educational effect for the program
Q. 3.1-3.4 = Q. 3.1-3.4 in Table 6
Table 11 Questionnaire for NTAM students for the program in Toyama in 2018

**Result and discussion**

Fig. 1 shows statistical results in percentage of the questionnaire survey for NIT students for the program at NTMA in 2018. NIT students can communicate with NTMA buddy even though their poor English. NIT 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. 2 shows statistical results in percentage of the questionnaire survey for NTMA students for the program at NTMA in 2018. NTMA students can communicate with NIT 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 NIT 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. 1 Statistical results in percentage of the questionnaire survey for NIT students for the program at NTMA in 2018

Fig. 2 Statistical results in percentage of the questionnaire survey for NTMA students for the program at NTMA in 2018
Fig. 3 Statistical results in percentage of the questionnaire survey for NIT Toyama students for the program at Toyama in 2018.
Fig. 4 Statistical results in percentage of the questionnaire survey for NIT students for the program at Toyama in 2018.

All sector shows remarkable motivation enhancements for 2nd grade Toyama students with the presentation by NTMA in 2018 as shown in Fig.3. Hosting NTMA give a big chance to many NIT students to study English without any extra personal cost.

All sector shows motivation enhancement for 2nd grade Toyama students for on board ship training with NTMA students in 2018 as shown in Fig. 3. Some Toyama students who have low English score can communicate with NTMA buddy very well. English skill and communication skill not equal. Nonverbal communication like gesture, eye contact are very important on board life. For them this kind program gives a chance to get study English.

All sector shows motivation enhancement for NTMA students for on board ship training in 2018 as shown in Fig. 4. It is very good chance to take real training ship experience. NTMA students just practice with ship simulator up to 3rd grade and go to training ship at 4th grade.

**CONCLUSIONS**

English study + internship program in NTMA in the Philippines which is affordable for all students was developed. Hosting NTMA give a chance to many NIT 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.
References

Acknowledgment
This program is sponsored by “NYK mirai project” from NYK corporation. The authors would like to express gratitude to instructors and staff of NTMA to perform this programs.
Development Of Accident Expert System Manager (AESM) As A Learning Tool For Students

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Road accident is a serious concern as it brings numerous complications to human life. This research discusses the development of an expert system that is used to manage accidents. This is in line with the University's sustainability initiative, eco-campus. This Accident Expert System Manager (AESM) is a software program that is able to provide consultation on managing traffic-related accidents, similar to the industry professionals. As a result, all layers of society can utilise the expert system to prevent, reduce and even solve the problem related to accidents, without having the experts to be present around them for consultation. A prototype of the AESM was developed with Microsoft Visual Basic 2010. The AESM was then evaluated and validated to ensure the specifications, quality and acceptance by end users is satisfactory. The validation and evaluation was conducted through the use of a Likert scale questionnaire which involves expert evaluators and novice engineers. Based on the result, the acceptance of AESM by the end user is high, and it can provide an optimum strategy to manage accidents on the road. Using the AESM, knowledge from experts is available to be use by all engineers in the traffic and transport field. Additionally, experts in this field can apply the system for the purpose of experiences sharing and peer evaluations. Other than that, it can also be used as a learning tool for engineering students.

Keywords: Expert System, Manage Accident, Learning Tool
INTRODUCTION

Transportation is the movement of humans, animals or goods from one location to another. There are many modes of transport including air, rail, road, water, cable, and space. Transportation is one of the crucial aspects that allow rapid development of economy, social and facilities. On top of that, transportation can also interrupt the development if a country as it may bring injury, disability, and even death due to traffic accidents.

As a mean to improve road-based mobility and safety, and to decrease the economic and environmental impact, the development of an Accident Expert System Manager (AESM) is rising a significant concern. Therefore, expert systems was introduced in this project to manage accident in the effort of resolving this issue. However, in this project it is primarily focused on managing traffic accident towards a sustainable eco-campus. One of the main challenges of the Sustainable Development Goal (SDG) is to cut half the number of deaths and injuries caused by road traffic accidents (RTA) by the year 2020 (Korchagin, Pogodaev, Kliavin, & Sitnikov, 2017).

The fundamental concept of expert system is simply that expertise, which is the vast body of task-specific knowledge, is transferred from a human to a computer. This knowledge is then stored in the computer and users call upon the computer for specific advice as needed (Luisa et al., 2017). Therefore, user can obtain multidisciplinary solution on accident within seconds rather than consulting a human expert. This will significantly slash the cost and time of the user.

The whole learning process of engineering will be more interactive and attractive if an expert system tools is integrated as one of the learning methods. The expert system can be used to better understand the problem and solution from the perspective of the expert’s past experiences and real-life history. Other than that, the expert system can be used as a decision-maker when comparing past cases and the analysis of data during case studies. However, as of today, the integration of expert system as a learning tools is still lacking. Lucy, Ober and Lemmas (2010) stated that the introduction of learning tools has drastically improved the tutor and students’ experiences in learning and teaching. Markham (2001) stated that, expert system is a
more user friendly tool as it can solve the questions of users especially when new users are more inquisitive on the reasoning behind the decision or solution given.

The main goal of the development of this expert systems is to guide the end users, in this case the students of a higher learning institute to understand the underlying principle of an expert system at the same time provide the optimum solution to effectively reduce the probability of an accidents from occurring for the end users. In any expert system, the end user must choose from several guided selection to provide an optimum solution to their problem. In the case of this AESM, the home page is the specific name of the expert system, library and Problem and Solution menu, shown in Figure 3. User need to select the types of road user that they are interested, shown in Figure 4. Then, all of the optimum strategy required as a pedestrian, bicyclist, motorcyclist, or motorist is shown, shown in Figure 5.

There are multiple sources of solution to prevent the source information to be limited to a single interpretation only Not only that, multiple sources of solution strengthens the effectiveness of the solution for each problem. Some examples of these sources includes standard encyclopaedia, manuals, academic journal and textbooks. The most optimal, and relevant strategy will be obtained from the diverse source in order to provide user the best road accident managements. However, all of the information gained from every source is followed by the consultation and discussion with the domain expert. Only then the data information is coded in the structure of the expert system. The main knowledge was attained through the consultation with the road safety institution and expert who were officially involved in road accidents problem. One of main the method to obtain consultation from the domain expert and professionals is to through a questionnaire distributed online.

Google Forms was used to as the main platform for the questionnaire. The main distribution channel used is through official emails of the domain experts and professional. Most of the he domain expert that was involved in completing the questionnaire are lecturers from universities.
LITERATURE REVIEW

The expert systems are the computerized system that are able to provide most effective strategies based on the experience and proven method from the domain expert and industry professionals. An expert system helps us to collect the data from the experienced expert and the collected knowledge can be combined, studied and analyzed repeatedly (Magnitsky2005).

Raza (2009), stated that acquiring knowledge for the expert system is the most important thing to be emphasized during the development of an expert system. The process of knowledge acquisition involves obtaining and classifying expertise from miscellaneous sources (Qian et al. 2008). Criteria for choosing domain experts ensure elicitation of correct expert knowledge. There are two major criteria for domain experts. First is the length of experience in the domain, which affects the judgment and analytical Behavior of the expert. The second criteria can be represented in circumstances in which the expertise is obtained, which could be theoretical, practical, or a combination of both (Osuagwu&Okafor 2010).

The selection of best strategies is based on the experience and advise of the domain expert. This would provide the end users and developer a better understanding in the process of managing accidents in the four categories of road user which are pedestrian, bicyclist, motorcyclist and motorist. However, the developed expert system is still required to go through a validation and evaluation to ensure that this system is user friendly and can be used without hesitation to its solution. The parties that involved in the validation process of the AESM are the domain experts, engineer and civil engineering students. It is considered as a valid system when there is no error found during the usage of the developed AESM. During the validation process, the developed expert systems are tested by the parties mentioned and is evaluated by using a Likert scale questionnaire. The respondents are required to rate from a scale of 1 to 10 for questions regarding to the effectiveness of the AESM.

Maintenance of AESM is necessary to ensure the provided strategies are in-line with the latest environment of the road. As the technologies improve for the different types of vehicles, and improvements to the. different kinds of facilities on road will
causes the strategies to become unsuitable or obsolete. The first version of AESM expert system will be named as AESM 1.0. Once there is update due to changes in the knowledge base, the version will be upgrades as AESM 2.0. This is to provide the latest optimum solutions for end users. Technology will keep developing and improving, thus a continuous effort to upgrade the expert systems is mandatory.

The concept of including expert system in the teaching and learning system would provide appropriate exposure to the students regarding the various methods and solutions available in the industry. Should development of an expert system be included in the curriculum it would be best if it is translated into a simplified English to prevent the end user from having to learn the Expert System's language. This is especially true during the coding phase especially to students that has no prior experience in programming language. However, with the abundance of materials and sources online, learning the basic programming language should be easier compared to the generations before online learning was easily available. This is especially true for a higher learning institute student as most institute provide these facilities for the students.

**METHODOLOGY**

There are various methods that have been used during the development process of this expert system application which include the collection of data from books, journals and also, domain experts. The knowledge acquisition process is significantly important in order to provide the optimum strategy towards the objective of this study. Next, the information collected was coded in computer programming using Microsoft Visual Basic 2010 to develop the AESM. Meanwhile, the flow chart as shown in Figure 1 shows the steps of developing the expert system application AESM, while Figure 2 shows the relationship between the parties involved in the development of expert systems with AESM structure.
Figure 1: Steps in Developing of an Expert System Application AESM
Programming language Microsoft Visual Studio 2017 was used in this study to create an Expert System - Accident Expert System Manager (AESM). The relevant information acquired from various sources was coded as knowledge base for the AESM. For the development of the AESM, these steps were followed.
Step 1: Start a New Project

The Create new project command was selected in the start page of Microsoft Visual Studio 2017 Express. The project was named as AESM with Windows Forms App (.NET framework) template selected.

Step 2: Creating Windows Forms Application
The default blank window form named as Form 1 was appeared as main window. Then, the selectable items in toolbox like label, button and radio button were dragged and dropped on the Form 1. After adding a control to the default form, set certain properties to determine its appearance and its interface such as font size, colour and adding picture on the form.

Form 1 was then renamed as Home as shown in Figure 3. This home page is the main page of the application, complete with buttons, labels and background design. The AESM consisted of two major sections which are library and strategy. The strategy
section is focused more on the location of user that was prone to accident, and is based on the types of road user, which are pedestrian, bicyclist, motorcyclist or motorist. On the other hand, the library section would provide a detail explanation of the types of road user which was design to ease the user to further understand the type of road user on asphalt road

Next, double click the Strategy button at Home window to enter the coding window. The properties of the button Strategy can also be modified by using coding. The coding shows the connection from Panel Home to the next panel which is selection of location.

When Strategy button was clicked, Panel Choose Location will be appeared where user was required to select a desired location of user, such as In-campus or Kota Kinabalu city. This selection was performed using the button tool. More location will be updated in this expert system in the future based on the location that was in a high frequency of accident occurred. After the location was selected, the Types panel will show up. In this panel, selection of types of road user is required to be select such as pedestrian, bicyclist, motorcyclist and motorist as shown in Figure 4. Then, a number of strategies to manage accident panel will show up based on the highest priority or effectiveness based on the types of road user selected. To restart from the beginning, user can click the Home button or back button for the previous panel.
Figure 4 Choosing Type Road User Panel

Figure 5 Strategy for Pedestrian

1. Pedestrian strictly should walk facing the traffic.
2. Always wear bright clothing.
3. Pedestrian should not involve in alcohol while walking on road.
4. Pedestrian should walk only on sidewalk which is specifically for pedestrians.
5. Crossing only at crosswalks or intersection.
6. Paying attention to every stoplight and sign board related to traffic.
When the type of road user is chosen, the strategy to manage accident will appear in a new panel as shown in Figure 5. Each strategy will show in panel form with the detail steps arrange in most prioritize and effective. There were total six strategies for each of the road user which is pedestrian, bicyclist, motorcyclist, and motorist as shown in Figure 5 for the pedestrian.

Next, the library section was created with similar coding and procedure as in the strategy section. There are a total 4 types of road user in the library window which are pedestrian, bicyclist, motorcyclist, motorist. Each of the road users are coded into buttons. Each button was linked to respective window panel which showed the description of the type of road users selected. The coding of radio button which mainly functions as the Back button, enable users to return to library panel. The explanation about this expert system was also included in the About panel along with its version number.

Step 3: Run the Completed Program

Lastly, the completed program had to be run to ensure there was no error in the program. At the menu bar, Start Debugging button was clicked to run the program. The program will not be able to run if there was error or bug in the coding. Therefore, the coding had to be checked and debug before the program can be started. Once it has successfully tested, the Stop Debugging button was clicked at the menu bar. Users can open the AESM program and starts with the Home interface. Then, selection of road user based on desired location was selected to obtain the optimum strategy.

FINDINGS

The process to measure system’s accuracy and effectiveness which involves end users in system utility determination is called evaluation (Liebowitz, 1986). This expert system was evaluated through the use of an evaluation form as shown in Figure 6 below. This evaluation involves engineers, and civil engineering students. The evaluation covered several important aspects such as efficiency, convenience, compatibility, user-friendliness and precision of the system with the working environment. The
A questionnaire was used to evaluate the usability of AESM application using the Likert scale ranging from 1 to 5. There were 10 questions and respondents were required to rate their evaluation from strongly disagree to strongly agree according to their evaluation as an end user of AESM.

![Accident Expert System Manager (AESM) Evaluation Form](image)

**Figure 6 Evaluation Form**

After the form was filled, the questionnaires were collected for data analysis. Figure 7 showed the results collected from respondents and is presented in percentage. Based on Figure 7, there are a total of 20% that rated 3, 20% rated 4, and 60% rated 5 for question 5. None of the respondents’ rate 1 and 2 for question 5 which is “I think this software is highly accessible anywhere”.

![Result Collected from Respondents](image)

**Figure 7 Result Collected from Respondents**
The user acceptance values were then summed up for each of those ten questions. This value indicates the user acceptance for the AESM expert system as shown in the graph in Figure 8. The utility level was categorized into five levels which were bad, poor, moderate, good and excellent with respective range of acceptance values and shown in Figure 9.

<table>
<thead>
<tr>
<th>No.</th>
<th>Feature</th>
<th>User Acceptance Value</th>
<th>Utility Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Expert System is easy to use.</td>
<td>5.00</td>
<td>Excellent</td>
</tr>
<tr>
<td>2</td>
<td>I could easily understand the explanation.</td>
<td>4.60</td>
<td>Excellent</td>
</tr>
<tr>
<td>3</td>
<td>I can read clearly all the words in AESM.</td>
<td>4.80</td>
<td>Excellent</td>
</tr>
<tr>
<td>4</td>
<td>I think most people will have benefit from this AESM.</td>
<td>5.00</td>
<td>Excellent</td>
</tr>
<tr>
<td>5</td>
<td>I think this software is highly accessible anywhere.</td>
<td>4.40</td>
<td>Excellent</td>
</tr>
<tr>
<td>6</td>
<td>I think that this Expert System can promote sustainable transport.</td>
<td>3.60</td>
<td>Good</td>
</tr>
<tr>
<td>7</td>
<td>The system's interface was comfortable of viewing.</td>
<td>3.80</td>
<td>Good</td>
</tr>
<tr>
<td>8</td>
<td>I think this system can be updated from time to time for future use.</td>
<td>4.80</td>
<td>Excellent</td>
</tr>
<tr>
<td>9</td>
<td>I think this system save time for consultation.</td>
<td>3.60</td>
<td>Good</td>
</tr>
<tr>
<td>10</td>
<td>I found that the solutions provide optimum strategy.</td>
<td>4.00</td>
<td>Good</td>
</tr>
</tbody>
</table>

**Figure 8 User Acceptance for the AESM**

**Figure 9 Utility Level**

Validation is the process of determination of the correctness of the final program of software produced from a development project with respect to the user needs and requirements (Darion et al, 1982). This can be achieved by comparing the solutions provided by another domain expert with the strategy provided from the AESM.
The result of strategies comparison between the AESM and domain expert were shown in Figure 10. There were four types of road user in the expert system. Also, there were many strategies for each types of road user. But in Figure 10, it only shows the most effective strategy in the AESM. Based on the table in Figure 10, the strategy suggested by AESM for motorcyclist was “Conduct campaign to raise awareness” while domain expert suggested “Enforce strict licensing procedure”. Only one of the strategies differs from the domain expert, while the other had the same strategy, between the AESM and domain expert. Therefore, the discrepancy of strategy provided by the AESM and domain expert was only 25% with 75% similarity as shown in Figure 11. This shows that the AESM has high accuracy and reliability.
Verification is defined by Darion, Branstad, and Zhirinovsky (1982) as “the demonstration of the consistency, completeness and correctness of the software”. As stated by O’Keefe, Bali, and Smith (1987), “verification means building the system right”. Both respondents and domain experts play an important role in evaluation and validation of AESM. This is because they provide information for the analysis of the utility of the system. Based on the results from evaluation and validation, the AESM that was developed is an effective, consistent and user-friendly expert system.

**CONCLUSION**

In this research, there were a total of four objectives. The first objective was to study the concepts and principles to develop an effective expert system and to review optimum strategies for accidents managements towards sustainable eco-campus. This objective was achieved in Chapter 3 methodology by studying the overall development of expert system concept and identifying the accidents strategies from various sources.
The second objective was to acquire information, data and knowledge from various sources as well as acquisition of knowledge from domain experts on strategies for accidents managements. This objective was accomplished in Chapter 4 by interviewing a domain expert and collecting related knowledge from books and journals.

