CEE BOOK SERIES

I-PHEX2015

Innovative Practices in Higher Education Expo

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Foreword by Director of Higher Education Leadership Academy (AKEPT)

The Innovative Practices in Higher Education Expo 2015 (I-PHEX 2015) continues its tradition of being the premier exhibition in recognizing the standards of higher education, in line with the government aspiration to make Malaysia an education hub in the region. Higher education is a key driver to social and economic progress of a nation with institutions of higher education playing important roles in the exploration, development and dissemination of knowledge.

In this era of globalization, changes in the education system at tertiary level are taking place at a very fast rate. These changes have a significant impact on learning and teaching, as well as continuous enhancement of quality in order to achieve high standards in educational programs conducted. A lot of incentives have been done by institutions of higher learning to increase the quality of teaching so as to improve the learning outcomes of their students.

IPHEX, held as collaboration between AKEPT, the Centre for Engineering Education, Universiti Teknologi Malaysia and Council of Heads of Public Higher Education Institutions Centre of Teaching and Learning (MAGNETIC), aims to acknowledge and award innovative efforts in improving and enhancing the quality of teaching and learning at the institutions of higher education in the region. The expo is not only viewed as a platform to showcase innovative efforts that contribute to resolving the challenges of education in this era but also as a trigger to inspire others who are equally involved in the discussion, research and the delivery of education for the development of the nation. It is hoped that the I-PHEX as an annual agenda remain an interest to many educators at tertiary level in the future.

Putting together the expo is a team effort. I am very grateful to the program committee who worked very hard in making this I-PHEX a success. Finally, I would like to thank UTM as the hosting university, and the organizations involved, which are MAGNETIC, the International Federation of Engineering Education Societies (IFEES), and the Society of Engineering Education Malaysia (SEEM) for their support.

Prof. Dr. Mohd Majid bin Konting
Director
Higher Education Leadership Academy (AKEPT)

Foreword by I-PHEX 2015 Chair

Ladies and Gentlemen,

Assalamua'laikum and greetings! Welcome to the International Innovative Practices in Higher Education Expo 2015 (I-PHEX 2015). I-PHEX 2015 is jointly organised by Higher Education Leadership Academy (AKEPT), Malaysian Council of Heads of Public Higher Education Institutions Centre of Teaching and Learning (MAGNETIC), the International Federation of Engineering Education Societies (IFEES), the Society of Engineering Education (SEEM), and Universiti Teknologi Malaysia (UTM).

I-PHEX is an annual platform to showcase innovative practices that can be shared and emulated among academics in higher education worldwide. The exhibition serves to recognize and award efforts to improve higher education. This is also part of our effort to develop and support change agents in higher education. It is our hope that this effort will lead to better quality and standards for higher education not only in Malaysia, but also throughout the world.

The committee received more than 70 abstracts, which were screened for appropriateness. Out of these entries, we have approximately 53 entries exhibited today, coming from all over Malaysia, and also from USA, Singapore, Korea, India and Japan. We hope that all participants and visitors can learn and take away ideas for implementation in your courses or programs.

Do enjoy the exhibition. We hope to see you again next year!

Associate Professor Dr. Khairiyah Mohd. Yusof
Centre for Engineering Education,
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1. INTERNALIZING ENGINEERING DESIGN FOR 1ST YEAR ELECTRICAL & ELECTRONIC ENGINEERING GRADUATES VIA MINI-PROJECT ACTIVITY

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Introduction

In this era, science and technology has developed numerous tools and product in improving ever complex lifestyle. Key outcome that demands creativity and innovation are the products of engineers who can design and think using complex representation. This is the base of the design process for engineering education that propose graduates to be equipped with transferable engineering skills, adapting professional thinking, practical skills and conceptual understanding. This calls for institute of Higher Learning (IHL) to adopt systematic approach in both acquiring transparent skill and fundamental knowledge in developing marketable and highly innovative graduates.

The World Bank (2007) specified that one of the main concerns in building a world-class higher education in Malaysia is the imbalance of technical and generic skills, soft skill acquisition, theory and practice, and human capital development. In addition, the report also mentioned that the challenge in mapping desired skills to graduates can be attributed to quality of education in IHL, teaching and learning pedagogy, curriculum and instructional method deployed that is relevant to the learning process. In fact, current practice in IHL and its direction hampers improvement in teaching and learning, which in turn affects student's outcome. In recently launched Malaysia Education Blueprint 2015-2025 (Higher Education) executive summary by Ministry of Education Malaysia (2015) states that *Innovation Ecosystem* as one enabler to support both university-driven and demand-driven research, development, and commercialization model, with IHL intensify their role as a solution provider to all stakeholders.

In realizing high income nation in 2020, highly skilled human capital is an important factor. However, Mohammad (2012) have found significant mismatch between graduates actual capability and employers' expectation particularly in creative and alternative thinking, inter- and intrapersonal, communication and problem solving. To realize the vision, IHL needs to create an environment that gives opportunity to student in partaking *real* project based learning approach with multifaceted activities that not only improves desired transferable skill and knowledge, but also mimics actual working environment usually less structured and complex. Musta'amal *et al.* (2013) have suggested that acculturation of inventiveness should come in parallel with conducive environment for inspiration and cultural change to occur.

The framework of this mini-project is based comprehensively on Activity Theory (AT) by Les Vygotsky (1978). The basic principles underlined in AT conceptualize object-orientedness, dual concept of internalization/externalization, tool mediation, hierarchical structure of activity, and continuous development (Bannon, 1990). Additionally, Zhang (2013) explains that AT offers multifaceted activity consisting of components within an activity system that are dynamically interrelated with continuous interaction. The components are: Tools/instruments, Subject, Object, Rules, Community and Division of Labor. The interactions between these components have a goal in building human capacity and the environment (Engeström, 1996).

This framework is implemented inside a mini-project activity and uses Engineering Design Process as the process tool. Engineering Design (ED), as elaborated by ABET(n.d) is an iterative process in devising/creating a system, process or component, to meet certain objectives in which science, engineering and mathematics are applied. The design process has fundamental elements including objective and criteria, synthesis, analysis, construction, testing and evaluation. In any design, particularly in engineering, collaborative design activity undergo different degree of difficulty that requires students to experience different stages: *Adaptive design, Development design and New design* (Haik, Y, Shahin, T, 2011). This research presents a systematic approach in engineering design that implements engineering design process, as a tool to cultivate good practice, transferable skill, creativity and innovation. This process implements methodical approach through step-by-step progression in product design that places emphasis on creative and innovative approaches in real practical problem solving.

This process was first initiated in 2013 during Teaching Workshop on Implementation of Student Centered Learning (TWISS), 2013. Then it was formally incorporated inside EEE125 Basic Laboratory course in 2014 specifically in mini-project session (part 3). Part 3 is implemented between weeks 9 to 14. In this session, students worked collaboratively in a mini-project activity, with a consumer themed project-based learning. The theme for both years so far centered at practical real design situation in consumer and agricultural sector. In 2014, 168 students participated in the design activity, and in 2015, 86 students have participated. All students were 1st year electrical and electronic students majoring in electronic, mechatronic and power engineering. There are 4 facilitators and 2 assistant facilitators were involved in supervision.

This study seeks to answer the following question:

1) Do students demonstrate any meaningful advancement in knowledge, skill or awareness in their learning approach after experience engineering design process?

This research elaborates improved instructional strategy that centers design and development into the learning curriculum. Within 5 weeks, students were involved in all 8 stages of engineering design process framework (Massachusetts Department of Education, 2006): *Problem Identification, Research Problem, Develop Possible Solution, Select Best Possible Solution, Construction of Prototype, Test and Evaluate the Solution, Communicate the Solution, and Redesign*. Students worked collaboratively in groups of three or four with some having mix gender, academic performance and background. It is imperative that each member of the team was responsible to perform specific major tasks, identified and distributed in the Problem Identification stage. Each stage requires certain outcome and these outcomes was scrutinized and commented by facilitators in charge for any particular groups. The feedback administered to each group provides valuable insight and chance to improve on certain aspect in the design process. Other than constant supervision and intervention by facilitators, online resources designed on blendspace.com, provides all necessary reference to students. Here, students can upload important information, watch educational videos and search for inspiration from various media shows that talks about the practical application on current mini-project theme.

Based on experience from 2013, additional changes were made to accommodate various plus and minuses in administrating the process. These changes were part of the Continuous Quality Improvements effort that looks at various disadvantages, downside and challenges in providing the right atmosphere for creativity and innovation to happen. A lesson learned in 2013 was students will be easily influence on design approach and schematics available online. Thus suppressing internal creativity, conceptual understanding, cognitive process and meaningful insights. The solution was to adopt AT as the framework with all relevant components planned to mediate students learning process, and be responsible for their own learning.

Qualitative study on internalization of engineering process was assessed through reflection essay. The assessment explored and tracked changes in abilities, awareness and process. Students were provided a guide to facilitate their reflection writing process. Generally, students were required to elaborate on their given individual tasks, elaborate on the challenges and solutions to their technical problem, and how this experience have helped in internalizing new approach or thinking towards future technical problem.

From the study, four themes have emerged. Firstly, students have learned the value of team working and mentioned that biggest challenge was time factor to complete their individual tasks amidst all other learning activities from other courses. Students have shown appreciation of their team members for providing alternative approaches to their problem solving and assistance. Secondly, students also showed their appreciation in understanding basic electronics and mechanical as a prerequisite for mini-project activity experienced in part 1 and 2. Thirdly, students shared their experience during circuit development and experimentation, and elaborate on consequence due to their choice of circuitry. They also have demonstrated techniques to overcome their problems using concepts previously learned, that includes from other courses in science and mechanical engineering, or from facilitators. Fourthly, there was also evidence that the social-cultural aspect in managing their learning process. Communication between peers and instructors were factors that influence the success of their project. Fifthly, students also concluded that attitudinal factors and competency engineering skill attributes to the success in their project. For them, a successful project is to fulfill all requirements in a functional project, and also embodiment of transferable skill e.g. time management, troubleshooting, decision making and leadership, are crucial. Some students have demonstrated iterative process after discovering their initial plan is impractical or unsustainable.

In conclusion, engineering design process implements a stage-by-stage approach from the idea conception, to prototyping. It is an iterative process that is continuous in improving a product. It is a method that requires collaborative approach and demands numerous transferable and practical skills, and knowledge to design and create an innovative product. From this study, students have demonstrated some understanding of circuit development and integration with other discipline, and transferable skills that is crucial for engineering field. Moreover, students have understood the need to adhere to good practice in the whole engineering process. Opportunity to acclimatize to this requirement is essential for students at the beginner stage to experience professional engineer problem solving environment. It is hoped that the experience learn in this stage will pave a better way for future creative and innovative ideas in engineering design.

Acknowledgement

Part of this work has been presented at IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE2014) entitled : Assessment of Level of Difficulty in Engineering Design Process for 1st year Undergraduate, in Wellington, New Zealand.

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2. HANDS-ON LEARNING PRACTICES FOR THE SHIP BRIDGE SIMULATOR

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Introduction

The Faculty of Science and Defence Technology (FSTP) at the National Defense University of Malaysia (NDUM) consists of two departments, namely the Department of Computer Science (JSK) and the Department of Science and Maritime Technology (JSTM). JSTM offers an exclusive bachelor degree program which is Bachelor of Maritime Technology that focuses on science and maritime technology. This program aims at providing technical, vocational education and training (TVET) to students and focuses on adding knowledge on theories related to maritime technology. All these knowledge, training, skills and theories simultaneously increase the learners' abilities and aptitude to handle related equipment as well as to produce more research focusing on national defense and security cluster. This program was first offered in 2006 for the naval cadets who are later commissioned into the service of the Royal Malaysian Navy (RMN). To date, this program has successfully produced a total of 298 graduates with 95% of them immediately employed particularly in the RMN after successfully completing their bachelor program.

Currently, JSTM is utilising a full mission Ship Bridge Simulator provided by Kongsberg Maritime, Norway. The simulator fulfils the compulsory requirements based on the Standard of Training, Certification and Watchkeeping (STCW) Convention, Regulation I/12 and DNV standards for maritime training. It complies with the class-A standard for certification of maritime simulators. This complex simulator covers considerably intense navigation training (especially during the emergency situation) and is ready to be used as a real ship (this service is often unavailable on other simulators). The associated software in this ship simulator can duplicate various kinds of ships movements and manoeuvers in different weather or sea state conditions. It is connected to an electronic engine room simulator to create a realistic ship environment as if the students were on a real ship whilst completing the entire operating watch. Furthermore, it offers a complete set of real instruments for merchant marine and navy application, advanced student assessment system and modelling tools for ship and area of exercise.

The full mission Ship Bridge Simulator consists of 24 students own ship and instructor station up to a maximum of 8 stations. The student own ship includes bridge instrumentation, Radar/ARPA, GMDSS, ECDIS and a visual system. Whereas the instructor stations includes closed circuit television (CCTV), configured instructor desktops used to control same or separate exercise, debriefing facilities such as colour printers, large screen projectors, voice recording, etc. At the moment, amongst all the higher education institutions in Malaysia, NDUM is the first and only university that provides training on maritime warfare. This training is conducted using the simulator with guidance, support and assistance from the subject matter experts in the university. This exercise includes basic tactical warfare, surface/air/EW reporting and surface attack group (SAG). Besides that, NDUM also supports typical ship training applications such as passage planning, conducting navigation, determining ship position and calculating the accuracy of ship position.Moreover, other trainings namely respond to emergencies such as Man-over-Board (MOB), respond to a distress signal at sea, and co-ordinate search and rescue operations are available at the university.The above trainings are designed based on the cumulative curriculum taught in various courses in the programme such as Seamanship and Ship Technology, Nautical Law, Maritime Communications, Navigation Science I and II, Astronomical Navigation, Maritime Law and Enforcement and Maritime Warfare Technology I and II. The learning outcomes from these courses can be assessed during the simulation training to ensure that students understood the theories explained in lectures.

NDUM as a boutique university with the niche area of defense and security, faces a major hurdle in providing actual training for students before they are placed on real ships due to lack of asset, high risk factor regarding safety and cost factor. Due to this constraint, NDUM managed to provide full bridge simulation for training purposes, plus, to allow learners to acquire experience, knowledge, understanding, attitude and skills before they undergo the six months internship training onboard RMN ships in Semester 5. The utilisation of the bridge simulator and method of training in conducting simulation training are vital in providing them with knowledge, understanding, teamwork, attitude and competencies.

Theoretical Foundation

Kolb's Experiential Learning Theory (ELT Kolb 1984) is a relevant theory used to guide this study. ELT is known as a useful framework in designing and implementing management education programs in higher education as well as management training and development. ELT defines learning as "the process whereby knowledge is created through the transformation of experience". ELT also consists of four stages learning cycle which are concrete experience, reflective observation, abstract conceptualization, active experimentation and involves planning, doing, thinking and analysing. Based on this theory, JSTM emphasises on the process of teaching and learning practices using full mission Ship Bridge Simulator as a continuous process grounded in experiences. This can be done in three phases; briefing, simulation execution and debrief or feedback session.

Teaching Innovation

The students who enter the simulator room have been equipped with the theories behind the exercise. However, to ensure that they are comfortable and to increase their confidence level, it is compulsory for them to attend a briefing session. The briefing session is one of the compulsory procedures that the students go through before beginning their hands-on training using the simulators. Students are divided into small groups between 4 to 10 members (crews) in each group. In every group, each student is assigned with a specific role/position which are the Navigation Officer, Port Lookout, Starboard Lookout, Radar Operator, Chart Plotter, Radio Operator, Helmsman and 'Officer on Watch'. To ensure that students are able to handle all tasks assigned on the ship bridge, they have to run the training on a rotation basis. Hence, everyone will experience all positions. Since all groups are required to be involved in the briefing session, all of them are supposed to have a clear overall view on simulation training, conduct research and make necessary preparation for the exercise on a rotation basis. Information such as entering or leaving the harbour, normal cruising, sea state, wind speed and direction, current, ship speed, next ship destination, traffic, compass error and other relevant data are informed accordingly during the briefing session.

After the briefing session, the first group enters the simulation room to practice their knowledge and skills by accomplishing all the tasks for ship navigation a rotational basis. While the first group is navigating the simulator, their performance are observed by other groups of students. An added feature of the simulator is video recording and voice and ship handling data recording throughout the training session which is used as a tool for improvement. Thus, all actions are monitored, recorded, and evaluated by the Ship bridge simulator system or lecturer.

Debrief or feedback session is a significant session throughout the training. It serves as a platform for exchanging and enhancing learning experience which involves the lecturer as the facilitator and students in evaluating their simulation experience. This session is conducted at the end of each simulation session where all the students who participated as crew members discuss and justify their actions and responsibilities. This assists in ensuring the students achieve maximum input of skills and knowledge while being trained using the simulator. Meanwhile, the other groups of students who observe them learn from the evaluation session so they can perform better when it is their turn to use the simulator. It is expected that subsequent groups not to repeat the same mistake as previous groups.

Impact

From the debrief session, it was found that the students are more confident in applying the knowledge gained from the simulations experiences to analyse and evaluate critically, work in a team, gain skills, leadership and communication. It is observed that students can remember better with simulation compared to the traditional lecture approach. The simulation based training help to increase students' interest to participate during the training compared to those in conventional training.The ultimate outcome of the simulator training is to assist students to obtain the certificate of competency (COC) as required by the stakeholders, RMN when undergoing industrial training onboard RMN warship. The certificates are Certificate of Passage Planning, Astronomy Navigation Part I & II, Engine Room Certificate, and Bridge Watch keeping Certificate which enabled the students to be commissioned as Executive Officer in RMN. 99% of students succeeded in obtaining the four certificates after experiencing the Ship Bridge Simulator training. To conclude, it is believed that ELT can be implemented in other organisation as one of the essential tool for effective teaching and learning and can be applied on simulator based training in other areas as well.

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3. INTRODUCING THE "NINGEN-RYOKU" CONCEPT: THE JAPANESE WAY IN HUMAN SKILLS DEVELOPMENT AT UNIVERSITI TEKNOLOGI MALAYSIA

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Introduction

The development of human skills for modern day engineering students, such as good communication and presentation abilities, technical report writing, teamwork, leadership, discipline and respect are key areas in which universities are placing increasing importance on in their academic programmes. Referred to by a variety of different names and terms, including 'soft skills', 'generic skills' and 'non-core subjects',these skills are important for students throughout their undergraduate and postgraduate studies and into the world of work after graduation.