The third objective was to develop a prototype system using the programming language Microsoft Visual Basic 2010 to create an Expert System – Accident Expert System Manager (AESM). This objective was also achieved in Chapter 4 by developing the AESM through Microsoft Visual Studio 2017 after the information was completely obtained. The objective was to validate and evaluate the expert system developed to ensure the specifications, quality and acceptance by end users. This objective was done by taking an evaluation questionnaire from civil engineering background respondents. Then, the determination of discrepancy of system and verification of system through some evaluation analysis.

In a nutshell, the AESM was successfully developed and was able to fulfill the requirements in the previous expected design of an expert system. Also, the reliability and effectiveness of AESM were high. Therefore, it was believed it is able to reduce and manage the accident problems towards a sustainable eco-campus.

At the moment, AESM expert system is only accessible through computer or laptop. Thus, in order to widen its range or accessibility, it is highly recommended that the AESM is programmed to be compatible with smartphones with Android or IOS operating system. Also, this expert system can also be implanted into internet websites program. Within this, the accessibility and mobility can be gradually increased as people can use this system regardless of the place and time. This is because nowadays most people have their own individual smartphones. This in turn can bring benefits to all layers of community along with its availability to be updated from time to time.

Expert system may be the best tutor or assistant to each of the student that pursue their study regardless of the level of education. An expert system does not only provide numerous benefits to the students, but also reduce the working loads of the lecturers in the university. Expert systems have a lot of advantage than the traditional
method that we are using in the education system. Therefore, blending in expert system in learning tool is the future of the innovation of the education field.

In the future, the transportation system may have improved over time. Therefore, it is recommended that the AESM to be regularly updated based on the domain expert during that particular time. Also, to ensure the effectiveness and reliability of the expert system, the evaluation and validation process must be repeated along with its updated version. This is to ensure that the strategy provided by the AESM is up to the latest technology and user can obtain the optimum solution. Last but not least, the most frequent cause of accident should be included in this expert system to enrich the system. Thus, users can obtain more understanding regarding both cause and methods to prevent the accident from occurring to themselves.
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Wiping gravure printing method for realizing trench pattern in printed electronics

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1. Background/ Objectives and Goals
Gravure printing is one of the most promising high-speed, roll-to-roll techniques for printed electronics. Roll-to-roll printing techniques are promising for the manufacture of electronic devices. Gravure printing in particular has attracted interest as a technique for fabricating printed electronics owing to the simplicity of its printing mechanism and its high productivity. An important first step in developing a gravure printing process is the fabrication of narrow and high-conductivity lines. A typical cell on a patterned cylinder, which can be engraved mechanically or chemically, is less than 40 µm in depth and greater than 100 µm in width. In a typical gravure printing system, a doctor blade is used for removing excess ink from the land that is surrounded by cells before the transfer of ink contained in the cell to the substrate takes place. There are some considerations regarding the use of the doctor blade. These factors are not directly applicable to performing ink doctoring with paste ink; rather, a printing system optimized for high-viscosity ink is required. We present a systematic study of gravure printing of high-resolution conductive features using a silver nanoparticle paste ink.

2. Methods
The silver particles were prepared by reducing an aqueous silver nitrate solution using diethanolamine(DEA) in the presence of poly(acrylic acid)(PAA) as a capping agent. After homogenization, a highly concentrated silver paste ink with solids loading of 75 wt% was obtained. In general, low-viscosity ink is used in gravure printing system because this type of ink quickly penetrates into the cell and thus allows for high printing speed. However, for printed electronics, high-viscosity ink exhibiting much lower fluidity should be used to improve pattern conductivity. To achieve a gravure printing system that is compatible with high-viscosity ink, we developed the wiping gravure printing process depicted in Fig1. Water-soluble wiping solutions and oil-soluble wiping solutions were prepared, in accordance with previous research, for use in the wiping gravure system. These two ingredients are commonly used in conventional gravure printing processes. Owing to the characteristics of the water-based silver ink, a higher concentration of water in an IPA solution causes more silver particles to be dissolved. To optimize the wiping solution-based gravure system, a wiping cylinder was fabricated using polyvinyl alcohol(PVA), because it offers high stability in water and its hardness can easily be controlled. This wiping cylinder played an important role in preventing ink loss that can occur when the doctor blade cleans
the ink residues off the gravure cylinder using the wiping solution. In order to realize high-resolution printed lines, a highly scaled trench pattern was manufactured using a wet-etch process on copper plate. To determine the ink transfer ratio based on various printing parameters, the pattern was fabricated with lines in the longitudinal direction. The line width, line length, and gap between lines were 50 µm, 10 cm, and 50 µm, respectively.

Fig. 1 The wiping gravure printing process, which is compatible with high-viscosity ink

3. Expected Results/Conclusion
We investigated gravure printing with a trench pattern and silver paste ink using a wiping gravure system. We gave special attention to the details of the processes involved in doctoring and printing. The printing system produced printed features as small as 50 µm. By controlling printing factors and observing the effects on printing results, we achieved an improved understanding of printing with silver paste ink in a trench pattern. Regarding the wiping process, we studied different wiping solutions and wiping cylinder types, and we determined combinations that more effectively remove paste ink residue. We also determined that ink residue can be reduced simply by choosing a proper doctoring speed. Under optimized doctoring conditions, faster printing speed resulted in lines that were thicker and wider. To explore this phenomenon, we simulated the doctoring process to analyze characteristics related to how the ink level forms in the trench. It represents a first step toward understanding gravure printing with paste ink and a trench pattern.

4. Acknowledgment
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A Study on Printability of WPOP Method According to Physical Properties of Paper

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1. Background/ Objectives and Goals
In order to realize the fine lines, we proposed the wax patterning printing method and were experimented using by nano particle silver paste ink on the wax patterned paper to improve printing quality and high conductive lines. Instead of coating method a new ink lithographic printing process was introduced to fill the trench patterns with the high viscous paste ink. This paper applied offset printing to reduce the defect rate and make use of an efficient printing method. Compared to other printing methods, offset printing has a problem that its resolution is a bit lower. In order to address this problem, we added the process that uses paraffin wax.

In this research, we demonstrated that high viscous paste ink with trench pattern is suitable for printing fine lines by studying specific printing parameters. The wax patterning and printing conditions were subsequently researched to obtain uniform and fine lines. High conductive lines with of resolution were formed based on the this method that resulted from offset lithographic printing process.

2. Methods
The WPOP experiment can also use a commercial common wax paper printed with partition printed by wax trench patterns, but the thickness of wax is not enough for this experiments, So this experiment was started by printing wax partition in the non-printed area of the papers using trench patterns. Since printing interval of patterns determines resolution, a wax printer may be used to form high resolution patterns, but the screen printing method was used in this experiment to create a thick wax layer with extreme hydrophobicity.[12] Here, it is important to prevent blocking of the plate by maintaining wax temperature at around 80°C.

Printing pressure, temperature and paste sintering time of the final objects printed with trench patterns and electrical resistance according to changing experimental conditions were measured to review whether the method can be applied to the manufacturing process of new printed electronics, and the experiment was carried out to find the optimal conditions.

3. Results and Discussions
3.1 Patterning by WPOP
In the conventional offset lithography printing, the dampening water is used in the non-printed area to make it hydrophilic, and the ink is made to be lipophilic. The printed area and non-printed area are distinguished by repulsive force between water and oil. However, the WPOP method of this study performs offset printing on a paper where a partition is already formed by the extremely hydrophobic wax. Inversely to the conventional printing method, a hydrophilic ink can be printed in the printed area. Figure 5 shows the printing result. The printing result shows that the ink pattern is formed properly according to the wax partition. Based on the results of this experiment, the transfer amount of the ink was found to be affected by composition of the ink, surface characteristics of the paper as the printed object, and printing conditions like printing pressure and speed. Whereas sample 1 with high porosity has large transfer amount on the surface and greater penetration depth at high pressure and low...
speed, sample 3 with low porosity has large transfer amount on the surface but low penetration depth at low pressure, as shown in Figure 5. Sharpness of the printing results is related to surface roughness of the paper, and soft paper was found to have desirable sharpness of the surface.

![Figure 5. Printed patterns of conductive ink on papers printed by WPOP method. (a), (b) and (c) are sample of 1, 2 and 3 respectively. The width of a line of each pattern is 100 μm.](image)

The hydrophilic ink can be used by mixing and dispersing the silver paste with a commercial hydrophilic varnish and the ink, but offset printing requires tack of the ink to adjust the transfer amount of the ink.[16] We maintained the tack value to be constant, lowering the value by adding the varnish when the ink is dry or has high viscosity. When the value was too low, it was necessary to adjust the value because roller-to-roller or roller-to-paper transfer became poor.

### 3.2 Penetration Depth of the Ink
Penetration depth of the ink is greatly affected by composition and formation of the paper, and Photograph 1 shows depth of penetration of the ink after printing. In Photograph 1, (a)–(c) are showing the depth of penetration and shapes of the printings when printing pressure is varied to 100, 300 and 500N, respectively. Similarly, (d)–(f) are photographs for sample 2 and (g)–(i) are photographs for sample 3.

![Photograph 1. Cross sectional views and depth of penetration of inks onto paper samples. (a)–(c) are sample of 1, (d)–(f) are sample of 2, and (g)–(i) are sample of 3. (a),(d) and (g) were printed under 100N, and (b),(e) and (h) were printed under 300N, and (c),(f) and (i) were printed under 500N printing pressure by WPOP method respectively.](image)

### 4. Conclusions
As the printing pressure increased within the experimental range, it was confirmed that the conductivity increased and the printing results varied with the surface roughness. As the printing pressure increased, the penetration depth of the silver paste increased f
from 14 μm to 69 μm.

Acknowledgments
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A Case Study of Online Assignment Submission for Engineering First-Year Students at Curtin University Malaysia

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Abstract

This paper studies student satisfaction with the implemented Online Assignment Submission (OAS) for lab reports of the Electrical Systems unit. Emerging internet and communication technologies provide opportunities for universities to transfer their teaching and management systems online instead of being bound by a physical environment. OAS is one of the new approaches that can be adopted to enhance educational quality. A case study was conducted for evaluating the satisfaction of Engineering First-Year students with the newly implemented OAS system based on 3 criteria: convenience, website support & internet connectivity, and feedback & learning. A questionnaire containing 12 questions was prepared online to collect respondents’ feedback. Descriptive Analysis, T-Test and ANOVA analysis were conducted to explicate student perception and satisfaction as well as evaluate comments concerning the OAS. Sample size consisted of ninety-two respondents that provided feedback through the questionnaire. Some significant findings were increased perception of environmental friendliness, user-friendliness and easier accessibility; whereas improvements were recommended on the transparency and accessibility of the online system.

Keywords: Online Assignment Submission; MOODLE; Descriptive Analysis; T-test; ANOVA.

1 Introduction

Development of the internet and communication technology have improved human life activities. More and more electronic devices can now connect to the internet at all times. In a university, teaching and learning are no longer solely undertaken between professors and students within a physical environment. The internet prepares an online environment for effective learning, forum discussion, and file sharing instead of using paper-based systems. Nonetheless, the paper-based education system has undoubtedly cemented itself as the best practice since many years ago though it is restricted by being labour intensive besides being time consuming and requiring a large spatial footprint (Paul Darbyshire, 2000). The improvement of internet connectivity in the country allows consistent downloading and uploading of e-
information and improved broadband penetration. In addition, universities are becoming more competitive in terms of service quality through online systems. The online system can facilitate the planning and curriculum design of the lecturers. The online system also promotes online content sharing, assessments and assignment submissions evaluation, and feedback processes into a one-stop online environment (Palmer, 2005).

Based off feedback from the previous semesters, there were quite a lot of issues raised about traditional education methods, particularly assignment submissions. Common issues are related to the management of physical files, costs, printing and submission dates. Eventually, these issues sparked the idea of the Online Assignment Submission. Fortunately, the growing sense and trends of students’ ability to deal with the internet and communication technologies is another factor to promote Online Assignment Submission (OAS). A review of studies in literature found that students, in general, do not resist the use of an online system for submitting their assignments as much as when compared to paper-based submissions. The paper-based assignment submission system has been relatively static and requires the involvement of both parties, such as staff, students and administrative staff in order to ensure that the assignment submission, marking and return processes are completed effectively (Heath Minogue Wilson, 2016). Besides, the use of OAS could potentially address the issues from the paper-based submission system such as misplaced or missing students’ reports, face-to-face submission & feedback, waiting time and costs.

The typical advantages of OAS are shown below.

- OAS allows students to post and upload their e-report in a designated online forum (Jones and Behrens, 2003) without submitting any printed paper report. It allows students to submit their assignment any time remotely before the due date.
- Students submit their assignments in the forum’s folder and the grade and feedback comments from the lecturers are shared in the respective forum to the respective student.
- All sequences of workflow from the assignment submission, marking, and feedback given need to be followed, improving the integrity and transparency in the evaluation process of the submitted e-report.
- OAS instantly displays the status of submissions, feedback, and a collated results spreadsheet that reduce manual work and improves the monitoring of students’ achievements leading to more effective educational-related decisions.

Curtin University Malaysia has adopted an online system known as MOODLE software that can create a discussion forum, share information, and upload any e-report in the format of Word or PDF documents, spreadsheets, and presentations slides. Moodle with its philosophy based on a social constructivist pedagogy (Moodle, no date), has been the fastest growing (in user numbers) open-source Learning Management
System in the higher education sector for the last few years. This platform can apply OAS to all lab reports of the Electrical Systems unit for Engineering First-Year Students. The MOODLE online system leads over paper-based submission as it is environmentally friendly, provides global access, security, and has excellent record traceability. The existing MOODLE online system in the university has started to gain attention because the software is ready for the usage and implementation of OAS, which improves upon current practices, without incurring any additional cost.

The implemented OAS is aimed at improving the communication, collaboration, and engagement among lecturers and students through the online forum discussion and e-lab report submission. All the submitted e-lab reports are managed by MOODLE in a single folder, which is easy to download and to be accessed. Lecturers and students can instantly retrieve the e-lab report as a reference for discussion. Apart from accessibility, OAS reduces the redundancy work for file compilation, analysis of the students’ achievement as well as monitoring progress of every student. In practice, the lecturers will start by creating a folder in MOODLE for students’ submissions. The submission due dates are announced to notify students so that the students can manage their own time for online submission before the deadline. Students are free to upload the e-lab report to the folder. It only involves a few steps: selecting the folder, and then uploading the e-lab report. After checking the confirmation notification, the submission is completed by clicking the ‘submit’ icon.

Students are able to submit draft lab reports in advance to the lecturer for pre-check, providing students comments on the e-lab report prior to the final submission. The lecturer can provide feedback whenever the lecturer is available. Whereas, the paper-based submission system requires the students to meet the lecturer in-office to query and receive feedback on their report. Then, the student must also submit the final report to the lecturer within the submission period. Both these scenarios necessitate a synchronization of the students’ and lecturer’s schedule which increases in complexity when considering the limitation of working hours and the number of students that may require help.

Another advantage provided is that MOODLE saves on feedback-cycle time. The grading and feedback of the marked report is displayed in MOODLE with OAS. The final grade is displayed in MOODLE for students to access as soon as the lecturer has done the marking for that e-lab report. Whereas, paper-based submissions require students to wait for the return of lab reports by the lecturer. Students who miss the collection time may also need to personally collect the paper-based report from the lecturer at a later date.

From the lecturer’s perspective, the OAS helps reduce the lecturer’s burden in carrying the physical reports to different locations for marking or returning. Moreover, extra space is needed to place those reports. In OAS, the lecturer accesses the folders and downloads all e-lab reports at once. Instant feedback can be provided with the grades.
that the students obtain. Both feedback and grades can be displayed immediately online where students can peruse them without time delays.

The purpose of this case study is to survey the extent of the students’ perception of the implemented OAS for the lab reports of the Electrical Systems unit. Several factors are considered include convenience, website support & internet connectivity, and feedback & learning. The content and explanation of the case study are shown in the following sections. Section 2 presents literature studies of OAS which will provide insight on how this case study was performed in an effective manner. Section 3 explains the research framework and the flowchart of the implemented OAS. Results of the analysis is examined through business analysis methods such as the descriptive analysis, T-Test and ANOVA test as described in section 4. Section 5 concludes the case study with recommendations for future studies.

2 Literature Review

There is quite a lot of literature related to the study of OAS. It is due to the inspiration and motivation from these findings that the OAS can improve teaching and learning practices. The history of OAS can be traced back to 2003. The first mention of OAS is by David and Sandy (Jones and Behrens, 2003) explaining the idea of Online Assignment Submission Management by proposing a model which encapsulates the issues, challenges, and opportunities within the Faculty of Informatics and Communication (Infocom) at the Central Queensland University (CQU). Byrnes & Ellis (Byrnes and Ellis, 2006) studied assessment practices at the Southern Cross University in Australia and found that web-based assessment tools were being underutilized by the teaching staff at that institution and more staff development time was needed to promote the usage of the online tools. Palmer (Palmer, 2005) presented a formal evaluation system to identify student perceptions of the introduction of online submission, marking and return of assignments in a fourth-year engineering unit. Palmer noted that, surprisingly, the majority of students rated their overall experience of the online marking system highly. Sivapalan & Cregan (Sivapalan and Cregan, 2005) observed students’ performance in a first-year mathematics-based subject with and without online resources and noted that online resources contributed significantly to the performance of students measured through their achievements.

Dalgarno et al. (Dalgarno et al., 2007) emphasized paperless submission, marking and return of assignments for the students on campus as well as distance learning and concluded that the respondents were very positive about the use of a paperless approach for assignment submission. Barker et al. (Barker, Fiedler and Johnson, 2019) further explored the perceptions of online marking processes on staff and students and found that most staff and students preferred the use of online rather than paper-based marking processes. Pete and Rob (Bridge and Appleyard, 2008) recommended online assignment submission and management to be used in the tertiary education
academic systems. Tsang (Tsang, 2004) presented his research findings of the electronic assignment management systems as a part of the new model of student support and quality control. Orit and Nitza (Naor-Elaiza and Geri, 2009) examined all the parties concerned with the online assignment submission system and investigated the reasons for its slow adoption rate.

Several researchers from academic institutions study the advancement of electronic submission, assessment feedback, as well as challenges in management work using IT skills include Vic (Jenkins, 2010), Sandra et al. (Barker, Fiedler and Johnson, 2019), Keith & Sue (Gregory and Morón-García, 2009), Rabab & Sameera (Wahab and Al-Alaiwat, 2015) and the American Medical Association (American Medical Association, no date). Poorya, Nor Azlina, and Khalida (Bagheri Faez et al., 2014) proposed an online system that decreased the complexity in managing student projects by updating the project status in a shared schedule and facilitated student communication with their supervisors through video calls and text chats. Osman & Tolga (Yildirim, ERDOGAN and Cigdem, 2017) investigated the usability of a web-based assignment system, determined its problem areas during use, and suggested solutions to those problems. Heath et.al. (Heath Minogue Wilson, 2016) studied staff and student perceptions of online marking processes for essay-type assignments in management courses at universities in Queensland, Australia. Animesh et.al. (Animesh Tayal, Ruchi Pahire, Sneha Suryawanshi, 2017) analysed the extended implementation of Online Assignment Submission providing a more comprehensive record of the project documentation on an organized platform. The extended study of this paper includes a survey of the effectiveness of the implemented OAS from the perspectives of convenience, website support & internet connectivity, and feedback & learning. The first factor investigates the perceptions of Engineering First Year students on the effectiveness of the Online Assignment Submission (OAS) as compared to the paper-based submission systems of other units in which they were simultaneously enrolled in in the same semester. Apart from that, website support & internet connectivity is also evaluated by the survey to ensure that utilizing OAS does not suffer from much interruptions from technical problems such as internet outages. Besides, the feedback & learning sections investigate whether the implemented OAS does indeed improve the visibility of feedback and impact students’ learning.
3 Method of the case study

3.1 The Framework

Figure 3.1 The framework of the OAS case study

The framework of the case study is shown in Figure 3.1. The framework for this case study is developed purposely to evaluate students’ satisfaction with the e-lab report submission, evaluation, accessing results and feedback. Criteria of the case study includes convenience, website support & internet connectivity, and feedback & learning. Each criterion has 4 questions to collect feedback from respondents. Data collected from the respondents will reflect the direct and indirect perception of students to the OAS using MOODLE.

3.2 Flow chart for implementing OAS

Figure 3.2 illustrates the flow of OAS and covers submission, evaluation and finalization of the results. The workflow provides a step-by-step process of the implemented OAS to be followed by the lecturers and students. It enables both lecturers and students to have a better understanding of their roles and responsibilities in managing the e-lab reports.
3.3 Questionnaire

In studying the students’ perception of OAS, a comprehensive questionnaire is developed that accumulates students’ feedback in terms of convenience, ICT support and internet connectivity, and feedback & learning. Prior to this, a draft questionnaire...
was prepared by the lecturer and distributed to colleagues for review and comment to identify improvements needed. The feedback phase was important to ensure that all the asked questions were reliable and could be linked to the objective of the study. Table 3.1 showed the model questions of each criterion in this case study.

**Table 3.1 Model question for the case study.**

| Convenience | A) I find it flexible for me to submit a digital copy of my lab report through MOODLE anywhere and anytime as I wish.  
| B) I am comfortable with the steps for submitting the e-lab report through MOODLE as it is clear and easy to follow.  
| C) I prefer online submission because it eliminates cost and time in printing hard copy reports.  
| D) I prefer the online submission system because it is environmentally friendly by going paperless.  |
| Website support & Internet Connectivity | E) I am comfortable with the user interface of MOODLE for my lab report submission.  
| F) I do not face any problems accessing MOODLE other than student account issues.  
| G) I do not face any problems uploading large files (i.e.: post-lab report) through MOODLE.  
| H) I do not face problems downloading the evaluated report from MOODLE.  |
| Feedback & Learning | I) I prefer to access the feedback/comments from tutors online sooner rather than collecting the hard copy report during my next lab session.  
| J) Online submission makes feedback/comments more transparent, where the strengths and weaknesses of my lab report are specifically highlighted.  
| K) Submitting the electronic report through MOODLE offers an opportunity to gain new IT skills.  
| L) The evaluated reports are stored in MOODLE and can be retrieved anytime without the hassle of misplacing hardcopy lab reports.  |

The questionnaire was prepared in a Google Form for the respondents to access and provide their feedback. The feedback was measured by using the Likert Scale with Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2, and Strongly Disagree = 1. Feedback in scale can be compiled in a generated spreadsheet to proceed to analysis using methods such as Descriptive Analysis, T-test, and ANOVA.
3.4 T-test

The T-test is a method of inferential statistical analysis used to determine if there is a significant difference between the means of two groups which may be related in certain features. William (Zikmund William, 2003) described the T-test as a technique applied to test the hypothesis that the mean scores on some interval-scaled variable are significantly different for two independent samples or groups. The T-test assumes that the amount of variability in each of the two groups is equal. In practice, the analysis is used to clarify the significance of the difference between means for two sets of scores and further declare or reject the hypothesis.

3.4 ANOVA

ANOVA or, in its full name, “Analysis Of Variance” provides a common statistical procedure for evaluating the variance of means for more than two groups of independent variables. William (Zikmund William, 2003) perceived ANOVA as an analysis of the effect of one treatment variable on an interval-scaled or ratio-scaled dependent variable. It is a technique used to determine if statistically significant differences in means occur between two or more groups. The data helps business researchers to make the decision of either rejecting the null hypothesis or accepting the alternative hypothesis.

4 Result and Analysis

4.1 Descriptive analysis

The case study received feedback from 92 respondents from a total of 184 students enrolled for the Electrical Systems unit in the same semester. Overall score and percentage of every question is depicted in Table 4.1. ‘SA’ stands for Strongly Agree; ‘A’ for Agree; ‘N’ for Neutral; ‘D’ for Disagree; and ‘SD’ for Strongly Disagree. The highest-ranking response from respondents supported the e-lab report submission through MOODLE because it is environmentally friendly by going paperless (Question D). Submission of an e-lab report does not use paper, which directly contributes to saving the environment.

Respondents preferred the newly implemented OAS because it saved time and eliminated printing costs (Question C). Referring to the situation on the university campus, respondents would have to queue up to print the lab report in an ICT lab. As many students tend to use the printers during assignment submission periods, the ICT lab was frequently crowded by students, even if just counting those printing the lab report. Moreover, students have to pay for the printing costs and paper. Indeed, the implemented OAS reduced inefficiency due to the waiting time and printing costs. Respondents were satisfied with the OAS due to its flexibility in allowing students to submit the e-lab report whenever and wherever they wished as reflected by Question
A. Most of the time, students are unable to submit lab reports out of meeting times with lecturers due to busyness with other student activities or by just not being on campus premises. Requesting help from friends to submit their report might raise concerns of the contents being plagiarised or misplacement of the lab report. Therefore, OAS can make submissions for every individual convenient without worrying about neither missing reports nor plagiarism cases.

**Table 4.1 The case study analysis spreadsheet.**

<table>
<thead>
<tr>
<th>Question</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Freq (%)</td>
<td>Freq (%)</td>
<td>Freq (%)</td>
<td>Freq (%)</td>
<td>Freq (%)</td>
</tr>
<tr>
<td>A</td>
<td>61</td>
<td>66.30</td>
<td>21</td>
<td>22.83</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>55</td>
<td>59.78</td>
<td>29</td>
<td>31.52</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>66</td>
<td>71.74</td>
<td>16</td>
<td>17.39</td>
<td>9</td>
</tr>
<tr>
<td>D</td>
<td>69</td>
<td>75.00</td>
<td>19</td>
<td>20.65</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>51</td>
<td>55.43</td>
<td>34</td>
<td>36.96</td>
<td>5</td>
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<tr>
<td>F</td>
<td>47</td>
<td>51.09</td>
<td>26</td>
<td>28.26</td>
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<tr>
<td>G</td>
<td>50</td>
<td>54.35</td>
<td>27</td>
<td>29.35</td>
<td>13</td>
</tr>
<tr>
<td>H</td>
<td>55</td>
<td>59.78</td>
<td>27</td>
<td>29.35</td>
<td>9</td>
</tr>
<tr>
<td>I</td>
<td>52</td>
<td>56.52</td>
<td>29</td>
<td>31.52</td>
<td>9</td>
</tr>
<tr>
<td>J</td>
<td>41</td>
<td>44.57</td>
<td>38</td>
<td>41.30</td>
<td>9</td>
</tr>
<tr>
<td>K</td>
<td>31</td>
<td>33.70</td>
<td>29</td>
<td>31.52</td>
<td>26</td>
</tr>
<tr>
<td>L</td>
<td>42</td>
<td>45.65</td>
<td>43</td>
<td>46.74</td>
<td>7</td>
</tr>
</tbody>
</table>

Most of the respondents were comfortable with the easy steps to submit the e-lab report as it was clear and easy to follow. It is well-reflected in the response to the Question B. In order to prevent mistakes or error during the submission, less steps are always preferred. Most of the respondents felt that they could adopt the steps applied for submission. However, there were eight respondents who had issues managing the e-lab report submission. Most of the respondents agreed that to instantly access feedback of the marked e-lab report from MOODLE is better than getting feedback only after the physical lab report was returned to them as depicted in Question I. Normally, the lecturer only provides the grade for the marked reports when returning the reports back to the students in the next meeting between lecturer and students. Time and effort are consumed when returning reports and also when doing the feedback session with the students. OAS basically eliminates the waiting time by enabling students to access the grade and feedback immediately online after the marking is completed.

OAS provided excellent support to the respondents in managing their assignment files. The report can be retrieved whenever and wherever it is needed without the hassle of misplaced hardcopy lab reports (in Question L). The submitted files were maintained
in the folder and retrieving of e-lab reports can be done globally wherever the internet is accessible. Besides, the submission folders highlighted the due dates which helped students to keep the date in mind and to take the initiative to submit their report before the due date. Apart from the strengths of using OAS, the case study also identified several concerns as expressed in the low scale marks by the respondents. One of the concerns was related to the consistency when accessing MOODLE and uploading the large file to MOODLE as illustrated by Question G. Problems potentially happen due to the poor internet connectivity in some areas. In addition, the settings of the submission folder limited the e-lab report submission to less than 20MB. Thereby, MOODLE returned an error when the e-lab report was larger than 20MB.

Approximate 15% or 13 respondents did not agree that the OAS improved the transparency in marking the e-lab report where the strengths and weaknesses of the submitted reports were highlighted in the feedback section. This finding was reflected by Question J. The transparency and integrity in marking essay-type assignments relies heavily on the lecturer’s determination to provide comments; a difficult task which cannot always be answered by referring to the standard marking scheme. Some respondents also disagreed with the comments by the lecturer in their e-lab report which might also have contributed to more negative feedback.

Question F reflected the issues of the respondents in accessing MOODLE other than issues with the student account. The feedback reflected that the respondents, in general, were able to access MOODLE well. However, there were still some students who felt it was difficult to use the OAS. Finally, the respondents did not agree that the OAS provided an opportunity to gain new IT skills (Question K). The response overall showed that students overwhelmingly supported the implementation of OAS for the Engineering First Year units at Curtin University Malaysia. In general, the respondents welcomed this as a new approach in line with the development of communication technologies which they were more comfortable dealing with. One of the respondents said that “Online submission is comfortable for me as I don't need to send my hard copy report to a pigeon box. I hope this system is available for other units.” Another respondent also commented that “Very convenient and avoids delays occurring during submission. Also environmentally friendly. Please promote it to other units”.


4.2 T-test Analysis

The similarity of one hypothesis to another hypothesis was tested using T-test. It tested the correlative relationship of one variable to another variable. In this case study, T-test analysed the relationship between two tested dependent variables. Feedback from multiple questions were compared and discussed.

4.2.1 Test 1 - Would the ease of use of the user interface of MOODLE impact its accessibility?

The test was purposely performed to reflect whether the user interface of MOODLE is closely related to the easy accessibility that was found satisfying by the respondents. The p > 0.05 showed that there was a close relation of features of the user interface in MOODLE with accessibility that was pleasing to the respondents. Therefore, this test accepted the null hypothesis. The result of the T-test is illustrated in Table 4.2.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Variance</th>
<th>Observations</th>
<th>Hypothesized Mean Difference</th>
<th>df</th>
<th>t Stat</th>
<th>P(T&lt;=t) one-tail</th>
<th>t Critical one-tail</th>
<th>P(T&lt;=t) two-tail</th>
<th>t Critical two-tail</th>
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<tbody>
<tr>
<td>Variable 1</td>
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<td>1.082059</td>
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<td>160</td>
<td>-0.24925</td>
<td>0.401744</td>
<td>1.654433</td>
<td>0.803487</td>
<td>1.974902</td>
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<tr>
<td>Variable 2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

alpha > 0.05 (accept the null hypothesis)

4.2.2 Test 2 - Would students perceive clear and simple steps in using OAS is closely related to the opportunity to learn new IT skills?

The test compared whether the implied simple steps for OAS is related to an opportunity for students to learn new IT skills. The result showed that p < 0.05, implying that both tested variables were significantly different. It is reasonable to note that the respondents possessed sufficient IT skills and did not feel that they were learning new IT skills when using the OAS. Thereby, the null hypothesis was rejected. The result of the T-test is illustrated in Table 4.3.
Table 4.3 Simple steps & new IT skills.

<table>
<thead>
<tr>
<th></th>
<th>Variable 1</th>
<th>Variable 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
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<td>3.891304</td>
</tr>
<tr>
<td>Variance</td>
<td>0.947324</td>
<td>1.043</td>
</tr>
<tr>
<td>Observations</td>
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<td>92</td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
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<td></td>
</tr>
<tr>
<td>df</td>
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<tr>
<td>t Stat</td>
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<td>P(T&lt;=t) one-tail</td>
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<tr>
<td>t Critical one-tail</td>
<td>1.653269</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
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<td><strong>0.023115</strong></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>1.973084</td>
<td></td>
</tr>
</tbody>
</table>

alpha <0.05 (reject the null hypothesis)

4.2.3 Test 3: Would students feel that online submission allows them to retrieve their e-report quicker helps them avoid handling a hardcopy report that could get lost or misplaced?

The students had a high opinion of managing their reports in a softcopy instead of a hardcopy. It was reflected by the T-test on the increased convenience of retrieving their softcopy reports and avoiding loss or misplacement of hardcopy reports. As the p > 0.05 showed that both test hypotheses were closely related and therefore resulting in an acceptance of the null hypothesis. The result of the T-test is illustrated in Table 4.4.

Table 4.4 Retrieving softcopy report and managing hardcopy report

<table>
<thead>
<tr>
<th></th>
<th>Variable 1</th>
<th>Variable 2</th>
</tr>
</thead>
<tbody>
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<td>Mean</td>
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<tr>
<td>Hypothesized Mean Difference</td>
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<td></td>
</tr>
<tr>
<td>df</td>
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<td></td>
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<tr>
<td>t Stat</td>
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<td>t Critical one-tail</td>
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<tr>
<td>P(T&lt;=t) two-tail</td>
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<td><strong>0.672294</strong></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>1.973534</td>
<td></td>
</tr>
</tbody>
</table>

alpha > 0.05 (accept the null hypothesis)

4.2.4 Test 4 - Would the quicker feedback of e-lab reports in MOODLE be closely related to a feeling of a higher degree of transparency?
The test result showed that earlier feedback of the marked e-lab report was closely related to the perceived degree of transparency. The tested result showed that $p > 0.05$. The respondents perceived the quicker feedback as higher transparency in the system, thereby, OAS had improved students’ satisfaction. The null hypothesis was accepted. The result of the T-test is illustrated in Table 4.5.

Table 4.5 Quicker feedback and transparency

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable 1</th>
<th>Variable 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.423913</td>
<td>4.23913</td>
</tr>
<tr>
<td>Variance</td>
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<td>0.777353</td>
</tr>
<tr>
<td>Observations</td>
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<td>92</td>
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<tr>
<td>Hypothesized Mean Difference</td>
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<td>df</td>
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<tr>
<td>t Critical one-tail</td>
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<td>P(T&lt;=t) two-tail</td>
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<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>1.973381</td>
<td></td>
</tr>
</tbody>
</table>

alpha > 0.05 (accept the null hypothesis)

4.3 ANOVA analysis

This test selected the key elements from the Questions B, E and J. Its purpose was to investigate the similarity of these questions, and the factors contributing towards students’ satisfaction for the newly implemented OAS. The result of ANOVA is illustrated in Table 4.6.

Table 4.6 User Interface, simple steps, and transparency

<table>
<thead>
<tr>
<th>ANOVA</th>
<th>SS</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
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<td>2</td>
</tr>
<tr>
<td>Within Groups</td>
<td>166.5217</td>
<td>273</td>
</tr>
<tr>
<td>Total</td>
<td>169.7391</td>
<td>275</td>
</tr>
</tbody>
</table>

P>0.05, accept the null hypothesis.