At Malaysia-Japan International Institute of Technology (MJIIT), considerable emphasis is placed on developing a number of soft skills – referred to as 'Ningen-Ryoku' or ('Human Skill' from the literal Japanese translation)– throughout the four year engineering programme. Drawing on the experience of Japanese Professors working full-time at MJIIT as well as Malaysian and international staff who have worked in Japanese institutions, Ningen-Ryoku courses are regarded as the means to develop engineers with strong inter-personal skills, necessary for the dynamic pace of modern industry, whilst also inculating key non-engineering knowledge in keys areas to support the development of well round and balanced individuals. Furthermore, emphasis is placed on developing students with renowned Japanese characteristics such as a strong work ethic, dedication and attention to detail.It is, thus, the aim of MJIIT to produce students of high competency in core engineering subjects with excellent human skills that will benefit Malaysia's ambitions of a sustainable and advanced society by 2020.

Teaching Innovation

Within the four year engineering programmes of Mechanical Precision Engineering (MPE), Electrical Systems Engineering (ESE) and Chemical Process Engineering (CPE) offered at MJIIT, there are four 'Ningen-Ryoku' courses: i) *Energy & Environmental Sustainability*; ii) *Professional Ethics, Safety and Health*; iii) *Management of Technology*; iv) *Entrepreneurship*. Each course follows a dual 'knowledge-skills' approach whereby key non-engineering knowledge is covered alongside specific human skill development. Recognizing that undergraduate engineering programmes are heavy on technical topics, the knowledge topics in 'Ningen-Ryoku' have been specifically chosen to educate the students on aspects important for human and societal development. This includes a focus on sustainable development, challenges faced by climate change and diminishing global natural resources (Ningen-Ryoku 1), the need for health and safety in engineering operations and the ethics dilemmas faced by engineers (Ningen-Ryoku 2), the skills to manage new and existing products and designs (Ningen-Ryoku 3), and the knowledge required to harness and develop an innovative spirit in engineering scenarios (Ningen-Ryoku 4).

The skills aspect of the Ningen-Ryoku courses focus specifically on: communication skills, technical report writing, leadership, teamwork, discipline and work ethic. These skills are introduced at a basic level in the first year followed by more advanced levels throughout the four year programme.The dual 'knowledge-skills' approach is thus a useful way to develop knowledge in non-engineering topics whilst simultaneously inculcating key human skills.

The Ningen-Ryoku courses also emphasize interactions with external stakeholders, such as industry experts, government and non-governmental representatives, and international academics. Guest speakers included a senior civil servant from the Malaysian Ministry of Green Technology, Energy and Water, a researcher from the National Institute for Environmental Studies (Japan), non-governmental representatives and a senior professor from Newcastle University (UK). The guest speaker sessions provide an opportunity for engagement with professionals outside of MJIIT facilitated by questions and answer sessions following the presentations.

Impact

The 'Ningen-Ryoku' framework developed in MJIIT has tangible impacts for the innovation of Malaysia's Higher Education. The gradual development and inculcation of human skills, and the exposure with professionals and the real life problems is anticipated to make them more extrovert, confident and resilient with outstanding characters and to have excellent academic performance, recognitions and achievements. In particular, the inculcation of an entrepreneurial spirit, tangible project management skills and development of ethics and environmental knowledge places such students in a strong position to move into postgraduate studies or take up attractive graduate employment positions. This framework reflects well on Malaysia's Higher Education sector as a whole – indeed, the sector can thus be seen to developing students with a necessary balance of core knowledge and softer skills. Considering Malaysia's position as a role model for countries in the ASEAN region, the Ningen-Ryoku framework can become a major selling point for overseas students who wish to develop critical core knowledge as well as important softer skills. Rolling out such a framework to all engineering universities in the country would help support Malaysia's ambition of becoming a Global Higher Education Hub.

4. LAKSANA MODULE: THE PSYCHOMOTOR AND AFFECTIVE LEARNING IN NAVIGATION SCIENCE USING SIMULATION TECHNOLOGY

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Introduction

Institute of Higher Learning (IHL) are responsible to produce holistic graduates for the requirements of the nation building. Graduates must have various forms of generic skills or soft skills apart from acquiring the knowledge on the subject matter. The teaching and learning methodology must incorporate a high level of taxonomy on cognitive, psychomotor and affective domains.

Basically there are three levels of capacity to be developed by IHL. The first level is the development of basic infrastructure such as classrooms, seminar rooms, a co-curriculum centre and a resource centre. IHL must have enough lecturers, tutors and laboratory assistants. The second level consist of laboratory that provides the plotting instruments, nautical charts and nautical publications. It shall also have the computer-based training software for navigation, seamanship and maritime communications training. For the third level, the IHL must have a Ship Navigation Simulator equipped with a radar, compass, global positioning system, echo sounder, speed log, electronic chart, engine and steering control system. Students needs to undergo training using the Ship Navigation Simulator before they are sent onboard ship for the industrial training.

Students have difficulty in learning a subject matter through teaching in class or laboratory work only. They are unable to visualize the working conditions onboard a ship because examples obtained from books and lesson in the classroom could not create the experiences needed by the students. A simulator technology is required so that the students can adopt and adapt the real situations onboard the ship.Therefore, an integrated approach needs to be developed to ensure the psychomotor and affective domains are able to be implemented effectively. The lecturers are not only able to deliver the subject's matter but can also link them with values that will benefit the students. Interaction with students should be encouraged to enhance the understanding of the teaching in the classroom. The requirement of generic skills or soft skills must be included in the teaching and learning in order to produce the holistic graduates for the maritime agencies and industries.Various teaching and learning methods can be implemented to improve the cognitive, psychomotor and affective domains for Navigation Science such as case study, problem-based learning, computer-based training, industrial training, practical training and learning through simulation. The methods should include individual and collective training and must comply with the curriculum and syllabus of the academic programme. The methods used must be creative, reflective and interactive to attract the interest of the students as well as be able to achieve the highest level of cognitive, psychomotor and affective domains.

A simulator is one of the essential tool that is found to be effective for the teaching and learning in Navigation Science. The simulator will allow students to practice psychomotor and affective domains in performing jobs onboard a ship. A good simulator should be able to create a realistic environment for learning of navigation science, ship handling and maritime communications. The navigation simulator is designed to create an interactive mock-up bridge of a ship. It has a display for the students to see the view at sea through the bridge window of a ship. All the equipment fitted at the simulator are similar to the equipment onboard a vessel. Students will be exposed to the learning in the simulator before they undergo internship training onboard the ships. In December 2014, National Defence University of Malaysia has installed a full mission Ship Bridge Simulator at the Maritime Development and Training Centre. Among the equipments that are fitted in this simulator are wheel, engine throttles, electronic chart, navigation radar, global positioning system, echo sounder, ship data panel, gyro compass, plotting table, radio communications and bridge compartment for the trainees. All monitoring panels are fitted in the console for the student usage.

The psychomotor and affective training using simulator is very reflective and interactive and a learning module has been develop in Navigation Science. The level of training is flexible to meet the requirement of learning outcomes. The lecturers use their experience and creativity to conduct the psychomotor and affective training of the students.

The Psychomotor and Affective Learning Module at Ship Navigation Simulator

During the affective learning module, students will interact with one another as a team to navigate the ship to a specific destination. Each group consists of 10 students and are rotated to carry out the responsibilities as in Table 1

No	Responsibility	Position
1.	Navigation Officer	Group Leader
2.	Officer of the Watch	Assistant Group Leader
3.	Helmsman	Member of the team
4.	2 Radar Plotters	Member of the team
5.	Chart work	Member of the team
6.	Engine control	Member of the team
7.	Look out	Member of the team
8.	Radio operator	Member of the team
9.	Tactical communication operator	Member of the team
	Total	10 students

Table 1: The responsibilities of students during training module at the Navigation Simulator

The objective of the module is to provide students with the competency on navigation watch keeping, to enable them to undertake the job as Navigation Officer onboard a ship. The schedule of the learning modules are shown in Table 2.

Psychomotor evaluation and assessment criteria are as follows:

1.	Ability to plot the parallel index of selected courses during radar pilotage and closest point of approach on all contacts.
2.	Ability to con and steer the ship to its anchorage position.
3.	Ability to navigate the ship on a safe track during entering and leaving harbor.
4.	Ability to manoeuvre the ship as ordered during fleet manoeuvering exercise.
5.	Ability to navigate the ships in a formation anchorage.

Table 3: Psychomotor evaluation and assessment criteria

Affective evaluation and assessment criteria are as in Table 4.

1.	Leadership skills to perform the job as Officer of the Watch and Navigation Officer.
2.	Ability to organise a ship navigation team.
3.	Communication skills to broadcast clearly within the ship.
4.	Ability in making correct decisions in accordance with the Standard Operating Procedures of navigation safety.
5.	Ability in critical thinking of appreciating the situation during entering, leaving and anchorage.
6.	Self-confidence by giving orders accurately.
7.	Ability to work as a ship navigation team.
8.	Attain moral courage and pro-activeness.