All the chosen elements similarly contributed to the students’ satisfaction in OAS: simple steps to follow, user-friendliness and transparent marking for the e-lab report. The result of ANOVA was $p > 0.05$ and the null tested hypothesis was accepted.
5 Conclusion and Recommendations

OAS has become a new trend in the education industry. Many academics have applied it to improve their management of student assignments. As noted, the case study was performed to investigate the perception of Engineering First Year Students on the newly implemented OAS to the Electrical Systems unit. 92 respondents replied to the questionnaire and provided their feedback on OAS as compared to other units which still implemented a paper-based submission system.

Results of the descriptive analysis showed that respondents had the good perception that the OAS is environmentally friendly, has a good user interface and had simple instructions to follow. Other feedback such as faster feedback and improved file management were also perceived as benefits of the implementation of OAS. T-test analysis had accepted null hypothesis for relationships between simpler user interface & accessibility, ease of retrieving softcopy reports & managing hardcopy reports, and quicker feedback & transparency whereas the hypothesis of a relationship between simple steps & new IT skills was rejected. The ANOVA test also stated that there was a close relationship between the user interface, simple steps and transparency.

In conclusion, implementing OAS using MOODLE is well-perceived by the students. The system should be extended to other units. Identically, the case study raised concerns about the OAS as some respondents still doubted using the MOODLE online system for OAS, the transparency of marking, and that they were learning new IT skills. Apart from that, a recommendation was highlighted to incorporate Turnitin to MOODLE. All the recommendations should be considered in-depth to ensure student satisfaction with OAS improves in the coming semester.

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International Joint Education for Student Interaction in the Field of Electronics and Information Technology

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Keywords: Engineering education, International joint education, Overseas study, International exchange

Abstract

With the aim of promoting globalization education, our fourth-year students visit Asian countries on an overseas study trip each year. Students from the Department of Electronics and Information Engineering visited Taiwan for five consecutive years from 2014 to 2018. They visited National Taipei University of Technology twice and National Chiayi University thrice. This paper revisits the content of the five years of our work towards encouraging international student interaction. Collaborative experiments can bring about some degree of student interaction, but introverted students still have difficulty in interacting. In 2018, students from Japan and Taiwan joined together to solve physical dynamics exercises. They had icebreakers such as introducing themselves and being seated next to each other to solve the problems. Almost all the Japanese students said that they were able to interact with Taiwanese students. We demonstrate the promotion of international exchange through teaching materials of international joint education.

1. Introduction

With the progress of globalization, higher education institutions are required to educate students from an international perspective. Specialized education on engineering has been offered for the past five years in the National Institute of
Technology in Japan where students who have graduated from junior high school can enroll. At Ishikawa College, fourth year students visit Asian countries on overseas study trips. In our college, visits have included China (Kaneki, Kitada, Uchida and Morihara, 2007), Korea, Thailand, Taiwan, Vietnam, Singapore, and Malaysia. Students of the Department of Electronics and Information Engineering, to which the author belongs, have visited Taiwan every year since 2014. From 2014 to 2016, the visit schedule consisted of three nights and four days, but after 2017, an increase in the travel reserve fund has allowed for a visit of four nights and five days. There is a direct flight to Taiwan from Komatsu Airport in Ishikawa Prefecture where our college is located, making Taiwan easily accessible.

As a different point from long-term study abroad, it is impossible to earn languages with certainty because of the short stays during training trips. Therefore, we have worked on the main theme of exchange between students. This overseas study tour aims at encouraging Japanese students to take an interest in different cultures through exchange with overseas students who are close in age (Kubota, Yazawa, Komatsu, Chiba, Kaino and Takahashi, 2012), (Tanaka, Mori, Unoki and Yamashita, 2013). However, except for the students who were originally interested, most of the students seemed passive, and there were several instances where conversations didn’t flow with ease between students.

After we prepared a setting where many students could talk to each other in small groups in the student exchange of 2018, the number of conversations between students increased. In the questionnaire results, the “We could not exchange” response declined sharply. On the other hand, through these student exchange activities, two short-term international students were accepted from the National Chiayi University visited by our students to the department of Electronics and Information Engineering for a week. We review the past implementation contents and examine the design of exchange activities with overseas students and the international cooperative education.

2. Revisiting the content across five years

Table 1 shows the list of universities visited and contents of exchange visits studied by this department from 2014 to 2018.
The setting of this experiment is shown in Fig. 1. We contacted the Taipei Economic and Cultural Office in Osaka listed on the back of the brochure and consulted the place of visit. We were able to visit the Department of Electrical Engineering of the National Taipei University of Technology. However, since this university had a comprehensive academic exchange agreement with the National Institute of Technology (NIT), it would have been possible to request a visit through the NIT. In 2014, we tried to synthesize an oscillator circuit on a breadboard using electronic components such as transistors, as well as observe the waveform and compare it with a simulation software. The setting of this experiment is shown in Fig. 1. Further, a state of the circuit assembled on the breadboard is shown in Fig. 2, and its circuit diagram is shown in Fig. 3.
Fig. 1 Joint experiment by students of Taiwan and Japan (2014)

Fig. 2 Circuit built on breadboard
After dividing 43 Japanese students into 2 groups, the experiment was conducted in groups that had 1 Taiwanese student with 2 Japanese students. When I visited NTUT for a preview in August of the same year, I thought that it would be good if students in the first meeting could interact with each other while being engaged in an activity, and we proposed an experiment using a breadboard. The breadboard has five vertical holes connected on the back, and the rows of holes are not connected. By inserting electronic parts and wires into the holes, it is possible to freely construct an experiment circuit to conduct experiments on electronic circuits. Since soldering is unnecessary, it is good that it can be used repeatedly by inserting and removing wiring and parts. In our curriculum, the circuit experiment using the breadboard was carried out from the first year, and because the multi-vibrator was studied a little in the electronic circuit class, the experiment ended smoothly and the rest of the time gave rise to a natural conversation between the students.
In 2015, we visited the department of Electronic Engineering of NTUT again. When we had a prior meeting, the department was designing and producing a drone as an educationap project, so we decided to incorporate the contents into the student exchange. Although it did not take time to assemble the drone, it took time to construct the system and rewrite the control program. This event is shown in Fig. 4. The completed drone flight practice was conducted in a separate laboratory. The drone flight operation ended in a short time, and communication between students did not seem to be actively conducted.

![Fig. 4 Rewriting the drone control program (2015)](image)

We visited Taiwan with a focus on Taipei City, but there are also many places of interest in southern Taiwan. For example, Ushantou dam is famous for its competition by civil engineer Yoichi Hatta. He was born and raised in the Hanazono next to our school’s location. A tour of the Ushantou dam constructed by Yoichi Hatta was included in the course tour.

A long time ago, the NCYU baseball team headed by a Japanese coach had participated in the Koshien tournament and was placed second. When I was visiting Taiwan, I heard that people in the south speak at a slower pace than those in the north of Taiwan. The difference between north and south Taiwan is interesting. If Japanese students study abroad in Taiwan, they might find the relaxed pace of the south pleasant. Traveling from Taipei Station to Chiayi
Station using the Taiwan Shinkansen was also considered interesting. Japanese technology is used for the Shinkansen in Taiwan.

With these considerations in mind, in 2016, we changed the visit destination from Taipei City to Chiayi City, and visited National Chiayi University. Japanese students visited the Virtua Reality (VR) and character recognition laboratories in the department of information engineering. This time again, we asked the Taipei Economic and Cultural office in Osaka to make adjustments, and we introduced the International Exchange Division of NCYU.

In 2017, in addition to the Department of Information Technology at NCYU, we also visited the Department of Electrophysics. Since students in the Department of Electronics and Information Engineering of NIT IC are studying information engineering and electronics, the Department of Electrophysics at National Chiayi University was selected as the visit destination. The class in the Department of Electrophysics had the experience of studying abroad with Japanese graduate students. Organizing a similar exchange study abroad is difficult because NIT IC majors study at the university level for three or four years. Figure 5 shows a Japanese student visiting a laboratory in the IoT field using a microcomputer.

Further, Fig. 6 shows a mini-lecture (of about 15 minutes) on opticap fiber.

Fig. 5 A tour of IoT related laboratories 2017
Considering the fact that our students studied abroad at NCYU, we decided to conduct lectures in English at the university. After being introduced to the Department of Electrophysics, the students of the Department of Electronics and Information Engineering were given lectures on optical fibers, light control research, and the Department of Electrophysics, for a duration of fifteen minutes each. Although Japanese students experienced the atmosphere of university lectures, there were many students who felt sleepy while listening to the lectures.

The university exchange program was formed on the assumption that Japanese students would study abroad at overseas universities. However, it is known that the number of students from Japan studying at foreign countries is less in comparison to other countries. Even in our school, in order to continue studying an advanced course after graduating from the department, the next step available is only the university in Japan.

Therefore, in 2018 again, we focused on student interaction and examined its contents. Development of STEM teaching materials is the subject of our research on education and research. STEM education is an education mode proposed in the United States, which is now in progress in each country. STEM can be elaborated as S for Science, T for Technology, E for Engineering, and M for Math. It was around the time that STEM teaching materials, which estimate the energy gap of silicon from the measurement of voltage-current characteristics of diodes and the information processing of their data, were applied to students in the
Department of Electrophysics. As a lecture related to physics, mechanics belongs to the curriculum both in Japan and Taiwan, so I thought it would be good to carry out this exercise problem. Using paper and pens, students can solve this problem anywhere. As students met each other for the first time, they participated in icebreakers such as introducing themselves and solving a simple quiz. The room where the students interacted was arranged with four chairs next to each other, and the communication environment was facilitated by mixing Japanese students and Taiwanese students.

Figure 7 shows how Japanese and Taiwanese students are working on the same exercises. Figure 8 shows a student visiting a VR laboratory and challenging a VR base game.

Fig. 7 An instance of student groups in Japan and Taiwan working on exercises, 2018

Fig. 8: Japanese students playing VR base games
Immediately after returning home, the students were surveyed regarding their overseas training trips. Among the contents of this questionnaire, one question pertains to whether or not a student interacted with the university student that they visited. The answers consisted of three choices: “Agree,” “Disagree a little,” and “Strongly disagree.” Five years of data are shown in Table 2. The number of students varies from 37 to 43, depending on the year, but the actual number is listed in the table.

Table 2 Questionnaire results after travel (about interaction with the university students visited)

<table>
<thead>
<tr>
<th>Year</th>
<th>Student Number</th>
<th>Agree</th>
<th>Disagree a little</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>43</td>
<td>12</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>2015</td>
<td>38</td>
<td>3</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>2016</td>
<td>38</td>
<td>5</td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td>2017</td>
<td>37</td>
<td>0</td>
<td>9</td>
<td>28</td>
</tr>
<tr>
<td>2018</td>
<td>41</td>
<td>9</td>
<td>31</td>
<td>1</td>
</tr>
</tbody>
</table>

In 2014, the students produced an oscillator circuit using a breadboard. The circuit was made by any group. The students in the group who finished the experiment gathered together by themselves, and one of the groups discussed student life in relation to each other’s situation. On the other hand, we could see a group sitting silently. The same trend was seen in 2015 during drone production. Although the visit destination had changed from National Taipei University of Technology to National Chiayi University in 2016, the communication tendency of the students remained consistent. As a small group, even if they visited the laboratory with about 10 classmate students, it was difficult for members to communicate in some way. As a result of having a mini-lecture in English in 2017, there were no students who said that they could “interact enough”. Even in Japan, there are few students who ask questions during and after lectures. More than one student actively asked questions from university teachers abroad. In 2018, we made use of our reflection points to think about an exchange program with particular consideration regarding the students and how they would communicate with each other. It was difficult for me to speak in front of a large number of people, but I thought it would be easier to
communicate naturally if there was a chattering interval between the neighbors. As seen in the questionnaire results in Table 2, only one person answered with “Strongly disagree.” Further, one of them was said to be a Japanese student next door because it was at the end of the seat and it was difficult to talk. If a student from Taiwan was sitting next to this student, I think that some communication could have been achieved.

In addition, in the paper and pencil environment, each table reaped the teaching exchange taking place between students, such as the transformation of mathematical expressions and the explanation using pictures. There were scenes where Japanese students were taught by Taiwanese students, and conversely, Japanese students taught Taiwanese students as well. Fig. 9 shows Japanese students explaining something to Taiwanese students.

Fig. 9. Japanese students teaching Taiwanese students

Fig. 10. A group of students gathered to teach
Furthermore, a situation where the groups were connected and taught each other was also seen. This is shown in Fig. 10. A situation arose where the ties between the students became stronger than this assumption. The distance between students had reduced through teaching and learning from each other. After most groups finished problem solving tasks, I asked a Taiwanese student to explain the solution examples using the whiteboard. This was a situation where Taiwanese and Japanese students thought about the same task together. Among the Taiwanese languages, the same expression exists as it does in Japanese. So, we made a quiz to find the same kanji in Japanese and Taiwanese as an ice-breaker.

The ice-breaker quiz is shown in Figure 11.

Fig. 11 Kanji quiz for ice-breaker

The preparation of the Kanji quiz provided an opportunity to affirm our knowledge of the history of Taiwan. It is important to work after knowing the history of the country. The problems of mechanics were written with reference to a collection of the problems of mechanics written in English (Hajiday, Resnick and Wapker, 2013). It was determined that these problems should be easy to imagine with pictures. I showed these mechanics problems to NCYU teachers and confirmed the level of difficulty. It was judged that these problems could be solved sufficiently by second
year and third year students. However, in the 2018 visit, coordination of second and third year students at NCYU was difficult, and first year and second year university students participated. Since the time of the visit was at the beginning of October, the first year students who had just entered college and the students who were in the first year to that point had participated. As a result, some students in Taiwan found the problems difficult and were unable to solve them. However, being at an age close to the students at our school made it easy for them to interact.

The tour of the laboratory is attractive, but as in the year 2018, we think about the interaction program, and taking on the role of moderator on the day of the production brought great stimulation as a teacher. Both the Taiwanese students and the Japanese students tackled the exercises very seriously. These exercises with students from overseas were quite interesting, and created situations where the teacher’s own international sense could be fostered.

As shown in the results of Table 2, student interaction in 2018 has improved more than ever. These achievements are attributable to the fact that the goal of solving the problem was easy to understand, and to the fact that students from overseas nearby and this facilitated conversation. After I visited NCYU in March 2018 to introduce education materials, an opportunity for two students from NCYU to visit our school in the week of June was realized. They participated in classes of applied physics and electronic devices in the department of electronics and were present for the experiments of diodes prepared as STEM teaching materials (Yamada and Su, 2018). In addition, they served as tutors and one year students from the electronic and mechanical engineering course experienced STEM education materials to approximate the physics constants prepared at National Chiayi University. The experiment using English expressions was fresh among the students of the same age. Efforts to exchange education materials with each other are effective in promoting future international exchange.

According to the student questionnaire results, city tours with local students are the most popular programs every year. If the student in this guide were a student at the visiting university, we think that the interaction with be further deepened (Kubota and Chiba, 2008). Local students in Taiwan as guides have a strong interest in Japan and many students are good at Japanese. Therefore, communication in Japanese is also a possibility in addition to English and Chinese. However, since there is a good opportunity to practice English during overseas training trips, there also exists the idea
of selecting a region that uses a large amount of English as a destination. Some NIT, colleges have implemented programs centered on company visits. In the case of our school, it is a program that incorporates company visits or university visits, exchanges with pocap students, and tourism. For the fourth year students, we think that the proposal to carry out overseas training trips during the third year and visiting the domestic companies in the fourth year is also worthy of an eye for a grade in which job hunting activities become serious.

3. Summary
We reviewed the university visit program we have been working on so far, with regard to the overseas training trip of NIT, Ishikawa College, Electronics and Information Engineering, for fourth year students. As a result, it turned out that while it is possible for the laboratory visit to have a certain extent of interaction, it is difficult for modest students to interact freely. However, as in the case of 2018, it turned out that even modest students can communicate with overseas students to some extent if facilitation ensures that students from overseas and Japanese students sit next to each other and work on common tasks. In addition, it turned out that the joint education with overseas universities is promoted by thinking about the interaction program. We will continue to conduct educationap activities with overseas universities in the future.

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References


Cultivating Well-rounded Students
-The Importance of STEAM in Engineering Education-

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Abstract

Recently, the concept of “STEAM” is gaining more attention in education. Fusing “Arts” and “STEM”, students can use divergent thinking and make sense of the creativity. In a trial, “Kids’ Science Class” students experienced art in a science class. “STEAM” can give us a broader and deeper view of life and help us to develop into well-rounded people with a clearer view of our world and our place in the philosophy of life. This paper describes the importance of “STEAM” education using examples with music.

Keywords: STEM/STEAM, music, divergent thinking, convergent thinking, philosophy

1. Introduction

Human resources are decreasing now because of the declining birth rate. We need well-rounded people who can lead our society diverse views, and we must cultivate such human resources. In conventional engineering education, the professor gives a research subject and the students study it. However, from now on, it is important for the students to discover their own topics in the society and work on them. Engineering education must be changed in order to cultivate young people who will be pioneers with a sense of creativity. Recently, the concept of “STEAM” is gaining
attention in education. Fusing “Arts” with “STEM”, students can practice divergent thinking and make sense of creativity. This paper describes the importance of “STEAM” education using examples with music.

2. Philosophy and STEM/STEAM

2.1. Philosophy in Europe and German Meister System

In order to try STEAM education, philosophy must be understood. Unfortunately, modern learning in Japan did not develop from philosophy but rather from knowledge or techniques that were borrowed from Europe. In Japan we do not really understand the philosophy that Europeans based their educational system on. In Fig. 1, the middle circle shows this philosophy. The different fields of learning come from this underlying philosophy. Exchanges between these fields promote innovation. As a result, surely truly well-rounded people who can take a broad view of things will be developed.

Learning in Europe developed from the basis of morality or ethics under laid by philosophy. It is deeply planted in the minds of European people. For example,
there is a system in Germany called "Meister". After the journeyman or "Geselle" qualification is the master or "Meister" qualification, which is for those aiming to be top in their profession. Not only do they improve their professional skill but they also study about the commercial side of the business. Further, they may become teachers for younger workers. Therefore, masters must not only have a high level of technological skill but they must also understand business administration, pedagogy and be able to develop the skills of other workers.

This highly challenging Meister qualification requires a wide range of knowledge on subjects such as human resource development, mathematics, business, arts, and psychology. Studying the underlying philosophy makes this possible. (Ref.1)

2. 2. What is STEM/STEAM

In Japan, liberal arts are declining in the field of education. Music classes are being cut back in number. Under this circumstance, the word STEAM has come to emphasize as a new approach from STEM.

STEAM means “Science, Technology, Engineering, and Mathematics”. STEM means “Science, Technology, Engineering, and Mathematics”. That is to say, STEAM is the fusion of STEM and Arts. STEM education began in the U. S. A. under President Obama. He recommended STEM education in order to enhance scientific learning. Recently, STEAM education has been gaining attention in the educational system.

2. 3. Divergent thinking and convergent thinking

When we create something new, the action of divergent thinking and convergent thinking operates in our mind. Divergent thinking is to imagine various new ideas and the amount of things accumulated by the past experience. On the other hand, the action of convergent thinking is to find the best answer based on information gathered by divergent thinking and present it.

In a conventional engineering classroom, the professor gives a problem to
students and the students solve the problem following decided. There is one answer for one problem. In this case, it is sufficient to use convergent thinking.

However, the new engineering education proposes that engineers must have the ability to discover unknown problems in society and find a method for solving the problems. In order to do this divergent thinking is necessary.

3. Divergent thinking and convergent thinking in music

How are divergent and convergent thinking utilized in art? Children sing, draw, or dance in their activity. These performances are the basic pattern of arts.

The divergent thinking is the brain’s action during their activity. Children think about many things during while playing and find many ideas to perform. After that, they gather up their ideas in their brain using their convergent thinking. The arts stimulate the brain, and promote cognitive skills.

Music is especially concerned with the creative activity using divergent and convergent thinking. There are three parts of musical activity; “listening”, “playing” and “composing”.

3. 1 Listening

**Divergent thinking:** When we listen to the music, we are impacted by it. We may feel that the melody is beautiful or the sound is great. It can also bring up memories of the past. We may also be impressed by the performance of the player. At the same time, we may remember another performance that we listened to before. Then we may compare the performances. Remembering all of these various experiences is the action of divergent thinking.

**Convergent thinking:** Afterwards, when we organize the impressions in our mind and create an opinion or review of the music this is the action of convergent thinking. In fact, do you want to share your thoughts, emotion, criticisms, and opinions with your
friend after the concert? New ideas will also come out by talking with other people.

3. 2 Playing

**Divergent thinking:** Listening to music and playing music are completely different. When playing we must understand the music notes one by one while moving both hands. In addition, not only we must play the notes and chords exactly, but also we must be careful of the strength and weakness of the melody. Moreover, we must consider how to play the music beautifully. We need to express the music in many different ways and it is important to try various playing styles. We must think about many things while we play the instrument. There are many elements of divergent thinking.

**Convergent thinking:** On the other hand, when we make choices for performing it is convergent thinking. Analytical skills are very important when performing, for example, in front of an audience in a public hall. The structure of each hall is different so the player must check the reverberation in the hall and the tuning of the instruments. It is necessary to gather and evaluate a lot of information. In addition, we need to consider how to best reach the audience. Not only the performance itself but also the music selection, the order and timing of pieces and the discussion about the music need to be considered. In a concert, very strict attention should be given to every second.

3. 3 Composing

**Divergent thinking:** When we create something, we must gather many elements and make them into a whole. For gathering information, we need to go outside, touch nature, read many books and so on. We may study music like chords and melodies. We get inputs from many things from what we experienced by divergent thinking.

**Convergent thinking:** Then, we create the music by correcting it again and again. In this way, we output our creation.
Arts are always innovative. There are many examples of artwork that was not accepted by the audience, because it was so avant-garde, but later became popular. It is possible to create unexpected results. The music not only utilizes the knowledge of music, but also helps you develop abilities through both of divergent and convergent thinking as described above.

4. Trial of STEAM in Kids’ Science Class

“The Kids’ Science Class” was held in 2014. The aim of this class was to raise the children’s interest in science through fun experiments and making new discoveries.

Elementary school children from 2nd to 6th grade participated in the class. At first, the children studied three elements of sound. After they understood the elements, they listened to two pieces of music played on the piano. After the performance, they drew pictures representing what they felt while listening to the music. For the music the following conditions were followed:

- The students did not know the music pieces. We wanted them to listen to music for which they didn’t have established memories and feelings.
- The pieces were composed by Japanese composer. We wanted them to know about Japanese modern music culture.
- The tempo and the beat of the two pieces were different. This made it easier to compare the two pieces.
- No information about the pieces was given.

Each piece was played live for them two times. Live performance was used because it can have a larger impact than recorded music. They drew with great concentration. They imagined various situations and they put their emotions and impressions on the paper. After drawing pictures, they showed their pictures to each other and exchanged their opinions. Many children said that it was fun because other students had such different impressions. Their pictures were surprising because they
were extremely talented and gifted. The pictures are shown in Fig. 2.

![Fig. 2 Pictures which children drew at “The Kids’ Science Class”](image)

Child A: “Sea storm”          Child B: “Start of 100m sprint”
(a) The first music with 4/4 beat and allegro scherzand

Child A: “Different dimension”  Child B: “Singing blue bird”
(b) The second music with 3/4 beat and tempo di valse

Children’s brains are a treasure chest of creativity. Listening to the music, the children experienced various emotions and impressions while using divergent thinking and then organized and produced the emotions which they felt using convergent thinking. After drawing pictures, they were interested in what the other children drew. They exchange their opinions about why they drew what they did. In the end, using divergent and convergent thinking they made new discoveries about art and themselves.
5. Summary

In engineering education, philosophy or art is rarely studied. However, if students study different fields of arts or understand philosophy, they will become well-rounded and have a larger worldview. In the future, these students will not only be able to produce research but also broaden their sense of humanity and emotion. STEAM education can be more helpful than the conventional engineering class. In addition, by studying the philosophy underlying as the basis of our life, we can get better understand what and why we learn. STEAM can give us a broader and deeper view of life and help us to develop into well-rounded people with a clearer view of our world and our place in the philosophy of life.

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Reference

Learning through Teaching Programs of Science and Technology for University Students

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Abstract

We have designed high school visit laboratory classes of biology, chemistry, mechatronics and programming, and physics to make opportunities for university students to teach high school students. The university students worked as a teaching assistant and learned through teaching high school students. We also introduce our new program, Tokushima University – Lecture & Experiment course for High School Students (T-LECS).

Keywords: Learning through Teaching; High School – University Collaboration; Basic Science; Mechatronics; Programming;

1. Introduction

Learning through teaching is expected to be an effective way for education of university students. We have been organizing a number of education programs including teaching experience of students, especially those majoring science and technology. We have designed high school visit laboratory classes of biology, chemistry, mechatronics and programming, and physics to make opportunities for university students to teach high school students. Actually, in some of these classes, graduate and/or undergraduate students not only work as a teaching assistant (TA) but also learn many things through teaching high school students. In this paper, we also introduce our new program, Tokushima University – Lecture & Experiment Course for High School Students (T-LECS): This program was designed for high school students to experience science and technology experiments at Tokushima University using the facilities of the university, under the guidance of university staffs and TAs. To develop this program, some costs were necessary to prepare the materials and equipments, and also for TA fees. Then this program was planned as charged one. The program cost for each student was 3,000 yen and additional cost for materials was 1,000 yen for the biology and chemistry courses. The program cost for the mechatronics/programming course was also 3,000 yen, but the additional cost for materials including a robot kit was rather expensive; 8,300yen. This program was the first trial for us to take participation fee from high school students, aiming at enhancing the university – high school cooperative education programs under satisfactory conditions.
2. University-High School Cooperation Programs

2-1 Biology

We have developed programs that high school students come to the laboratory of the university and experimented using university facilities and experimental equipments with an assistance of university students. We will describe two such examples that we did recently below.

During the spring to summer in 2018, we did a biology program which focused on learning biotechnology as one of the T-LECS programs. In this program, with a help of university students, high school students experienced a digestion of DNA fragment by several restriction enzymes and made a restriction enzyme map of DNA fragment from the results of restriction patterns. They also experienced DNA amplification by PCR and the amplified DNA was analyzed by agarose gel electrophoresis. These experimental techniques have been so commonly used in the basic biology experiments in the university that university students not only helped high school students well, but could learn these techniques more deeply through teaching them. The biology program of T-LECS was initially planned to hold three times, however, since not all high school students could come to the university on the same day, the program was held six times to cover all students. This would be a problem to be solved in future. This program was actually fee charged as mentioned above; the program cost was 3,000 yen and the experiment cost was 1,000 yen. Nonetheless, in the questionnaire after the program, some students answered that the fee was reasonable regarding to the contents of the program, and wanted to join the program again next year. This experience convinced us to perform the same types of fee-charged program for high school students, opening the new possibility of programs for high school students.

![Fig. 1 T-LECS (Biology: 1).](image1)

![Fig. 2 T-LECS (Biology: 2).](image2)

In January 2019, we did another biology program, that is, mouse and frog experiments. In mouse experiments, high school students dissected whole mice; two students used one mouse, and observed internal organs. The students measured the lengths of digestive organs, such as pharynx, stomach, and intestine and compared them with that of mouse body. Frog
experiments included artificial fertilization of frog eggs and observation of the early frog embryos. They also observed internal structures of early embryos using sectioned specimen. Using the albino frogs, the students also learned the genetics of frog skin color. This year, more than 120 high school students have participated in this program. Some students were the repeaters of this program; they had participated in last year program too. Many students participated in this program after listening to seniors who did before. The university students helped the high school students to use microscope, dissect mice, and observe frog embryos. According to the questionnaire after the program, high school students were interested in sciences through this program, and some said that they wanted to join the program next time again. Also, this program was valuable to train university students; according to the questionnaire to the university students, they realized that they should understand very deeply what they would teach high school students. This was one of our main aims to build this program.

![Fig. 3 Mouse experiment.](image1)

![Fig. 4 Frog experiment.](image2)

2-2 Chemistry$^3,4$

We have produced a chemistry laboratory class for freshmen at Tokushima Prefectural Senior High School of Science and Technology since 2009. The students of Tokushima University majoring chemical science and technology join as a TA of the program. The aims of this class are to provide experience of chemistry laboratory for high school freshmen and also to improve knowledge and skills of university students through teaching the high school students. The effective ways of teaching by the students have been continuously checked based on a survey after the class.

The chemistry laboratory class was carried out according to the procedure reported previously. The program consists of three short experimental courses which can be easily performed by the high school students under the guidance of TAs; i.e., (A) Water purification, (B) Surface modification, and (C) Properties of plastics. The details of these experiments were described elsewhere$^3,4$. The teaching skill of TA has been found to be improved during the courses, where the undergraduate students learned from the graduate students who experienced the same experiments in the past. Figures 5 and 6 show these experimental works.
In the previous school-visit programs, it was easy to find TAs from the graduate school because many students are continuously enrolled and they are interested in teaching their majoring research topics. On the other hand, undergraduate students have little experience of specialized theme and no research experience. Then we need some way for facilitating their participation in the program. On the occasion of reconstruction of faculties in Tokushima University, we encouraged the teacher-training course students to attend to our program, because most of them intend to be a high school teacher. We explained them that the experience of university – high school cooperation program would be useful for their future. As a result, some students joined to the program in 2017 and 2018 with graduate students, and all of them had the impression of this teaching program as a good experience. Further effort is necessary to increase the number of undergraduate participants.

2-3 Mechatronics and Programming

We have also developed a robot manufacturing class for high school students in our university. The aim of this class is to study mechatronics and programming skills using basic robot kits. Especially, this class focuses on the programming skill from basic to advanced level by using two programming development systems, one is a visual programming system and the other is a C language system. In this class, we had five lessons, and five students participated to this class. Figure 7 shows a scene of this class. We show details of each lesson as follows:

Lesson 1. As first, students build up their robot kit. This robot kit includes a micro-computer board, two motors and wheels, four IR sensors, battery case and robot frames. Figure 8 shows this robot (Vstone, Beauto Rover). Students make this robot by themselves while referring to a manual. Two university students supported this class. After they built up their robots, they checked their robot operation.

Lesson 2. This lesson is the first contact of the programming for students. We use a visual programming software for exclusive use of this robot kit. By constructing a flow chart, we can use it as a robot program. We also taught the structure of the program, sequential, condition branch and iteration. The students made programs, such as, LED blinking, beeper
and run with motors to various directions.

Lesson 3. Students make a line trace robot program using a visual programming software. The line trace robot follows a black line on a white paper. This is a basic autonomous robot, that is, robots decide their motion only from the status of sensor input, and humans do not operate a robot motion. Students should think their program becoming the robot, and make a program which works for desired motion. In this lesson, all students could make program and move robot which follows a black line.

Lesson 4. This lesson is very important because we change the programming tool from a visual programming software to C language. In this lesson, we use the flow chart programs in lessons 2 and 3 as examples. We also show C language program and denote corresponding parts between a flow chart and C language. We had prepared some useful commands (then are called ‘functions’ in C language) to use robot functions. Hence, students can write C language programs combining these commands.

Lesson 5. In this final lesson, students try to make a soccer robot. We use balls which emit infrared ray light. From the status of four IR sensors, the soccer robot detects the ball direction, and decides its motion. Students design this program and check the motion of their robots. After that, they performed a soccer game using their robots.

At the end of each lesson, we carried out questionnaire to the students. As a result, almost all opinions are "interesting" and "easy to understand" about contents of this class. But, from Lesson 4 which handled the C language program, the opinion "making program is difficult" increased. We think this is because that, it is hard to understand the program only by a letter, and student are not used to the keyboard typing, and then it takes time to input programs.

It is necessary to increase opportunities to program to improve a programming skill. This is related to the improvement of the typing skill. As future works, it will be necessary to examine a learning method to program at home.
2-4 Physics

We have co-operating with a number of senior high schools, where many of the students have an interest in science and hope to major physics after entering a university. It should be useful for the high school students to experience the way of scientific thinking necessary for majoring physics and related fields. We have designed some school-visit programs including lectures and/or experiments, and already reported the results of a recent example of this program previously\(^5\); a visiting lecture at Tokushima prefectural Tomiokanishi high school in March 2018. In this program, we used liquid nitrogen to demonstrate magnetic levitation, diamond dust, and phase transition of air. These experiments attracted the students because of the unexpected phenomena caused by an low temperature. Introducing the design of effective experimental presentation would be useful for future development of the university education programs.

3. Conclusion

We have developed some programs incorporating learning through teaching methods for education of university students majoring science and technology. The experience of teaching high school students is a good opportunity for university students to improve their teaching skills and also to enhance deep understanding. The organizing cost sometimes being a problem could be partly solved by introducing charged programs. Optimization of the cost-effectiveness is necessary in order to generalize these programs.

Acknowledgement

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References

Introduction to WISET and Women Included Engineering Education Program of PKNU in Republic of Korea

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1. Background/ Objectives and Goals
From 2006, women included engineering education and WISET program which is women in science, engineering and technology program have performed in PKNU in Republic of Korea. Science, technology, engineering and mathematics STEM are the subjects that women students are not interested in. So, in order to increase the retention rate of women engineering students in college of engineering, the specialized APPLE program for women engineering students and the simulation based teaching and learning on the STEM subjects were introduced and analyzed the effectiveness by experts in the field of education, instructional technology in engineering fields. The analytical results of 500 students included 250 woman engineering students who were studied from 2006 to 2016 for 10 years in PKNU shows significant differences with man and woman in respect of the factors of understanding, satisfaction, motivation, learning ability and expectation grade. Also the retention rate of women engineering students in college of engineering at PKNU has decreased from 4.4% in 2006 to less than 1 % in 2016. So we hope to discuss and exchange the information related to WISET program as well as women included engineering education program with other Universities in Asian countries if they have same problems with us.

2. Methods
Simulation based education method is an excellent teaching method for many skills but especially for women engineering students. Learning in engineering is most effective when the level of women students is different. Some of the women students’ family is pressman otherwise other students have had no experience to training industrial fields. Another important feature is that students receive immediate feedback. Using simulation based teaching and learning method is an excellent way to both teach and practice skills (Morgan 2002). Traditional learning methods focused on physical training. Using simulation based teaching and learning method is a method of learning that allows or requires learners to apply theory to practice in an integrated manner. This method can avoid danger and loss of expenses of laboratory training and conditions can be varied and outcomes investigated. Also simulation based education method has an advantage that critical situations can be investigated without risk and that it is cost effective. And it can be sped up so behaviour can be studied easily over a long period of time. However it has the disadvantage that it is very difficult to make a simulator and it can be expensive to measure how one thing affects another, to take the initial measurements, to create the model itself, and to simulate something a thorough understanding is needed and an awareness of all the factors involved, without this a simulation cannot be created.