Table 4: Affective evaluation and assessment criteria

The IHL should review and develop the curriculum of existing programmes to produce graduates that meet the stake-holder requirement for maritime agencies and industries. The learning outcomes in the Navigation Science should be strengthened in the psychomotor and affective domain with emphasis on leadership skills, communication skills, teamwork, problem solving, creativity and critical thinking. A shipping and maritime operation programme should also incorporate the psychomotor and affective learning during the industrial training onboard government and merchant vessels. The recommended period for the industrial training should not be less than 6 months onboard the merchant and government vessels. IHL must provide the industrial training guide book that incorporates all the tasking, a supervisory system, assessment criterias and guides on awarding the certificates of competencies.

Week	Summary of Tasks	Frequency of Practice
1	To prepare a pilotage plan for an anchorage.	Three times
2	To practise the duty of Pilotage Officer for an anchorage off an island.	Five times
3	To prepare a pilotage plan for leaving and entering harbor.	Two times
4	To practise the duty as Pilotage Officer for leaving and entering harbor.	Five times
5	To prepare the visual pilotage plan for leaving and entering harbor.	Twice
6	To practise the visual pilotage for leaving and entering harbor.	Five times
7	To practise the calculation of course to steer and time taken during the tactical manoeuver.	Five times
8	Semester Break.	
9	To practise the calculation of course to steer and time taken during the replenishment at sea.	Five times
10	To practise the calculation of course to steer and time taken during the sector screen.	Five times
11	To practise duty as Navigating Office for leaving and entering harbor at the Ship Navigation Simulator.	Three times
12	To practise duty as Navigating Office for visual anchorage.	Four times
13	To practise duty as Navigating Office for anchorage using radar.	Three times
14 and 15	To undergo competency tests as a Navigation Officer at the Ship Navigation Simulator as follows: a. Preparation of a radar and visual pilotage plan for anchorage, entering and leaving habour. b. Conduct of a radar pilotage for entering andleaving habour. c. Conduct of a radar pilotage anchorage plan. d. Conduct of a visual pilotage for entering and leaving harbor.	 Once Once Once Once

Table 2: Weekly Learning Modules at Ship Navigation Simulator

The government must provide adequate funds to upgrade existing facilities and laboratory equipment for teaching and learning in Navigation Science such as a Ship Navigation Simulators. These facilities are required in the implementation of training modules to produce graduates with high level of psychomotor and affective capabilities.

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5. INTEGRATED DESIGN PROJECT (IDP)

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Introduction

Civil engineering graduates should not be only endowed with the current knowledge of the field but, equally important, skills and oriented values required as an engineer. However, in most universities and higher education institutions, courses for design education that cater towards these issue are lacking in their curriculum. In addition, the development of mini projects by groups of students encountered several difficulties including time management problem, interpersonal problems as students learn to accommodate one another's work and study habits, roles are not distributed among members and lack of planning. The above issues highlight the difference between a group of people put to work together and a team of students learning cooperatively while working together to achieve desired goals. To address these problems, the Faculty of Civil Engineering, Universiti Teknologi Malaysia (UTM) is offering a four year program that incorporates an innovative approach known as the, Integrated Design Project (IDP). This program was introduced and implemented to promote design education for undergraduate students and to reduce the burden on students caused by multiple, short-term projects and to give them the experience of developing a more in-depth long-term project. Oriented values such as communication, teamwork, management by project, quality management and creative thinking are considered and evaluated in the IDP courses, and fostered through active learning methodologies.

IDP is a compulsory course for third and fourth year students in the Faculty of Civil Engineering. This course is conducted simultaneously where IDP 1 and IDP 2 are offered in the third year and IDP 3 in the fourth. The chosen project task comprises of all civil engineering elements including site planning, earthwork design, erosion and sedimentation, costing and estimation, reinforcement concrete design, road design, water supply design, project scheduling, geotechnical design, drainage design and sewerage design. The project is planned to incorporate all the key elements listed above and is undertaken as though best practice methods are fully implemented within the group members. Students need to come out with complete conceptual design and justify how they choose an appropriate design concept in which safety, sustainability and cost effectiveness are among the major considerations. Their findings shall be in the form of written report as well as oral presentations. The delivery of the conceptual design is in the form of a technical report complete with relevant sketches and will also be orally presented by every group member. Grading is based on the conceptual report, oral presentation as well as peer assessment (respective group members).

Teaching Strategies

IDP 1 is devised to encourage students to explore the inception and conceptual planning stage of a civil engineering development project. The subject focuses on site and utility planning of a development project given to students, working in groups. Such exercise may include developing a survey plan for the specific proposed site, developing a general drainage and sewerage plan including evaluation of and connection to existing infrastructure and possible need for sewage lift station. Other exercises includes proposing location and type of soil investigation to be carried out, producing preliminary road and utility cross sections and recommending any improvements to ease traffic congestion. In addition, students may need to develop an environmental mitigation plan including sittings of detention ponds and wetlands, consider alternatives for sustainable design, evaluate the impact of relocating existing utility services and produce a preliminary project design schedule showing milestones and critical path. The scope and brief of the proposed development will be reflective of a real life development project. Students are required to integrate their knowledge of civil engineering disciplines such as (but not limited to) geotechnical engineering, highway and transportation, waste water engineering, and sustainable development considerations into their overall project work.

IDP 2 is designed to expose and familiarize students to conduct a feasibility study and preliminary design of a civil engineering development project that has been developed previously in IDP 1 (conceptual planning stage). The aim of the Feasibility Study phase is to determine the optimum scheme from a technical, economic, environmental, and construction view. A Feasibility Study Report is the minimum expected output of this phase. The Feasibility Report shall encompass all the engineering options and attributes developed in the Planning Stage (IDP 1). Each option shall then be investigated to measure its capability to sufficiently address the project constraints and the optimum scheme determined. The chosen scheme will then be developed to the stage of producing a Detailed Design Brief to be adopted at the final Integrated Design Project phase. Such exercise shall in part maintain the continuity of the IDP project series.

IDP 3 is the final phase of the IDP series tailored to process the Detailed Design Stage of a development project that has previously undergone the (i) Planning Stage Integrated Design Project 1 (IDP 1) and (ii) Feasibility and Preliminary Design stage Integrated Design Project 2 (IDP 2). The subject focuses on the implementation and integration of infrastructure design and building design to produce a comprehensive final technical report including engineering proposals and drawings, specifications and bills of quantities, cost estimates of development projects given to students working in groups. Apart from basic infrastructure design, students are also required to integrate their knowledge of other civil engineering disciplines such as (but not limited to) structural analysis and design including geotechnical (foundation) design, project scheduling techniques and sustainable development considerations into their overall project work. The content on this subject (apart from structural analysis & design, geotechnical engineering, construction management including sustainable issues etc. which has been covered in other core subjects) covers basic infrastructure design such as earthworks design, stormwater drainage design, potable water supply design, sewerage reticulation design and road design.

Impact

IDP best practice models advocate the integration of teamwork, simultaneous engineering, tools and techniques, a front loaded process and project management. The design of the model is relatively straightforward compared with implementation which is significantly more difficult. This IDP course takes the premise that problem-based learning is an effective way of delivering sustainability education. Besides, the implementation of IDP shows that team working dampens the negative effect of task conflict and offers the opportunity to substantially improve students' performance. Studies revealed that short and intense projects provide rich experiences when it comes to tasks conflict and working in groups. The implementation of IDP project will bring great success when a chosen development project is used as a platform for good practice demonstration and learning process. The development of team skills is greatly enhanced through faculty-facilitated work meetings by organizing a mandatory lecture on teaming with in-house experts. Whatever shape it takes, some provision is necessary to familiarize the students with the uncertainties and ambiguities of both team skills and design. At the end of IDP courses, the students will be able to comprehend the importance of proposing a viable and workable development project, reviewing and selecting a feasible technical proposal, the needs and requirements of local/government authorities regarding submission procedures thus appreciate the importance of integration and synthesis of various discipline of civil engineering knowledge. The basic goal of IDP course is to give students the chance to develop a design project in more depth than is usually expected in many courses, allowing them to exercise their skills in applying fundamental principles to a greater degree than is usually possible. This course aims to synergise all the basic engineering knowledge gained previously to solve real civil engineering problems in an integrated and comprehensive manner. To date, IDP has been implemented for three semesters.

6. IMPLEMENTING ENGINEERING DESIGN THINKING AND DESIGN PRACTICE MODULES INTO ENGINEERING CURRICULUM

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Introduction

The 21st Century, marked by technological revolutions, has significantly changed the demand of skills required in workplaces, which in turn triggered many educational intuitions to look into how well they are preparing their graduates to meet those demands [1].

In 2012, as part of the annual course review, Ngee Ann Polytechnic Mechanical Engineering (ME) Division identified curriculum design and development as the area of focus for addressing the changes in the skillsets required by our engineering graduates. The review was conducted on the four ME diploma courses [2], namely:

a. Automation & Mechatronic Systems (AMS)
b. Aerospace Technology (AT)
c. Mechanical Engineering (ME)
d. Marine & Offshore Technology (MOT)

The students enrolled into these four courses are primarily GCE 'O' level or Institute of Technical Education (ITE) graduates. In recent years, there has been a decline in interest among these school leavers into engineering courses. While the more popular courses, such as AT and MOT are still seeing good enrolment figures, the rest of the courses have shown a decline in the number of enrolment. The profile of students in the less popular engineering courses varies greatly in terms of academic strength and interests.