This research has been progressed since 2006 annually, and we had proposed to programs for the women included engineering education and the using simulation based engineering education for women engineering students. The retention rate of female engineering students was increased from 18% at 2006 to over 30% in 2016. And the rate of women students who change their major from 4.4% to decreased less than 2 % as shown in Figure 1. According to the lecture evaluation, 98% of women students were very satisfied the simulation based education classes.
3. Expected Results/ Conclusion/ Contribution

To increase the retention rate of women engineering students at P university in South Korea, we introduced the simulation based engineering education method and women included engineering education for same purpose. The results of factor analysis showed responses that the physical differences between man and women students, such as the ability to drive machines or to handle tools. Those two obstacles were covered by simulation based education method. Also, parents’ financial support to students reduced as a decrease the cost for experiments. In this research, we developed the measurement tool to measure women students’ competencies in engineering industries and contributed to make the women in engineering education. This research have been progressed since 2006 annually, and we had proposed to programs for the women included engineering education and the simulation based education for women engineering students. The retention rate of female engineering students was increased from 18% at 2006 to over 30% in 2016. And the rate of women students who change their major from 4.4% to decreased less than 2 %. According to the lecture evaluation, 98% of women students were very satisfied the simulated education method. So we found that the factor analysis and the simulated engineering education system for women students have progressed successfully.

4. Acknowledgement

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Practical Engineering Education Program Based on Forefront Technologies Accompanied with Students before Starting Graduation Studies --- Superconducting Materials and Fabrication ---

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Abstract

A characteristic engineering education program in which university students before starting their graduation studies on the forefront technology has been conducted in the scientific research laboratories in Niigata University. We have constructed a novel educational program called "Smart Dormitory" project, which has been carried out as one of the educational reform activities. Since the practical R&D activities conducted in the laboratories, in general, contain the engineering educational factors for the university students, it should be effective for the students to obtain the proper skills, abilities, attitudes, and knowledge of engineering even before the acquisition of their basic skills and knowledge of science. As an instance, the authors focus on the students from the freshman to junior, who made their own team together and have conducted the forefront scientific research on the superconducting materials, their fabrication methods and practical applications. The activity has been carried on by the theoretic lectures by the professor and the experiments conducted by themselves. The program has been characterized as a kind of research internship to the actual laboratory, where the students work on their forefront studies for three years. In the process, the students have been assigned the scientific presentations on their researches in some international meetings held overseas as well as Japan. The educational program is characterized as a kind of leadership programs. Actually, their averaged academic scores have raised through the planned period, which means the program stimulated the student’ motivation to their academic studies.

Keywords; engineering education, research internship, forefront technology, scientific presentation, leadership

1. Introduction

In the recent trends on the educational reform for universities, a project team in Faculty of Engineering of Niigata University in Japan has conducted various challenges to establish the practical engineering education. Fig. 1 shows the footprints of educational reforms for 15 years. On the process, we established an education center which has been taking care whole of the faculty of engineering [1]. The history shows two branches of educational and scientific areas. One contains interdisciplinary, career-design, primary-starting projects, respectively. The other indicates the scientific research projects driven in the collaborative R&D activities which have been individually
conducted by professors and researchers out of university. In 2012, these branches got together to “Smart Dormitory” project, aiming at making the leadership programs [2]. These programs merged into the internationalization program. In Niigata University, a novel project called “G-Dorm” has started with novel internship program [3].

In the process on “Dormitory-type Education” we call, the university students before starting their graduation studies have joined in the forefront R&D projects conducted in the academic/scientific laboratories. As seen in Fig. 2, since the practical research activities conducted in the laboratories must intrinsically contain the educational factors for the university students, we thought learn-by-doing practical education programs effective for the students to obtain the proper skills, abilities, attitudes, and knowledge of engineering even before the acquisition of their basic skills and knowledge of science. The learn-by-doing educational program has started in 2005, and a couple of novel projects including “Environmental Purification by Intense Field” joined in the program in 2007 [4]. In this paper, we focus on the scientific and international activities which have been conducted with forefront technology “superconducting materials and application to intense magnetic field generators”.

2. Forefront technology on superconductivity

Fig. 3 shows the practical R&D on the superconducting magnet which are cable of generating intense magnetic field over several tesla. The research has been conducted by Prof. Oka for years on the material fabrication, magnetic activation, magnet designing, and practical applications of magnetic field. The figure shows the collaborative application to water purification on the garbage furnace coolant in the regional plant [4]. The student team composed of master-course students, and a few of undergraduate students who were working on their graduation papers and ones before
starting it has carried on the experiments by the magnetic separation technique in cooperation with city official technicians. In the project, the students of freshman to senior grades joined this project-based learning (PBL) among senior and master course students. These student teams are interested in the forefront researches. In the sense, the projects have a character of internship to research laboratories in university, as well as the feature of project-based-learning.

Fig. 4 shows the views of material which we call “superconducting bulk magnet” (a) and the carriable intense magnetic field generator containing bulk magnet, which emits about 2 T from the pole surface (b)[5][6]. The novel material may realize novel practical devices in the future. Thus, we are capable of showing students the research topics on superconducting materials, practical designing, magnetic activation methods.
usage of magnets would let the students choose the research themes among the various issues to investigate over the wide research areas from fundamental nature of materials to practical device applications.

3. Leadership program “Smart Dormitory” and team “Superconductor”

Fig. 5 shows a recruiting article for Smart Dormitory, which shows a standardization of this educational program for whole students of Faculty of Engineering, as mentioned above. The number of the themes and student participants reached 16 and 80 in 2014, respectively [7]. The dormitory-like circumstances allow the students to make their own research plans by themselves. The research team “Superconductor” has been mainly composed of several students of Materials Science and Electric and Electronic Departments, with the weekly seminar and experimental activity. The class lessons by the professor were scheduled once in every week. The students took the three-year plan in the laboratory from freshman to junior grade. The research theme for the first year was the application of intense magnetic field the bulk magnet system generated to purification of environmental water purification with use of intense field by bulk magnets. In the next year, they investigated how to make the materials. In the 3rd year, they studied the fundamental discipline how superconductivity works.

In Smart Dormitory, the students are assigned to in order to be certificated as “Top Graduates”, the excellence of research performances. On the way of students’ research activities, when the students were assigned to the chances for scientific presentation, they would be well motivated to the research works. Fig. 6 shows one of the
Fig. 6. International conferences on fusion technology

international meetings which were held at Hanyang in Korea. International Symposium on Fusion Technology ISFT was established in 2007 at Niigata, and the meetings have been biannually held in turn among a university group composed of five universities in China, Korea and Japan [7]. In 2014, they allowed the students’ presentations in the conference. Then, the students before starting graduation researches made 31 research presentations for 4 years till 2017, including an oral presentation by team Superconductor [8]. The figure also shows the photos taken at the meeting with the part of presentation poster which was performed by one of the junior grade students in the team.

4. Presentations in international academic meetings

Fig. 7 shows the international conferences where the faculty gave the talks, which includes the meetings the students from freshman to junior grades, which are indicated

*Fig. 7. International conferences on engineering education*
by (*) in the figure. In Asian Conference on Engineering Education (ACEE) meeting, Japanese students in the dorm have attended to announce their research results. The educational performance is very effective when the students participate the academic meetings. At the same time, many students recognized lack of English ability of their own, while they satisfied themselves of the response of audiences. This educational program based on the forefront technology may possibly be expanded widely to other universities. As shown in Fig. 7 in practice, a junior grade student made a poster presentation in ACEE 2018 held in Niigata [9]. The students in the team Superconductor has totally presented 10 talks in the academic meetings till 2018, including 8 international talks. The project of the team Superconductor is continuing even now in the same manner.

5. Conclusion

The forefront technology with respect to superconductivity and its R&D project was adopted to the leadership program for the students in Niigata University. The undergraduate students from freshman to junior grades have been participated in the academic research activities in the novel learn-by-doing program called “Smart Dormitory”. There, the students before starting their graduation studies built their own research team “Superconductor” together to study the material science and its practical applications about the topics they freely choose. The students are assigned their scientific presentations about their on-going studies in the academic meetings in international academic meetings and qualified as “Top Graduate” [7]. This engineering education program is characterized as one of the leadership programs for the students in the international industries.

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References


A case in action learning on basic programming course

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Abstract

In this paper a case of basic language course for engineering student is introduced. The class is offered to the 2nd year engineering students. The aim of the class is to give students basic ability to write basic c-language program by themselves. Flipped learning technique was used with partial problem based approach.

In flipped learning, preparing well-organized and considerately prepared basic materials which corresponds to the coming class hours is very important to draw the interests on the subject and draw motivation from the students. In this case for the beginning part of the semester short youtube videos within 15 min and simple problems are provided one week before the class hour. For the remaining part of the semester, simple exercise problems are suggested with the several keywords are provided. Each class hour, 75 min, consists of three parts, i.e. 15 min voluntary presentation from the students, 20 min questions and discussions, 20 min supplement lecture, 20 min practice. For the final 3 weeks, each class is assigned to small projects which includes real data collected from the internet. Real world data can draw better motivation from the students.

In flipped learning class student’s workload increases compared to lecture only class. While there are some increase of the student’s motivation, some students do not like their increased workload. So compromise between flipped class and normal lecture need to be considered to make most effective class.
Keywords: Action learning, Programming, C-language, Flipped learning

1. Introduction

Basic computer language skills are essential ability for the every engineering students. Especially in electrical or electronic area the importance is even bigger. But traditional way of teaching, i.e. lecturing is not thought enough to be effective to cope with the current day’s students’ style. Educational environment changed due to the wide spread use of the mobile phone and video games. There need to be more efficient way of lecturing to induce the motivation from the students. In the area of computer language teaching, several attempt was tried such as activity-based (Luo & Hovis, 2006), problem-based (Handur, et al., 2015) (Gorrfried, 1997) or flipped classroom style (Puarungroj, 2015) (Garg, 2015). The aim of those tries were all to motivate students to the class and draw their ability to come closer to the computer language coding and applications. In this paper flipped class approach of the c-language course for the 2nd grade engineering students was reviewed and its effect was discussed.

2. Flipped Learning in C-Language Teaching

2.1 Aim of the class

The aim of the class is as follows. First, students can express data using c-language. Second, students can implement processing of the data using c-language. Third, students can write their own c-code. Fourth, students can understand and exaplain the c-code which was written by other person. The students in the class is 2nd year in robot and control track, i.e. similar to the electronics major. To prepare a class in flipped-learning style, there need to be some considerations on
the characteristics of engineering classes.

2.2 Fipped class design

Before the class students are asked to pre-study the contents using youtube or simple example code. Pre-study materials’ contents are focused on the basic topics of the c-language. Length of the youtube material did not exceed 15 min. During the class students participated by presentation and discussions. At the end of the class hour summary of the topics are given to the students.

2.3 Preparation

Both students and faculty need to prepare for the class to make a successful teaching experience. The role of the faculty is to prepare a proper assignment for the next class time. Some materials are provided for the students to help prepare the class. Those can be written materials, youtube clips or simple program etc.

Each class hour(75min) was managed as follows.

(1) Voluntary Presentation on the Pre-study Topics
Let the students ,who prepared the pre-study topics, give chance to present. And they explain the topics to other students.
Presentation Sequence:
- Explanation on the Pre-study Topics
- Explain the partial answers for the Pre-study Topics
- Q&A for the presentation

(2) Supplementary Presentation for the Presentation
After presentation of the pre-study assignment, point score was given to the students who presented. Also the students who did question were given some points which will be added to evaluate the semester scoring.

(3) Additional summary session for the topic
Concerning the presented topic of the class, special short lecture were given to the students, i.e. some grammar or examples of c-language.

(4) Homework assignment
Focusing on the topic of the class, assignment are given to the students to enhance the understanding of the topic. Assignments were focusing on the problem solving using c-language.

Here are some considerations and points when developing pre-study assignments

(1) Proper study time
Find materials which do not give too much study burden to the students, from the internet or from the text. Assignment topics are announced before a week at least.

(2) Announcement time
Assignments are announced at least before a week. So students can study the contents with enough time.

(3) Difficulties in step
For the beginning part of the semester, contents of the assignments start from simple information search. The difficulties of the assignments increases step by step to cover more detailed c-language contents.

3. Evaluation
We analyzed questionnaire which were collected from the students after the semester.

Here are the questions asked.

1. What was your purpose to join the c-language class?
2. Was flipped class more helpful than normal lectures?
3. Were pre-study assignments helpful to understand the topics.
4. Was final practice homework helpful to apply c-language for practical problem solving?

Motivations of the students to the class are surveyed with questionair1. Most of the students participated to the class without definite motivation. Only 6/14 expressed that they had motivation or detailed
interest about the class.

Unfortunately the answers to question 2 and 3 are not affirmative from the students. Many of the students felt uncomfortable for the flipped way of the class and preferred conventional lecture style.

To compensate this phenomena, it is strongly recommended that some procedures to give them definite motivation with case or examples at the first week of the semester. Students need much effort than normal class style and have difficulty to do self-study for pre-study assignments. Possible recommendations are to make the pre-study assignment as simple as possible.

Here are some points need to be considered after the semester.

(1) Giving motivation to the students to evaluate the pre-study, i.e. quiz etc., is required.
(2) Various methods to motivate the students to the class are required.
(3) Learning levels need to be considered according to the group of the students who have different learning ability. Levels of the pre-study assignments or problems can be adjusted according to the students’ learning ability and pace. And the ratio of the style during the lecture need to be adjusted by the faculty.

(Ex) Lecture 4, Flipped learning 3, Team study 3

While pre-study is very important in flipped class, there are tendency that sometimes the students refuse the pre-study because they are not familiar to the pre-study, they prefer traditional style lecture, which is easy to do for them. So it is required to develop good way for the students to participate to the pre-study actively in terms of the contents or topics which can motivate the students.

Prestudy assignment used youtube contents were limited to within 20min, some contents and class pace did not match some times.

4. Conclusions
In this paper some aspects of flipped class on basic c-language learning was observed and discussed. Knowing or estimating the learning ability of the students in the class is an important factor to make a successful flipped class. Deciding a proper ratio between lecture and flipped style presentation is also important for the students to maintain focused during the class. Also students’ performance ability need to be considered to decide the level of difficulty for the pre-study assignments. Some drawbacks found was flipped learning can limit the amount of the contents because it requires more time to interact with the students. So we need to choose and focus on relatively more important topics of the class.

5. References


Effect of Design Related Engineering Activity on Engineering Design Competency

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Abstract

The purpose of this study is to analyze the effects of design-related activities on engineering design competency of university engineering students. The existing engineering design competency test comprised of six domains (competency of design performance, competency of considering economic and social influence, competency of utilizing mathematical and scientific knowledge, competency of teamwork, competency of design-centered thinking and competency of collecting and using date) was used. University engineering students around the nation were surveyed, and 2,992 responses were collected. Regression analysis was performed at a significance level of 0.05. The study results are as follows.

First, engineering design competency do not increase linearly with increasing number of design-related courses taken.
Second, engineering design competency increases linearly with every increase of engineering design activities.

Keywords : engineering design, competency, engineering design competency

I. Introduction

1. Necessity and purpose of research
Engineering is a subject that leads human progress by solving the real problems human beings are facing. Many scholars emphasize that engineering design is a comprehensive process related to the creation of products which meets market needs and it is the most important field in the whole engineering (Thompson, 1988; Cross, 2000; Haik, 2003). Accreditation standard for engineering education suggested by ABET (Accreditation Board for Engineering and Technology) and ABEEK (Accreditation Board for Engineering Education of Korea) underlines engineering design. Accordingly, engineering colleges are making much effort to implement curriculum to develop engineering design ability.

Several researches to identify engineering design ability were conducted along with the endeavor to develop engineering design ability. The engineering design ability requires diverse capabilities as it is the process connected to several fields and is the complicated and creative activity. Thus, Kim et al. (2005) and Kim (2015) clarified evaluation elements of engineering design ability and deducted definition and sub areas of engineering design ability. But, these studies could not actually evaluate or assess engineering design ability. In particular, it is an overall capability consisted of several abilities. So, there is a need to approach it not as a simple ability but as a concept of competency. This approach from a point of view of competency would enable us to pay attention to the possibility for accomplishing engineering design successfully. This means that an engineer with plenty of engineering design competency is able to conduct successful engineering design. Therefore, this research aims to find out the significant effect of diverse educative activities related to engineering design in engineering college on the improvement of engineering design competency for future engineers.

2. Definition of terms

A. Engineering design competency

In this research, engineering design competency is defined as the overall individual ability that is necessary for an engineer for his/her successful accomplishment of engineering design.

II. Theoretical background

1. Engineering design

Engineering design is defined from various perspectives by many scholars.
Thompson (1998) referred to it as the most important part in engineering field and defined it as the whole process of manufacturing or creating products that meet market or consumers’ needs. Cross (2000) distinguished between traditional craft-based design and modern industrial design. Engineering design in modern industrial society has tendency to concretely separate a variety of activities when designing. However, traditional engineering design does not divide it up into suggesting ideas and making them. Haik (2003) separates engineering design in terms of process approach. He referred to it as processes of planning, combining, analyzing, making, examining and evaluating the goal of design and its standard. Ford and Coulston (2009) regarded engineering design as problem-solving process on several stages to suggest idea and to embody final system for it. Eggert (2010) regarded it as process or activity of decision making to manufacture products that meet customers’ or consumers’ needs. We can find out the fact that engineering design is commonly mentioned as the activities to fulfill the needs by manufacturing necessary products.