With the shifting of student demographics and declining interest in engineering, amidst the changing economic landscape, the ME Division looked at how well the courses were preparing these students in meeting the skills demanded of the 21st Century workplaces [1] [3] and how appropriate were the pedagogies in developing these skills.

The course review identified the following gaps in the area of design:

- While the four courses have aspects of design in the curriculum, spread across various modules, throughout the three year courses, the scaffolding and stacking of the design curriculum was not strong. The design subjects have weak connections to other modules, and do not put together a complete picture of design to the students.
- There was lack of design thinking process and opportunities for students to encounter and practice design earlier in their courses.
- Students' understanding of basic principles and concepts were weak as they could not see the relevance to the real world applications. Many students resorted to surface learning. Therefore, knowledge and skills retention were short and they failed to relate them to something further or apply them alternatively. When these students reached their final year, they struggled as they were unable to pull together their learning and apply them effectively to solve the real-world problems posed in the final year design projects.

The gaps identified from the course review prompted the curriculum revision of the four ME's courses where design-related modules were realigned for better scaffolding and stacking, and two new design modules, *Engineering Design Thinking (EDT)* and *Design Practice (DP)*were introduced in second year.

This paper describes the learning design for the two design modules introduced and their teaching and learning strategies adopted that was found useful in driving greater engagement and deeper learning amongst the students taking the modules, as well as bridging the gaps in design skills.

EDT and DP Modules Teaching & Learning Strategies

Based on the theory of constructivism learning [4] [5], EDT and DP were introduced with the objectives of developing student's engineering design and design thinking skills. It also aims to address the issue of engaging students deeper in their studies. With these considerations, project-based approach, the pedagogy commonly used in design courses that has shown significant impact on deepening student learning [6] [7] [8], enabling the transfer of knowledge and enhancing students' motivation through keystone design projects was used with the following key features:

- *Complex Real World Design Problem* - Students are divided into work teams and assigned engineering design problems to work on. The problem was crafted such that it requires students to synthesize and apply their engineering foundational and domain specific knowledge and skills to solving the problems (Table 1).
- *Lecturers as Design Critiques and Mentors* - The Lecturer's role is to facilitate the learning process. They serve as design critiques and mentors, guiding and assisting students to seek their own solution to the design problem.
- *Active and experiential learning* - Through the use of paper and pen sketching, mock-ups and prototypes engages "thinking with hands" design thinking methodology. Students become active and independent learners in the process of finding and achieving their project goals.
- *Collaborative Learning* - Students working in teams enable them to learn from one another and develop critical 21st century skills such as of communication, interpersonal and teamwork.
- *Driving Learning through Assessment* - A set of measurable design criterions is given to the students along with the problem. Students are encouraged to set their own goals, e.g. in EDT what load, timing and accuracy the ground vehicle will achieve (Figure 1 shows an example of the design criterion for ME EDT - "Design and

manufacture a remote controlled ground vehicle that is able to move loads to reach a defined destination"), strategize their designs, and hone their knowledge and skills to achieving them. In the process, analyzing alternatives in designs, making decisions and trade-offs when necessary. For example strengthening chassis, hull or fuselage by adding more material to carry more loads will impact the weight and center of gravity [9].

- *Iterative Prototyping* - Students are expected to put their design through an iterative process of prototyping, testing, analyzing, and refining to achieving the design goals. By putting their prototypes to test, immediate feedbacks is obtained of how well or worse off their designs are through their actions. Every failed attempt in achieving the goal becomes an opportunity for students to think about why their design failed, what they have learnt and how they can improve.
- *Learning Spaces* - To nurture the culture of creating and building [10], the traditional workshops were redesigned to create spaces that foster creativity, collaborative learning and experimentation. Machining and fabricating equipment, 3D printers, laser cutting machine, electronics and soldering equipment, etc., are also made more accessible to the students to realise, test and improve their designs.

Course	Problem Statements	Foundational Knowledge	Domain Knowledge
AMS	Design and build a device that is able to carry out an autonomous mission of retrieving an object and dropping it off at designated locations.	• Applied mechanics • Engineering materials • Strength of materials • Electrical technologies and electronics • Fabrication and manufacturing workshop skills	• Arduino microcontroller and interfacing • Computer programming
AT	Design and build a fixed-wing flying craft capable of carrying payload and dropping it at a designated location.		• Aircraft structures design • Aerodynamics and principles governing flight and control
ME	Design and manufacture a remote controlled ground vehicle that is able to move loads to reach a defined destination.		• Engineering system design • Computer-aided design (CAD)
MOT	To design and construct a remotely controlled vessel that is able to move a payload.		• Ship construction and floatation principles • Marine hydrostatics • Marine CAD

Table 1: Engineering design problems specific to course of study

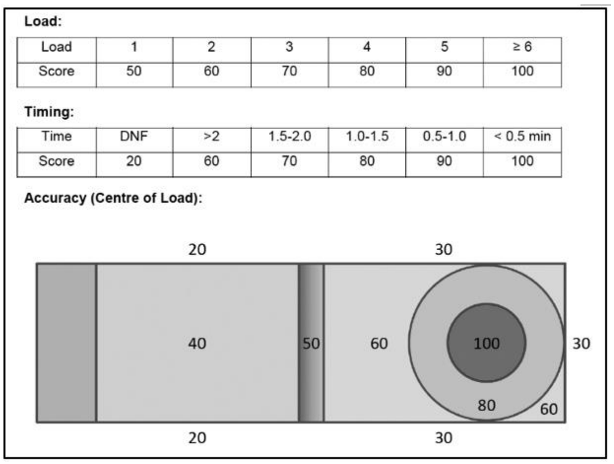


Figure 1: EDT design criterion for ME problem

Engineering Design Thinking (EDT) Module Implementation

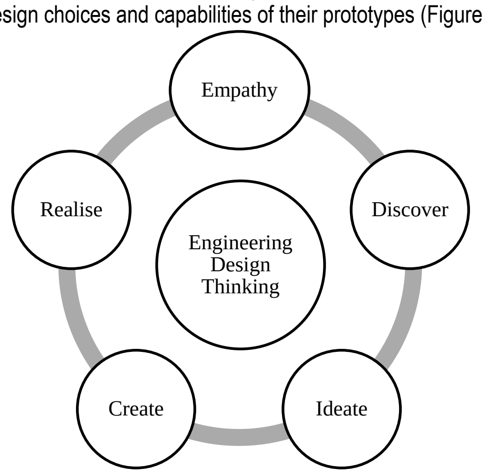
A typical semester of EDT is implemented as follows:

<u>EDT – Semester 1 – Term 1 (6 weeks)</u>

- Introduction to the design problems and students are divided into work teams.
- The five-stages engineering design thinking process (Figure 2) is taught using design toolkits and student guides, while the students work on their course problems (Table 1).
- Constant feedbacks by the teaching staffs and sharing amongst the students are conducted in class during the design and mock-up stages.
- Students pitch their ideas and final conceptual designs with presentations and mock-ups where they will be critiqued for improvements.

<u>EDT – Semester 1 – Term 2 (6 Weeks)</u>

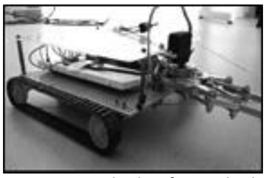
- Students improve and fabricate their final conceptual designs into working prototypes.
- Testing and refinements are required to iteratively improve their prototypes towards the design criterions.
- Students manage their own use of resources, tasks, project milestones and timelines.
- Finally, the students are assessed by the comprehensiveness of their design choices and capabilities of their prototypes (Figure 3).



Stages	Description of Stage
Empathy	To identify the needs of the problem from various sources, e.g. stakeholders perspectives.
Discover	Students find feasible solutions from the needs arisen from the empathy stage to find opportunities for ideas creation.

Ideate	Ideas are formed using the feasible solutions. Selection matrices are applied to choose the most suitable ideas.
Create	Chosen idea(s) are developed into the final concepts, while resources and processes are planned and prepared.
Realize	Mock-ups and prototypes are created to evaluate, test and refine the final products.

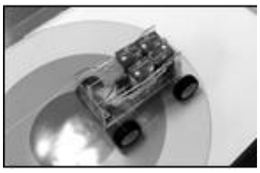
Figure 2: Five-stages of engineering design thinking process [2]



Autonomous device for retrieving and dropping objects (AMS)

Fixed-wing flying craft (AT)

Remotely controlled vessel (MOT)



Remote controlled ground vehicle (ME)

Figure 3: Samples of EDT prototypes

Design Practice (DP) Module Implementation

Upon successful completion of the EDT module, the students proceed to take the Design Practice module in Semester 2. This module builds on the EDT design thinking process and prototypes to solve engineering design problems that are more complex and challenging (Table 2).

Course	Enhanced Problem Statements
AMS	Increased complexity in the mission of the autonomous robot.
AT	Incorporating aircraft maneuvering during flights.
ME	Adding steering and enhancing the remote controlled vehicles to carry more loads and overcome an obstacle course (Figure 4).
MOT	Jumboizing and manoeuvring the lengthened vessels though an obstacle course while carrying heavier loads.