2. Engineering design competency

Competency is a concept of successful accomplishment of duty and assignment with proficiency which has been mainly discussed in vocational education field (So, 2007). The viewpoint of competency includes performance, its diverse influencing factors and its level as this concept commonly connotes performance though the latter is classified and defined in terms of nation, discipline and way of approaching (Hoffmann, 1999).

Engineering design competency can be defined as necessary ability for the successful accomplishment of engineering design. The competency in engineering design means potential characteristic or skill needed for desirable accomplishment and it focuses on series of processes of it. To explore engineering design competency, we should not ‘solve’ ‘problem’ simply through duty or task but should consider all the necessary process for problem-solving. Diverse activities such as recognition of problem situation, team activity for problem solving, use of based-knowledge and effective communication should be considered in the middle of engineering design process.

III. Methodology

To identify the effect of educative activities related to engineering design on the improvement of engineering design competency of future engineers, We assessed engineering design competency of engineering college students using self-report test and surveyed the numbers of completed design courses and of actual design experience through questionnaire.
1. Self-Report Test for Engineering Design Competency

Self-report test to assess engineering design competency was developed through document review, definition of category and subfactor, making item and construct validity verification. Exploratory factor analysis and confirmatory factor analysis were conducted to verify construct validity.

Self-report test for engineering design competency consists of 6 categories and 40 items. 6 categories cover competency of design performance, competency of considering economic and social influence, competency of utilizing mathematical and scientific knowledge, competency of teamwork, competency of design-centered thinking and competency of collecting and using data. 6-point Likert scale was used for each item. Items of test for engineering design competency are shown in Table 1.

<Table 1> Item of Engineering Design Competency

<table>
<thead>
<tr>
<th>category</th>
<th>item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency of design performance</td>
<td>I am well aware of what to design when designing.</td>
</tr>
<tr>
<td></td>
<td>I can find out matters to improve in the middle of performing task.</td>
</tr>
<tr>
<td></td>
<td>I can distinguish between desirable design and undesirable one when designing.</td>
</tr>
<tr>
<td></td>
<td>I can suggest proper solution when designing.</td>
</tr>
<tr>
<td></td>
<td>I can suggest diverse ideas solution when designing.</td>
</tr>
<tr>
<td></td>
<td>I always make effort to improve my designing ability.</td>
</tr>
<tr>
<td></td>
<td>I can maintain very powerful concentration when performing task.</td>
</tr>
<tr>
<td></td>
<td>I can look for matters to improve when receiving design results.</td>
</tr>
<tr>
<td></td>
<td>I can find out common feature when looking through various cases of design.</td>
</tr>
<tr>
<td></td>
<td>I can analyze completeness of prototype of design.</td>
</tr>
<tr>
<td></td>
<td>I can define design problems to solve when being assigned design task.</td>
</tr>
<tr>
<td></td>
<td>I can draw conclusion through analysis of data from experiment for design.</td>
</tr>
<tr>
<td>Competency of considering</td>
<td>I can estimate economic value of design solution.</td>
</tr>
<tr>
<td></td>
<td>I can plan design budget by applying economic principle.</td>
</tr>
<tr>
<td></td>
<td>I can design considering economic aspects like ‘value per input’</td>
</tr>
<tr>
<td></td>
<td>I can make use of market information when designing.</td>
</tr>
<tr>
<td></td>
<td>I can give shape to design goal by understanding consumers’ needs.</td>
</tr>
</tbody>
</table>
| economic and social influence | I can predict influence of my design on society.  
|                              | I can collect design information through market survey.  
|                              | I can perform design task reflecting socio-cultural situation when receiving.  |
| Competency of utilizing mathematical and scientific knowledge | I can apply mathematical principle when designing.  
|                                                             | I can use necessary mathematical knowledge when designing.  
|                                                             | I can express matters related to design using mathematical formula when designing.  
|                                                             | I am well aware of necessary mathematical knowledge when designing.  
|                                                             | I can apply scientific principle when designing.  
|                                                             | I fully understand necessary engineering knowledge I majored in when designing.  |
| Competency of Teamwork   | I can smoothly settle conflict between team members in the middle of performing task.  
|                          | I can efficiently interact with team members in the middle of performing task.  
|                          | I can perform design task based on coordination of ideas with team members.  
|                          | I can derive active participation of team members when performing design task.  
|                          | I can maintain interacting with team members when performing design task.  
|                          | I can organize appropriate team for performing design task.  |
| Competency of design-centered thinking | I can consider various possibility when designing.  
|                                   | I can understand advantage and disadvantage of diverse ideas when designing.  
|                                   | I can find out common feature of design cases upon which can predict actual design result.  
|                                   | I can provide evidence of result predicted when designing.  |
| Competency of collecting and using data | I can make use of various documental information for design.  
|                                    | I can collect design information through document retrieval.  
|                                    | I can search design information from foreign materials.  
|                                    | I can organize and keep information collected for design.  |

2. Survey target

Test of engineering design competency and survey were conducted targeting engineering college students nationwide in Korea. The number of them are about 520,000 nationwide as of 2016. 5,000 students were selected in consideration of regions and departments.
IV. Findings

1. Background variable response status

Mail and Google Docs were used to distribute and retrieve test and survey. There were total of 2,992 of responses.

Background variable response is shown in Table 2 and Table 3. There is a difference in responses for each variable depending on presence of missing value. 75.5% of responders were male students and 24.5% of responders were female students. 38.2% of responders were construction majors, 26.5% were IT majors, 26.4% were machinery majors, 7.7% were chemical engineering and material majors and 1.2% were others.

<Table 2> grade and gender status table

<table>
<thead>
<tr>
<th>Grade</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>226</td>
<td>115</td>
<td>341</td>
</tr>
<tr>
<td>2</td>
<td>727</td>
<td>250</td>
<td>977</td>
</tr>
<tr>
<td>3</td>
<td>830</td>
<td>218</td>
<td>1048</td>
</tr>
<tr>
<td>4</td>
<td>451</td>
<td>141</td>
<td>592</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>2244(75.5)</td>
<td>728(24.5)</td>
<td>2972(100.0)</td>
</tr>
</tbody>
</table>

<Table 3> grade and gender status table

<table>
<thead>
<tr>
<th>Department</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinery majors</td>
<td>789</td>
<td>26.4</td>
</tr>
<tr>
<td>Construction majors</td>
<td>1143</td>
<td>38.2</td>
</tr>
<tr>
<td>IT majors</td>
<td>792</td>
<td>26.5</td>
</tr>
<tr>
<td>Chemical engineering and material majors</td>
<td>229</td>
<td>7.7</td>
</tr>
<tr>
<td>Others</td>
<td>36</td>
<td>1.2</td>
</tr>
<tr>
<td>Total</td>
<td>2989</td>
<td>100.0</td>
</tr>
</tbody>
</table>
2. Difference in engineering design competency for each background variable

A. Difference in grade

Analysis of difference in engineering design competency according to grade is shown in Table 4. There was no difference between freshmen and sophomores. However, engineering design competency increased as grade became higher. Overall competency and its dimensions were higher for juniors and seniors compared to freshmen and sophomores, and seniors showed higher competency than juniors.

<Table 4> Difference in engineering design competency by grade

<table>
<thead>
<tr>
<th>Part</th>
<th>Grade</th>
<th>Frequency</th>
<th>average</th>
<th>S.D</th>
<th>F</th>
<th>Scheffe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total competency</td>
<td>1</td>
<td>344</td>
<td>146.87</td>
<td>41.04</td>
<td>39.667***</td>
<td>3,4 &gt; 1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>979</td>
<td>151.01</td>
<td>33.88</td>
<td>39.667***</td>
<td>3,4 &gt; 2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1052</td>
<td>160.59</td>
<td>33.91</td>
<td>39.667***</td>
<td>3,4 &gt; 3</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>596</td>
<td>170.58</td>
<td>33.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency of design performance</td>
<td>1</td>
<td>344</td>
<td>44.32</td>
<td>12.67</td>
<td>36.875***</td>
<td>3,4 &gt; 1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>979</td>
<td>45.66</td>
<td>10.67</td>
<td>36.875***</td>
<td>3,4 &gt; 2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1052</td>
<td>48.54</td>
<td>10.78</td>
<td>36.875***</td>
<td>3,4 &gt; 3</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>596</td>
<td>51.56</td>
<td>10.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency of considering</td>
<td>1</td>
<td>344</td>
<td>28.93</td>
<td>8.51</td>
<td>32.660***</td>
<td>3,4 &gt; 1</td>
</tr>
<tr>
<td>economic and social influence</td>
<td>2</td>
<td>979</td>
<td>28.88</td>
<td>7.25</td>
<td>32.660***</td>
<td>3,4 &gt; 2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1052</td>
<td>31.04</td>
<td>7.29</td>
<td>32.660***</td>
<td>3,4 &gt; 3</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>596</td>
<td>32.93</td>
<td>7.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency of utilizing</td>
<td>1</td>
<td>344</td>
<td>21.72</td>
<td>6.52</td>
<td>31.117***</td>
<td>3,4 &gt; 1</td>
</tr>
<tr>
<td>mathematical and scientific</td>
<td>2</td>
<td>979</td>
<td>22.29</td>
<td>5.56</td>
<td>31.117***</td>
<td>3,4 &gt; 2</td>
</tr>
<tr>
<td>knowledge</td>
<td>3</td>
<td>1052</td>
<td>23.41</td>
<td>5.67</td>
<td>31.117***</td>
<td>3,4 &gt; 3</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>596</td>
<td>25.25</td>
<td>5.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency of teamwork</td>
<td>1</td>
<td>344</td>
<td>22.32</td>
<td>6.41</td>
<td>35.223***</td>
<td>3,4 &gt; 1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>979</td>
<td>23.85</td>
<td>5.67</td>
<td>35.223***</td>
<td>3,4 &gt; 2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1052</td>
<td>25.21</td>
<td>5.48</td>
<td>35.223***</td>
<td>3,4 &gt; 3</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>596</td>
<td>26.34</td>
<td>5.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency of design-centered</td>
<td>1</td>
<td>344</td>
<td>14.92</td>
<td>4.39</td>
<td>26.515***</td>
<td>3,4 &gt; 1</td>
</tr>
<tr>
<td>thinking</td>
<td>2</td>
<td>979</td>
<td>15.29</td>
<td>3.65</td>
<td>26.515***</td>
<td>3,4 &gt; 2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1052</td>
<td>16.18</td>
<td>3.72</td>
<td>26.515***</td>
<td>3,4 &gt; 3</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>596</td>
<td>17.01</td>
<td>3.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency of collecting and using</td>
<td>1</td>
<td>344</td>
<td>14.63</td>
<td>4.36</td>
<td>48.241***</td>
<td>3,4 &gt; 1</td>
</tr>
<tr>
<td>data</td>
<td>2</td>
<td>979</td>
<td>15.01</td>
<td>3.68</td>
<td>48.241***</td>
<td>3,4 &gt; 2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1052</td>
<td>16.18</td>
<td>3.75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Analysis of difference in engineering design competency according to major is shown in Table 5.

<table>
<thead>
<tr>
<th>Part</th>
<th>major</th>
<th>Frequency</th>
<th>average</th>
<th>S.D</th>
<th>F</th>
<th>Scheffe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total competency</td>
<td>Machinery</td>
<td>789</td>
<td>161.80</td>
<td>35.23</td>
<td>10.555***</td>
<td>Ma&gt;IT</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td>1143</td>
<td>159.74</td>
<td>35.71</td>
<td></td>
<td>Ma&gt;Ch Co&gt;IT Co&gt;Ch</td>
</tr>
<tr>
<td></td>
<td>IT</td>
<td>792</td>
<td>154.03</td>
<td>33.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical, Material</td>
<td>229</td>
<td>150.04</td>
<td>40.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency of design performance</td>
<td>Machinery</td>
<td>789</td>
<td>49.13</td>
<td>11.20</td>
<td>10.180***</td>
<td>Ma&gt;IT</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td>1143</td>
<td>46.65</td>
<td>10.64</td>
<td></td>
<td>Ma&gt;Ch Co&gt;IT Co&gt;Ch</td>
</tr>
<tr>
<td></td>
<td>IT</td>
<td>792</td>
<td>45.38</td>
<td>12.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical, Material</td>
<td>229</td>
<td>28.56</td>
<td>8.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency of considering economic and social influence</td>
<td>Machinery</td>
<td>789</td>
<td>31.02</td>
<td>7.44</td>
<td>15.101***</td>
<td>Ma&gt;IT</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td>1143</td>
<td>31.34</td>
<td>7.61</td>
<td></td>
<td>Ma&gt;Ch Co&gt;IT Co&gt;Ch</td>
</tr>
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<td></td>
<td>IT</td>
<td>792</td>
<td>29.27</td>
<td>7.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical, Material</td>
<td>229</td>
<td>21.74</td>
<td>6.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency of utilizing mathematical and scientific knowledge</td>
<td>Machinery</td>
<td>789</td>
<td>23.72</td>
<td>5.99</td>
<td>11.174***</td>
<td>Ma&gt;IT</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td>1143</td>
<td>23.67</td>
<td>5.73</td>
<td></td>
<td>Ma&gt;Ch Co&gt;IT Co&gt;Ch</td>
</tr>
<tr>
<td></td>
<td>IT</td>
<td>792</td>
<td>22.61</td>
<td>5.59</td>
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</tr>
<tr>
<td></td>
<td>Chemical, Material</td>
<td>229</td>
<td>21.74</td>
<td>6.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency of Teamwork</td>
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<td>789</td>
<td>25.25</td>
<td>5.77</td>
<td>4.523</td>
<td>-</td>
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<tr>
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<td>Construction</td>
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<td>24.55</td>
<td>5.68</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>IT</td>
<td>792</td>
<td>24.54</td>
<td>5.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical, Material</td>
<td>229</td>
<td>24.00</td>
<td>6.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency of design-centered thinking</td>
<td>Machinery</td>
<td>789</td>
<td>16.38</td>
<td>3.84</td>
<td>11.904***</td>
<td>Ma&gt;IT</td>
</tr>
<tr>
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<td>Construction</td>
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<td>16.13</td>
<td>3.83</td>
<td></td>
<td>Ma&gt;Ch Co&gt;IT Co&gt;Ch</td>
</tr>
<tr>
<td></td>
<td>IT</td>
<td>792</td>
<td>15.47</td>
<td>3.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical, Material</td>
<td>229</td>
<td>14.89</td>
<td>4.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency of collecting and using data</td>
<td>Machinery</td>
<td>789</td>
<td>16.29</td>
<td>3.86</td>
<td>6.698***</td>
<td>Ma&gt;IT</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td>1143</td>
<td>16.00</td>
<td>3.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IT</td>
<td>792</td>
<td>15.55</td>
<td>3.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical, Material</td>
<td>229</td>
<td>15.47</td>
<td>4.27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. The relationship between design related activity and engineering design competency

Status of design related activity of responders is shown in Table 6.

<Table 6> Design related activity table

<table>
<thead>
<tr>
<th>Number of course</th>
<th>frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>302</td>
<td>10.8</td>
</tr>
<tr>
<td>1</td>
<td>461</td>
<td>16.5</td>
</tr>
<tr>
<td>2</td>
<td>579</td>
<td>20.7</td>
</tr>
<tr>
<td>3</td>
<td>571</td>
<td>20.4</td>
</tr>
<tr>
<td>4</td>
<td>452</td>
<td>16.1</td>
</tr>
<tr>
<td>5</td>
<td>436</td>
<td>15.6</td>
</tr>
<tr>
<td>Total</td>
<td>2801</td>
<td>100.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of design experience</th>
<th>frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>486</td>
<td>20.6</td>
</tr>
<tr>
<td>1</td>
<td>493</td>
<td>20.9</td>
</tr>
<tr>
<td>2</td>
<td>489</td>
<td>20.8</td>
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<tr>
<td>3</td>
<td>416</td>
<td>17.7</td>
</tr>
<tr>
<td>4</td>
<td>250</td>
<td>10.6</td>
</tr>
<tr>
<td>5</td>
<td>223</td>
<td>9.5</td>
</tr>
<tr>
<td>Total</td>
<td>2354</td>
<td>100.0</td>
</tr>
</tbody>
</table>

In order to confirm engineering design competency through design related activity, regression analysis was carried out and results are as follows. Simple and multiple regression models are used to find a fitted model to improve accuracy of predictors. Regression equation is derived to build a model, and t-test, alpha level, R2 and adjusted R2 are analyzed to decide whether the model is appropriate or not. Appropriate model for testing is finally selected by repeatedly identifying and estimating until the model which fits verification is presented.

In order to build a model Equation 1 and Equation 2 are defined below

\[ \hat{y} = \hat{\beta}_0 + \hat{\beta}_1 X \]  \hspace{1cm} (1)

\[ \hat{y} = \hat{\beta}_0 + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \cdots + \hat{\beta}_n X_n \]  \hspace{1cm} (2)

Regression coefficient is increased when an independent variable is increased by 1 unit while the other independent variable is held constant. Two independent variables, which are the numbers of courses related to design and of design experience, were used. And engineering design competency was used as a dependent variable for analysis in this research.

The relationship between engineering design competency and the number of courses related to design taken is shown in Table 7.

<Table 7> Regression analysis result according to number of course
The result showed that the number of design courses taken does not affect engineering design competency.

The relationship between the number of actual design experience and engineering design competency is shown in Table 8.

\textit{<Table 8> Regression analysis result according to number of design experience}

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>S.E</th>
<th>( \beta )</th>
<th>t</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>155.234</td>
<td>1.601</td>
<td>96.970</td>
<td>.000***</td>
<td></td>
</tr>
<tr>
<td>Number of course</td>
<td>0.656</td>
<td>0.386</td>
<td>0.031</td>
<td>1.702</td>
<td>.089</td>
</tr>
</tbody>
</table>

A positive cause and effect relationship between the number of actual design experience and engineering design competency was established. In average, as the number of design experience is increased at once, engineering design competency is increased by 10.000, which relationship showed a statistical significance.

Actual design experience had more influence on engineering design competency than taking design related courses.

IV. Conclusion and Suggestion

1. Conclusion

Conclusion of this research is as follows.

First, engineering design competency increases as the grade becomes higher in engineering college. The results showed that freshmen and sophomores have higher engineering design competency than juniors and seniors, and seniors have higher one than juniors though there is no difference between freshmen and sophomores.

Second, engineering design competency of machinery majors and construction majors
is higher than other majors in engineering college. It showed that there is no difference of teamwork competency between majors. Engineering design competency of machinery majors and construction majors is higher than other majors concerning comprehensive and miscellaneous competency.

Third, there is positive cause and effect relationship between the number of actual design experience and engineering design competency. It showed that there is no cause and effect relationship between the number of design courses taken and engineering design competency.

2. Suggestion

Suggestion based on this research is as follows.

The researches related to engineering design have generally focused on the assessment of educative effect using engineering design with setting engineering design as independent variable or on exploration of successful engineering design plan so far. However, this research found out variables having influence on engineering design competency. Follow-up research is needed to improve engineering design competency by identifying various variables which affect further engineering design.

Reference


49-56.


A Case Study of Exploring the Direction of Woman Engineering Education by the Analysis of Learner's Recognition

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The purpose of this study is to explore the direction of woman engineering education by the analysis of learner's recognition. In order to investigate the direction of woman engineering education, the literature reviews are explored in the context of the human resource development and in the viewpoint of instructional technology. The survey results such as the learner's experience recognition of engineering education are analyzed and they are discussed by experts in the field of education, instructional technology, and engineering. The analysis result of 399 students (man: 206, woman: 193) in P university shows significant differences with man and woman to the factors of (a) understanding, (b) satisfaction, (c) motivation, (d) learning ability, (e) parents' expectation, (f) pleasure in the study, and (g) expectation grade. This study is suggesting the recommendations of woman engineering education in the view points of cognition, emotion, motivation, environment and instructional strategy. The research results will show the cues of human resource development for women in the field of engineering education.

1. Background/ Objectives and Goals

Until the 1960s, the main industry was the male-dominant primary industry where most of the operation was done by manpower. However, in this modern society, the tertiary industry where emotional engineering plays an important role became the mainstream. Therefore, introducing new subjects related to female engineering and promoting university education in the sector became important.

This dissertation aims to mention the necessity of studies that can be a basis of gender-cognitive engineering education. Another goal is to develop and disseminate cultural subjects for engineering majors to nurture highly skilled female engineers by teaching the female students an emotional engineering approach in their career planning.

2. Methods

Before setting up new subjects, the existing subjects that can teach female engineering majors the role of female and their future career direction were surveyed. Most of the female subjects in universities can be divided into the following three categories. The first category includes 'Women's Studies' focusing on feminism and gender equality, 'Women and The law' that can enhance women's right, 'Women and Politics', 'Women and The economy', 'Women's Right', 'Women and Society', 'Women's Welfare', 'Women's Policy' and 'Women's Employment'.

The second category includes 'women and literature' with a psychological approach of women, 'women and media' and 'women and psychology'. The third category includes 'women and engineering', and 'women and technology' which hold significance. Related 'women and leadership' and 'women's career exploration' are also considered significant. However, there are no suitable books for female engineering majors in Korea. Planning and conducting lectures are mostly done by outside lecturers. Considering such circumstances, we introduced new subjects for female engineering majors, developed books and sought ways to offer female students a future direction.

Evaluation method was designed to encourage the submission of various types of reports. To enhance presentation skills, create motivation and build up leadership of students, reports were
submitted in audio file and video scripts. Males and females were given enough time to discuss with each other, and the qualification of the discussion was evaluated in 10 levels. Analysis of the lecture was done by conducting pre and post surveys. The feedback data was used to enhance the lecture quality. A new textbook is developed and scheduled to be published. Lecturers were also allowed to use fast changing statistics and internet data. The lecture was designed to give internet-savvy students an accurate concept of gender-sensitive perspectives. Each chapter of the book selected female as a team leader or an expert, and presented discussion topics with which female students should play a leading role. It also encourages females to lead team activities such as presiding meetings. When it comes to male students, the book aims to remove the prejudice against female students. As for female students, it offers an opportunity to renew their understanding of gender role and build self-leading learning skills and leadership.

![Image](image.png)

*Fig. 1 Result summary of evaluation with objective questions after the lecture in the second semester.*

### 3. Expected Results/Conclusion/Contribution

The new subject was developed to provide gender-cognitive engineering education. In addition, the lecture was established to teach female engineering majors an emotional engineering approach in deciding their future careers. As a result, the subject was proved to induce interests in engineering from female students. It also helped them advance into the engineering fields. With the female emotional engineering approach, coexistence and communication rather than competition with males were emphasized. It also received favorable comments from the students. Therefore, it will be great to adopt 'Women and Engineering' as one of the cultural studies for all engineering majors. We hope the subject will be spread to other universities to generate more highly-skilled female engineers in Korea.

### 4. Acknowledgement

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On the Enhanced Wax Patterning Offset Printing for the manufacturing of Printed Electronics

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1. Background/ Objectives and Goals
Offset lithography printing is a printing method that is divided into the lipophilic non-printed area which transfers dampening water and the hydrophobic printed area which transfers ink. This printing method uses the principle in which only the printed area is stained with ink because of repulsive force between the two areas. However, the most common screen printing method has problems like difficulty of roll-to-roll continuous work, slow printing speed, and damaging of substrate or pattern from irregular printing pressure. Accordingly, this study aimed to apply the offset lithography printing method to the manufacturing of printed electronics in order to overcome problems of the screen and ink jet printing methods. In other words, the purpose of this study is to propose a new printing technology that accommodates for characteristics of diversifying printed electronics, reviewing the potential of the WPOP method and finding the optimal condition based on significant experimental results.

2. Methods
First, when the wax is printed on the printed object using a screen printer as shown in Figure 1 (a), the wax is printed in the non-printed area in the form of Figure 1 (b). If temperature of the paper is increased to 120°C or above after printing, appropriate amount of wax penetrates into the paper and remaining wax settles down on the surface. Commercial paraffin wax was used for the wax, and viscosity of the paraffin wax was adjusted by mixing gelatin. In the next step, the hydrophilic conductive ink was printed on the printed object formed with the wax partition using an offset printability tester model (IGT-C1, Holland), as shown in Figure 1 (c).

Figure 1. Schematic diagram of WPOP (wax patterning offset printing) process for the manufacturing a printed electronics.
3. Results and Discussions

3.1 Wax Patterning

Figure 2 shows values comparing the front and back sides of paper sample 1 after heating the printed wax to 120°C for 10 ~ 60 minutes. Figure 2 implies that there is no smudging in the lateral direction of the wax when it approaches the 45° line.

![Figure 2](image)

Figure 2. Cross sectional view of paper sample which was patterned by wax. Schematic (a) is a wax patterned model and photography (b) is a wax patterned paper sample 1.

In other words, it is important to adjust penetration rate of the wax in order to precisely form the wax partition. Figure 3 is the result of measuring penetration depth according to time while heating the wax transferred to the three papers to 120°C for 90 minutes.

![Figure 3](image)

Figure 3. Microscopic measurements of depth of penetration of wax pattern onto papers. (a),(b) and (c) are the sample of 1, 2, and 3 respectively.

3.2 Electric Conductivity of Pattern

The resistance value decreases when sintering temperature increases. However, excessively high sintering temperature can affect the paper and wax partition. Based on the results of this experiment, the value of electric resistance becomes almost constant at temperature of 160°C or above, optimal electric conductivity was obtained by setting temperature at or below 160°C within the range of not causing deformation of the wax and paper and after about 60 minutes past printing. There can be differences among paper samples, but sample 3 showed the resistance value drop to
3.1Ω when a wax partition of 100 μm width was made on the printed object, printing was done at printing pressure of 500N, and sintering was done for 60 minutes at 160°C. This resistance value indicates that the WPOP method is adequate for the manufacturing of printed electronics.

Figure 4. Electric resistances differences on the depth of conductive silver paste inks at temperature 80°C.

Figure 5. Electric resistances differences on the constant printing pressure of WPOP.

4. Conclusions
1. When the silver paste ink was printed by patterning printing of 100 μm width using this WPOP method, electric resistance was lowered to 3.1Ω. This result is adequate enough to be applied to the manufacturing process of printed electronics.
2. Although this study had limitations in resolution and penetration depth because commercial papers were used, the WPOP method can maximize penetration effect of porous papers by applying appropriate printing pressure. However, it was discovered that resolution and quality can be greatly improved by using papers with uniform composition.
3. The WPOP method that prints on papers can be used to manufacture flexible printed electronics. It can exhibit outstanding conductivity and stability through 3-dimensional penetration of the ink compared to the conventional printing method that simply prints on the surface.

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A Survey on Students’ Readiness to Adopt Blended-Learning at Faculty of Engineering, UMS

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Abstract
With the advancement in technology, the education industry has gradually moved into blended-learning, whereby the traditional face-to-face learning time is complemented by online educational materials and interaction with peer and lecturer. This method of teaching and learning provides more flexibility to lecturers and students in terms of time, and students are able to learn at their own pace. One of the obstacles faced by students is the sudden transition from traditional face-to-face teaching and learning process pre-tertiary education to blended-learning in tertiary education. A survey was conducted for engineering students at the Universiti Malaysia Sabah to investigate the readiness of students to adopt this learning approach. The survey was taken by 466 students across all disciplines of engineering studies. Of those who took the survey, approximately 11% of the students have negative feelings towards blended learning. Among the common reasons for this is that students feel that they lack motivation and time management skill to manage their study times. Some of these students also felt that there is a lack of instruction as to what task they were to carry out. On the other spectrum, students who are ready and comfortable with adopting blended-learning prefers this method as it provides them with flexibility in terms of time and that they are able to review the materials numerous times, at their own pace. From the survey carried out, approximately half of those who participated in the survey prefers blended-learning over traditional face-to-face learning.

Keyword: Blended-learning, face-to-face learning, tertiary education

Introduction
With the advancement in technology available in the education sector, where internet network readily available to students and educators, the teaching and learning process has been undergoing a shift, whereby students can now easily learn through resources online. With this shift, educators are urged to move towards ‘blended-learning’, such that the teaching process is not only confined to the space of a classroom (Garrison and Kanuka, 2004).

Blended-learning is a teaching and learning approach that combines educational resources online with traditional face-to-face teaching. One of the biggest advantages of this approach is that students gain flexibility or control over the pace they learn, and when or where lessons delivery can take place. This also enable students to repeat a lesson, when necessary, with resources made available online. It provides educator a platform to be creative and innovative with their teaching approach, and to build a more collaborative learning environment with students (So and Brush, 2007; Guzer and
Caner, 2014). The benefit of collaborative learning has been studied by Laal and Ghodsi (2012). Blended-learning, unlike online-learning, which limits social interaction and would be an unsuitable learning platform for students who are used to rely heavily on the presence of an educator (Heinze and Procter, 2004), provides an additional outlet for students and educators to interact outside of the classroom.

In spite of the vast potential and the benefits that can come from implementing the blended-learning approach, it is important to consider the readiness of students to adopt this method of learning (Haron et. al., 2011; Abdul Rahman et. al., 2015). A survey was conducted amongst the engineering students at the Faculty of Engineering, Universiti Malaysia Sabah (UMS) to investigate the students’ readiness to embrace this learning approach.

**Methodology**

An anonymous survey was conducted for students at the Faculty of Engineering, UMS, through a survey form created in Google Forms. In the first section, some basic information of students is collected. This includes the gender of the student, their programme of study and year of study, and their current cumulative grade pointer average (CGPA).

The questions next section investigates students’ perception on ‘blended-learning’, which includes:
- students’ understanding on what is ‘blended-learning’
- how comfortable they are with blended-learning
  - for those who felt that they are not ready for blended-learning, they were also asked to provide reasons
- how ready or prepared they are with blended-learning
- aspects of blended-learning that they like
- their preference between blended-learning and traditional face-to-face learning approach.

**Result and Discussion**

Survey was collected from students of all engineering disciplines at the Faculty of Engineering, UMS, across all years of studies. A total of 470 responses were received. Out of the 470 responses, only 408 students had experienced blended-learning. Responses that states that they had not had experience with blended-learning is excluded in the following results and analysis.

To test the students’ understanding on what ‘blended-learning’ is, four (4) statements were given, and students were asked to choose which statement(s) they think best defined ‘blended-learning’ (multiple answers allowed). The statements and responses from students are as shown in Table 1.
The first two statements would best represent what ‘blended-learning’ is, while the latter two statements are less accurate representations of what ‘blended-learning’ is. It can be seen that majority of students understand that ‘blended-learning’ has both aspects of independent study done online, which supplements face-to-face learning time in classrooms. This is a positive sign, as students do have a good understanding of this learning approach. 58% of students choose the most comprehensive statement that defines ‘blended-learning’, which shows that they are aware of the collaborative nature of this learning approach.

**Table 1: Students’ Understanding on ‘Blended-Learning’**

<table>
<thead>
<tr>
<th>Statements</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blended-learning is an educational approach where learning can be done</td>
<td>237</td>
</tr>
<tr>
<td>through traditional lectures, supplemented by online educational materials</td>
<td></td>
</tr>
<tr>
<td>and interaction opportunities with peers and lecturer.</td>
<td></td>
</tr>
<tr>
<td>Blended-learning is learning lessons through an online platform, as well</td>
<td>184</td>
</tr>
<tr>
<td>as face-to-face time with lecturers.</td>
<td></td>
</tr>
<tr>
<td>Blended-learning is obtaining learning materials on online platform, which</td>
<td>83</td>
</tr>
<tr>
<td>are required for the traditional lectures.</td>
<td></td>
</tr>
<tr>
<td>Blended-learning is using online tools, such as YouTube, graphic tools,</td>
<td>168</td>
</tr>
<tr>
<td>online calculators to study.</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1: Students’ Level of Comfort and Readiness for Blended-Learning**
In terms of the readiness and how comfortable students are with ‘blended-learning’, students were asked to rate themselves on a scale from 1 to 4, with 1 as the least ready or comfortable, and 4 as the most ready or comfortable. The results are as shown in Figure 1. The results are broken down to show the distribution of responses according to students’ CGPA. It should be noted that students were asked to rate three criteria: level of comfort, level of enjoyment, and level of readiness for blended-learning. It was found that the number of responses for each of the three categories were exactly the same. Hence only a single result is shown, labeled as comfort/readiness in Figure 1. In all CGPA categories, more than 50% of students feel comfortable and prepared for the blended-learning approach, indicating CGPA has no effect in their readiness in blended-learning.

From the follow up questions, the biggest factors for students enjoy blended-learning because it provides flexibility in terms of time and provides ability to review the material numerous times. The breakdown is as shown in Figure 2.
On the other spectrum, the top reason why students felt that they do not enjoy and are unprepared for blended-learning is found to be that they simply are not interested in blended-learning, and they prefer face-to-face learning experience. There are also a lot amongst those who do not enjoy and feels unprepared for blended-learning because they felt that they lack self-discipline or motivation when left on their own to take charge of the learning process, and they are poor in managing their time. Majority of students who cited lack of self-discipline or motivation and having issues managing their own time are students who are with CGPA ranging from 2.00 to 2.99. The breakdown is as shown in Figure 3.

Students were ultimately asked to state their preference between blended-learning and traditional face-to-face learning. The results are as shown in Figure 4. As expected, a majority of students who stated that they felt that they are unprepared for the blended-learning approach prefer traditional face-to-face learning. However, there are a minority of these students who would prefer blended-learning. These students are prepared to try blended-learning, to go out from their comfort zone.

Figure 3: Students’ Feedback on Why They Do Not Enjoy Blended-Learning
Figure 4: Students’ Preference Between Blended-Learning and Face-to-Face Learning Based on Students’ Preparedness

It is also interesting to note that for students who stated that they felt that they are prepared for the blended-learning approach, approximately 45% of these students chose traditional face-to-face learning over blended-learning. Most of these students cited that they would still prefer to have face-to-face learning time with their course instructors and felt that some courses may not be suited for the blended-learning approach, as their main reason for this choice. As engineering courses involves a lot of practical and laboratory work, this may be one of the reasons why students felt that traditional learning in classrooms and laboratories are essential.

As a whole, it was found that the total number of students who prefer blended-learning and face-to-face learning to be similar.

Conclusion
Blended-learning, when implemented correctly, can bring benefits to students’, helping to enhance their learning process. Students at the Faculty of Engineering, UMS are generally prepared to adopt this learning approach, in spite of their personal preference. Students do acknowledge that the blended-learning approach allows time flexibility and provides them with flexibility to learn at their own pace. Some of the bigger factors that deter students are the lack of interest in this approach, and that they personally lack self-discipline to enable this learning approach to be effective for them.

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