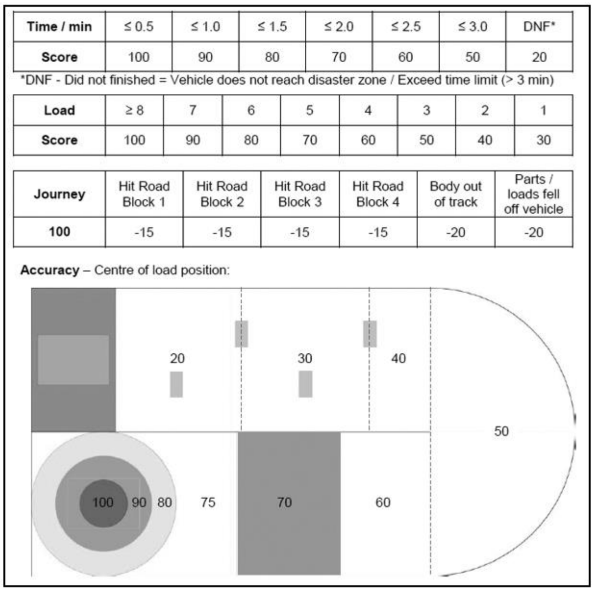
Table 2: Design problems in DP modules

These enhanced problems further stretch the students to strengthen the design and their hands-on skills. They are also to think beyond conventional methods to overcome the design challenges. The DP module ends with a course level competition where the students will compete against their peers from other classes. This further hones their interpersonal skills, teamwork and competitive skills.

A DP module semester will run as follows:

DP – Semester 2 – Term 1 & 2 (12 weeks)

- Introduction to the enhanced design problems.
- Students recap their previous ideas and designs and improve upon them based on the new design problems.
- Fabrication and enhancing their prototypes, followed by testing and refinement in tighter timelines.
- Students are assessed in inter-classes showcases and poster presentations, viva voce examinations and prototype competitions.



Time / min	≤ 0.5	≤ 1.0	≤ 1.5	≤ 2.0	≤ 2.5	≤ 3.0	DNF*
Score	100	90	80	70	60	50	20

*DNF - Did not finished = Vehicle does not reach disaster zone / Exceed time limit (> 3 min)

Load	≥ 8	7	6	5	4	3	2	1
Score	100	90	80	70	60	50	40	30

Journey	Hit Road Block 1	Hit Road Block 2	Hit Road Block 3	Hit Road Block 4	Body out of track	Parts / loads fell off vehicle
100	-15	-15	-15	-15	-20	-20

Figure 4: Enhanced ME problem assessment rubrics

Impact on Students Learning

At the end of the semesters, Module Experience Surveys (MES) were conducted to gather feedback from the students on the modules. The MES results for Academic Year 2013/14 and Academic Year 2014/15 showed that the overall learning experience of the students was positive for EDT (Table 3) and DP (Table 4) modules.

Acad Yr / Sem	Q1 S&K	Q2 Thinking	Q3 T&L	Q4 Feedback	Q5 Materials	Q6 Activities	Q7 Overall
14/15 S1	4.62	4.68	4.48	4.48	4.20	4.52	4.62
13/14 S1	4.32	4.53	4.29	4.29	4.06	4.26	4.39

Table 3: Module Experience Survey EDT AY2014 vs AY2013[1]

Acad Yr /Sem	Q1 S&K	Q2 Thinking	Q3 T&L	Q4 Feedback	Q5 Materials	Q6 Activities	Q7 Overall
14/15 S2	4.80	4.90	4.49	4.43	4.37	4.67	4.63
13/14 S2	4.43	4.60	4.34	4.39	4.15	4.49	4.49

Table 4: Module Experience Survey DP (ME) AY2014 vs AY2013

The following were comments provided by students for EDT AY2014 Semester 1 MES, indicating that students were engaged and learning has occurred in terms of skills development as well as a better

[1]*Mean Rating: 1-Strongly Disagree, 6-Strongly Agree*
Q1 S&K - The module helped me to develop useful skills and knowledge
Q2 Thinking - This module stretches my thinking
Q3 T&L - The teaching and learning approaches are appropriate for this module/project
Q4 Feedback - I received useful feedback in a group/individually on my progress in this module
Q5 Materials - The module materials helped me understand the content of the module.
Q6 Activities - The module activities enhanced my overall learning
Q7 Overall - Overall, this module provided a good learning experience

appreciation of the knowledge and skills learnt in other engineering modules:

- *"(AMS) I like that it is a freestyle kind of working with my team to build this model. I also enjoy building it!"*
- *"(AMS) I like that we are actually building our ideas. It is really awesome that we are putting all of the things we learned into practice."*
- *"(AT) The building of the glider was the highlight of this module, we have the freedom to think out of the box for the design of the glider. It was very interesting as a student to apply what we have a learned in the past to build the glider."*
- *"(AT) Making a plane is always fun."*
- *"(ME) It teaches me how does a remote controlled car work and what the requirements for it to work are. And most of all, it allows to work with car."*
- *"(ME) We get to create structures for the first lesson which enhanced our thinking ability and through the weeks of presentation, our communication skills increased!"*
- *"(MOT) I enjoy the process of building a ship. The hands on approach is fantastic as it is not boring. The greatest form of success for this module comes when my team's ship floats and is able to carry out tasks assigned by the lecturer."*
- *"(MOT) I am being exposed to a new program which are useful to build a ship model and were given more than enough time to complete the model ship. Staffs in the workshop are also really helpful because some of us are not familiar with the tools available in the workshop."*

Conclusion

The revision to the curriculum towards being more design-centric enables ME division to better prepare their students for the 21st century workplace [11] through the new EDT and DP modules. With different pedagogical approaches to teaching and learning, the feedbacks from the lecturers and students are positive. There are still many learning points and room for review and improvements. The EDT and DP module team will continue to review and improve the modules offering to stay relevant, such as:

- In April 2014, Empathy of the EDT process was introduced to the students via persona role playing of the less convenient people of our societies. The students were put though real-world scenarios of different personas, e.g. wheel-chair bounded, using under-arm crutches, partially blinded or parents with baby prams through daily activities like grocery shopping to empathize their commonly faced problems. They were later led through a week-long design workshop to create engineering concepts to solve some of the issues faced.
- In October 2014, the DP modules' course level competitions were conducted during a week-long Creativity and Innovation (C&I) Week. The students have to undergo panel presentations and compete against their course-mates. Students get to mingle around exhibits of various designs and posters.
- In April 2015, the EDT incorporated community service via beach cleaning by students along coastal shorelines. Through research and activities, students experience and understand the problems of pollution. They then address the issues with innovative engineering designs through a week-long design workshop.
- Design Studios and a Design Resource Centre are currently undergoing construction and will be ready to support the EDT and DP modules from Q4 2015 onwards. The Design Studios will feature configurable furniture and gallery spaces to enhance teaching and group activities in creativity and sharing. The Design Resource Centre will feature engineering solutions, components, ideas and materials students can reference for their own designs.
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7. THE DESIGN CENTRIC PROGRAMME AT THE NATIONAL UNIVERSITY OF SINGAPORE

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Introduction

The Design Centric Programme (DCP) was initiated and implemented at the Faculty of Engineering, National University of Singapore in 2009. It has since graduated 2 cohorts of engineering students from various disciplines. The DCP is a multi-year multi-disciplinary programme in which students from different Engineering disciplines come together to work on real world projects.

The DCP was an attempt to address a critical gap in engineering education, that being the lack of authentic engineering experiences in the engineering programmes to enable graduates to meet the expectations of industry. While industry still values mathematics and science, their relative importance may have diminished in recent years as the world demands more sophisticated engineers with good communication skills, persistence, problem solving, intellectual curiosity, drive and motivation, economics and business acumen, effective teamwork, critical thinking and willingness to take calculated risks. In short, industry now seeks a T-shaped engineering graduate who brings broad knowledge across domains and the ability to collaborate within a diverse workforce as well as deep expertise within a single domain.

Strategies

The DCP addresses some of the shortcomings of many existing traditional engineering programmes using the following strategies:

(a) Teaching students new skills to engage with stakeholders Students in the DCP are taught Design Thinking (DT) skills. The DT process involves the 4 stages of empathize, define, ideate, prototype and test. DT is a human centred process which is highly relevant since Engineering and problem solving typically touches humans and the society we live in. We start by teaching students how to engage with people they are designing for. The objective of this stage is to help them uncover needs which they may or may not be aware of. The next stage is where students define and develop a deep understanding of the users and based on this understanding, come up with actionable problem statements. The ideation stage aims to generate radical design alternatives which can be prototyped and eventually tested. Students practise the DT stages in projects such as "Designing for the Disabled" and they engage with the various stakeholders to understand problems and to uncover needs.

(b) Providing them with opportunities to learn in a multi-disciplinary environment DCP project teams consist of students from various disciplines including non-engineering. In the last academic year, we have seen students from business, psychology, social science and geography joining us in our projects. These students bring different perspectives to Engineering, particularly knowledge and skills which are complementary.

(c) Broadening their perspectives and experience

DCP students are exposed to a variety of activities and project experiences. These include:

- Boot camps to teach students how to use machine tools such as 3D printers, laser cutters and Arduinos.
- Case studies in engineering where founders are invited to share first-hand experiences with students about innovations and entrepreneurship, social innovation projects, and design of complex engineering systems such as the satellites. Students are encouraged to consider their own projects in the broader contexts similar to those shared in the case studies.
- Projects in the DCP are not restricted to only Engineering. Students are encouraged to participate in social innovations. For example, students are working with an NGO to study the problems faced by slum dwellers in Cambodia. Students visited the slums to interview dwellers to understand their ways of living, livelihood, aspirations and problems faced. The objective is eventually to bring in both social and engineering solutions to help them lead more normal lives. Besides the Cambodia project, students are also working in local communities in Singapore to identify the main problems faced and subsequently, to deliver engineering solutions to alleviate their problems.

(d) Connecting students to domain knowledge experts in the industry

Many projects in DCP are guided by domain knowledge experts in the industry. In particular, many of our engineering-in-medicine projects are work-in-progress with clinicians, physiotherapists, and doctors. They not only provide valuable insights but they also allow access to patients whom our students interact regularly to understand the real problems faced by them when undergoing treatment and rehabilitation. The interactions with all stakeholders involved in the treatment are valuable opportunities for students to understand how to deal with the issues holistically. For our satellite projects, students intern at space systems companies during the vacation to learn the state of the art equipment that are used.

(e) Providing longer runways for students to work on complex engineering projects.

Projects in DCP are conducted over at least 4 semesters. Students often experience cycles of failures and successes through numerous iterations of their design and build activities. This helps students to build deeper insights, gain valuable experience in what works and what does not and from these experiences, gain confidence and beliefs in themselves.

Outcomes

Overall, the DCP is a unique engineering experience for students who are enrolled in this programme. It is a powerful combination of a traditional engineering programme with hands-on experience in real engineering projects conducted by multi-disciplinary teams. A summary of the educational outcomes which are generally not found in traditional engineering programmes are as follows:

- Students with critical thinking skills through the design thinking process. Their abilities to engage stakeholders, identify opportunities and uncover needs from the stakeholders.
- Students gain multi-disciplinary exposure, through working with students from different departments and faculties. This also inculcates sensitivities amongst team members who are from different discipline and cultural backgrounds. They also interact with relevant domain knowledge experts from industries and hence are able to learn from the experience of the experts. Overall, it is a richer exposure which takes them out of the classrooms.
- Students gain project management skills as their projects are conducted over several semesters. The nature of real engineering projects gives students the opportunity to exercise project management skills beyond just time management. The complexities of the project requires proper planning in the execution. Team members have to be assigned appropriate roles and design and procurement of components have to be carefully planned. These are experiences which are generally not found in traditional engineering programmes with lab-based projects.
- Students gain a broader mindset through a combination of classroom teaching and exposure in the industry. The four case studies delivered in the classroom introduce students to how a successful entrepreneurship can be achieved, how a complex engineering system such as a satellite is designed and built, how innovations is achieved through a study of the 3M Post-It Notes case study and lastly, how social innovation is taking place in the slum areas in Cambodia. Some students are actively engaging with NGOs to study the problems in the slums in Cambodia and this presents a unique learning ground for students.

Awards and Achievements

Our students have won numerous prizes in local and international competitions. Some of them travel overseas to present their work to international audiences. Anecdotal evidence and student interviews show that the programme has a positive impact on their learning experience. Some have shared their excitement with us when they land internship opportunities based on the design portfolio which they present. Others have shared that their engineering education has been made more meaningful by participating in the DCP, when compared to their non-DCP peers. Many companies are interested in partnering us because our students have been trained to do real engineering work. Many students gain employment even before official graduation. Some examples of the different types of projects are given in the figures on pages 5 and 6.

A select list of competitions won and conferences participated by students is as follows:

1. Development of a Dysphagia Rehabilitation Training Device, 8th Asian-Pacific Conference on Biomechanics, Sep 16-19, 2015, Sapporo, Japan (provision patent filed)

2. Singapore Space Challenge, Oct 1 – 17, 2014, 1st and 2nd prizes in the mini-satellite category
3. World Advance Vehicle Expedition 2014 (WAVE), May 30 – June 8, 2014, Third Place in Electric Two Wheelers
4. 7th Singhealth Allied Health Innovative Practice Award 2014, GEM (Ground-breaking, Effective and Momentous) award, "Innovative Electronic System to Quantify Vestibular-Ocular Reflex Dysfunction and Assist In Gaze Stabilization Re-Training In Patients with Vestibular Dysfunction"
5. Top Prize, Engineering Education Festa 2013 Capstone Design Competition, Busan, Korea, "Supine Gait Rehab Device"
6. 2013 IEEE Global Humanitarian Technologies Conference, San Jose, California, Top 3 papers in 2013 GHTC Student Paper Contest
7. Intel Global Challenge 2013, Best Team of Young Entrepreneurs, "eZMon - Non-invasive wrist watch to monitor vitals signs"
8. 6th IEEE International Conference on Cybernetics and Intelligent Systems (CIS) and the 6th IEEE International Conference on Robotics, Automation and Mechatronics (RAM). Nov 12-15, 2013, Manila, Philippines, "Novel Automatic Posture Detection for In-patient Care Using IMU Sensors"
9. Electric Vehicles and Renewable Energies (EVER) Monaco 2014, Grimaldi Forum, Mar 25 – 27, 2014, Monaco, "Design of Rear Wheel Torque Vectoring for Dual Motor Electric Drive System"
10. Electric Vehicles and Renewable Energies (EVER) Monaco 2014, Grimaldi Forum, Mar 25 – 27, 2014, Monaco, "Performance Simulation and Testing of a Converted Electric Lightweight Sports Car with Differential Drive Concept"
11. Electric Vehicle Symposium 27, Nov 17-20, Barcelona, Spain, "To produce or convert: A case for large scale electric motorcycle conversion in Singapore"
12. Formula SAE® competition, May 13 -16 , Michigan, USA, Prizes won as follows :
    - World champion for Cummins Inc. Applied Technology Award for the innovative wireless telemetry system
    - 1st place for the Business presentation event
    - 2nd place for the Acceleration drag race
    - 3rd place for the FEV Powertrain Development Award, which recognises overall performance for acceleration, fuel economy, cost and the 22 km endurance race
    - 4th place for the Bosch Engineering Design Drawing Award

8. CUSTOMIZING RUBRICS TO FACILITATE STUDENT ASSESSMENT IN INQUIRY-BASED LEARNING: WEB-BASED RUBRICS FOR IBL

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Abstract

Inquiry-based learning (IBL) is practiced in a wide range of disciplines, in both undergraduate and postgraduate coursework programs, in smaller and larger classes, and in universities which are more and less research intensive. In the context of a worldwide paradigm shift towards student-centered outcomes-based approaches, UTM has been developing, practicing and improving various learning, teaching, and assessment strategies to produce powerful learners. Initiatives have been taken to facilitate lecturers in using inquiry-based learning (IBL) methods to promote effective and active learning.In order to ensure that student learning is assessed effectively, it is necessary to develop a reliable assessment tool to go along with IBL practices. The most common assessment and evaluation tools used for collaborative learning such as in IBL are web-based rubrics. Developing meaningful rubrics can be a challenge. A rubric should give clear guidelines to a reviewer on how to evaluate or "grade" a task. The criteria for assessment are clearly defined in gradations from poor to excellent, different reviewers can arrive at similar conclusions when comparing a given presentation to each of the graduated criteria on a rubric. In view of this, the current study developed a set of systematic web-based rubrics for IBL to assess problem-based learning, case-based learning, project-based learning, presentation, peer and self-reviews. Effective assessment rubrics are crucial to monitor and assess students' learning. In order to make assessment of students more authentic and to avoid variances across faculties and lecturers, a set of systematic web-based rubrics and at the same time "fit for all" was designed to assess students' performance constructively and reliably in IBL. The rubrics are comprehensive in its scales, the scoring is easy to manage and is customized to meet the assessment and learning needs of different fields of study. The customized rubrics are based on learning theories and extensive literature search on the best rubrics used by various universities. The online assessment provides an alternative which is easy to use, convenient, embedded sustainability awareness, and minimizes variances which may otherwise affect the reliability of the assessment. Responses received from reviewers and practitioners are encouraging and it is suggested to have more comprehensive and systematically developed on-line rubrics to facilitate assessment among lecturers.

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9. ASSESSING THE SELF-EFFICACY LEVEL OF ENGLISH AS A SECOND LANGUAGE (ESL) STUDENTS IN ORAL COMMUNICATION ABILITY

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Introduction

The importance of oral communication skills in mastering a second language is evident as second and foreign language acquisition involves the ability to use the sound and grammar systems to communicate meanings. Oral communication means communicating orally in a manner which is clear, fluent, and holds the audience attention, both in group and one-to-one situations. In second language learning, one of the biggest difficulties for the learners to improve is the lack of self-confidence in using the target language. They tend to be very reticent when it comes to communicating or expressing their thoughts and ideas in the target language. Oral communication skills are also essential for engineers and technologists who aspire to carry out professional practice in the global arena.

The inability to communicate well in English is one of the causes of unemployment among university graduates. In August 2004, a Malaysian leading newspaper reported the Government's concern about the increasing number of unemployed graduates, many of those who lacked communication skills. JobStreet, a Malaysian employment agency also found that weakness in English as the most prominent factor for graduates' unemployment in Malaysia. Another leading Malaysian newspaper stated that a government survey has revealed that of nearly 60,000 unemployed graduates, many could not obtain jobs largely, due to poor English and communication skills. Perceived self-efficacy, which refers to as a judgment of one's ability to organize and execute given types of performances, plays a significant role in predicting human performance in several areas of human effort. Strong personal efficacy beliefs enhance motivation and performance. Conversely, low efficacy beliefs are characterized by low aspiration and weak commitment to goals. These individuals are more likely to become frustrated when they encounter difficult challenges, and see these challenges as personal threats to be avoided rather than challenges to be mastered.

This assessment tool is useful to language educators because it can give them information on how confident are the students in their oral communication ability in English. Language educators must be cognizant of what factors contribute to the perceived speaking ability of their students and the reasons behind them so that they can be helped should they face any problems in the future. Enhancing students' self-efficacy beliefs may help them achieve more in the English language learning process. By using this assessment tool, the findings will provide the educators with a better way to understand the students, in order to guide them to be better speakers of English. The tool can also be used to assess the self-efficacy level of students learning other second or foreign language, not necessarily English.

Description of the innovation and the underlying principles used as the basis of the innovation

Self-efficacy is explained in the theoretical framework of social cognitive theory by Bandura (1986, 1997). Social-cognitive theory is based on the principle that people are not entirely self-directed, nor do environmental forces primarily control them; rather there is a reciprocal relationship between person, environment and behavior. How a person acts is determined by a combination of interacting factors like previous experiences with similar behaviors which are either vicarious or first hand, environmental conditions and reflective thoughts processes. For this 23-item assessment tool, the respondents indicated their agreement or disagreement to each statement on a 5-point Likert scale that ranged from Strongly Disagree which scored "1", to Strongly Agree which scored "5". The self-efficacy scores are obtained by calculating the mean score for the items in the scale. A principal component analysis with varimax rotation is conducted on the intervariable correlations to identify the underlying factors measured by the variables. Kaiser's criterion for important factors, significance test on factor loading, and the interpretability of the extracted factors are used. Cronbach's alpha formula is applied to estimate the internal consistency of the factor. Three factors extracted from principal component analysis which are ability, attitude and aspiration. Ability measures traits such as ability to participate in discussions conducted fully in English, ability to communicate with lecturers and international students and ability to speak in English with peers. The second factor, aspiration, measures traits related to students' aspiration with respect to speaking in English. The third factor, attitude measures traits like students' attitude towards activities like drama, debate, oral presentation and in-class discussion. An internal consistency was conducted on the three factors using Cronbach's alpha to measure the reliability coefficient that assessed the consistency of the entire scale. Factor 1 with 13 items found to be valid with an alpha level of .91. Factor 2 with 6 items has an alpha level of .79, while factor 3 with 4 items is also valid with Cronbach's alpha of .82. The overall level alpha for all three factors was .91, thus, the scale is highly reliable.

How the effectiveness of the innovation is measured/determined

The effectiveness of the tool is measured through the performance of students in a professional communication skills course. The tool was used at the beginning of the semester to gauge the self-efficacy level of the students. Based on the findings, the lecturer would assist the students through the class activities and instructional strategies, so that they could improve in group discussions and oral presentations which are evaluated for course assessment.

Contribution of the innovation to the current the practice

The tool is used to measure the self-efficacy level of ESL students in communicating in English. By knowing this the teachers are able to know the ability of the students and integrate into their lessons activities and create learning environment that will provide opportunities for the learners to master the skills and become effective oral communicators. In addition, the learners may also be encouraged to learn through observation and be given genuine constructive feedback while at the same time be given sufficient language tools and strategies as scaffolds to motivate them to challenge themselves to climb to the next level and explore the language. The ability to communicate in English is one of the important skills that are sought after by employers during job interviews. This indicates the importance of having high self-efficacy level among university students and graduates. It is also worth noting here that the author has received several emails from postgraduate students from Indonesia and Thailand seeking permission to use this tool for their research since this is one of the few tools in assessing self-efficacy in oral communication ability among ESL students in this region.

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10. USING THE ROSEVALUATION SYSTEM FOR AUTHENTIC ASSESSMENT OF STUDENT ACHIEVEMENT

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Introduction

In the realm of higher education, faculty and administrators are searching for tools that can help them assess and evaluate their students' achievement of defined learning outcomes in fields as diverse as engineering, business, health professions, math, science, and technology (to name a few). In the United States, these assessments and evaluations are part of a national trend toward transparency and accountability regarding the value added in education. Currently a number of sources have emerged that offer information on costs, tuition, and students' self-reports of achievement of learning outcomes, such as the University and College Accountability Network (U-CAN) and the National Survey of Student Engagement. It is interesting, however, that these sources do not provide information if the college or university decides not to share it. In addition, the only data provided on achievement of student learning outcomes comes from self-report surveys.

While the calls for accountability have reached a crescendo during the past several years, they are not new, particularly in the field of engineering education accreditation. Beginning in the 1980s, engineering educators responded to the call from industry for better-prepared students. In addition to asking for students who were well prepared to solve problems and perform engineering design, industry also wanted students who could communicate effectively, work on cross-disciplinary teams, and demonstrate an awareness of global cultures. This multifaceted call was translated into a focus on outcomes-based assessment and codified into the Engineering Criteria, a set of defined student learning outcomes used by the Accreditation Board for Engineering and Technology (ABET), in conjunction with the American Society for Engineering Education (ASEE) and the Institute of Electrical and Electronics Engineers (IEEE) to measure US engineering programs. This radical shift in focus—from course accounting to outcomes assessment—produced another radical shift. Engineering faculty would now need to document student learning beyond simply reporting course grades. They would need to define outcomes and assess student achievement, producing results that could then be used to improve curricula and pedagogy. And these results would ultimately need to convince accreditors of the quality of the engineering programs themselves.

The Rose-Hulman Institute of Technology (www.rose-hulman.edu) responded to accreditation demands early in the 1990s by developing an assessment and evaluation process using online tools for data collection and evaluation. The RosE Portfolio System (REPS) was first used in 1998 to collect students' work products that were then evaluated against a set of established rubrics by teams of faculty evaluators. In 2008, a revised system, the RosEvaluation System (RosEval), designed with the same assessment approach, was used to evaluate students' work products in conjunction with the campus learning-management system. The project continues to be used for institutional and program assessments, and it forms the bedrock of our preparations for program and institutional accreditation requirements. This presentation will provide an overview of RosEval, the online tool developed within the course-management system that provides faculty and administrators with the ability to collect, assess, and report on students' performances against a set of learning outcomes. This presentation will also present information regarding how the data are used in conjunction with other assessment information and explain how these assessment practices have impacted faculty.

Teaching Strategies

The structure of the RosEval is predicated on the Institute Student Learning Outcomes that were developed early in 1997 and then revised in 2006 and again in 2014. These outcomes define what we believe all graduates of Rose-Hulman should be able to do once they enter their professions or graduate schools. The challenge of the outcomes, however, is that they are not measurable; in other words, while we expect each student to demonstrate the skills necessary to work successfully on a team, the broad outcome does not provide measurable behaviors we could observe and then evaluate to determine if the student has met the outcome. For that reason, we developed a set of performance criteria and evaluation rubrics to define the required behaviors and to quantify the levels of performance that we expect. An example of this aspect of the system follows.

Each Rose-Hulman student is expected to demonstrate effective communication skills. Thus, the Institute Student Learning Outcome for Communication states that "Communication—regardless of the media—requires unique skills whether communicating with individuals or with groups." This statement alone, however, is not measurable, meaning that the statement does not describe what the student should actually be able to do or the skills that he or she should possess. To measure this level of behavior, we developed a set of performance criteria (specific statements that explain exactly what the outcome means) and evaluation rubrics (descriptions of what successful performance means) for each criterion. The nature of the performance criteria and rubrics should be noted. First, it would be possible to define "communication" and the expected behaviors in many different ways. For the purposes of our assessment project, we decided to focus on three primary performance areas:

Criterion1--Provide a substantive critique that includes recommendations for improvement.
Criterion 2--Adapt technical information for a non-specialized audience.
Criterion 3--Convey information effectively through visual media.

Student work products that can provide evidence of student learning are not specified; thus, faculty members can determine which of their assignments provides the best evidence of student achievement. Example evidence documents for these communication criteria include but are not limited to the following:

Criterion 1--peer reviews, performance evaluations, team evaluations;
Criterion 2--technical reports, product-design presentations for non-engineers
Criterion 3--PowerPoint presentation slides, charts, tables, and visuals from a technical report.

For each criterion, there is a rubric that describes specifically how the student work product should be evaluated. For example, for criterion 1, the evaluation rubric states that "a passing submission for this criterion must (1) provide helpful/constructive criticism that gives recommendations for improvement and (2) justify recommendations." The design of the rubric is supposed to offer students, faculty evaluators, and instructors making assignments specific descriptions and examples that will help them understand exactly what is expected. The outcomes, performance criteria, and rubrics were developed by a campus-wide committee made up of faculty from all disciplines. They are periodically reviewed and revised.

Results

To determine students' success in achieving the learning outcomes, all student submissions to RosEval are assessed each year by a team of trained faculty raters. The purpose of the rating session is to assess evidence of student learning in the six outcomes. Student work products serve as evidence of student learning in these six outcomes, and the evidence is collected each year through assignments made by faculty in technical and nontechnical departments. For example, some engineering faculty members require that students submit documents from capstone senior design courses as evidence of the teamwork outcome. Humanities and social sciences faculty members require that students submit documents produced in their courses for evidence of the cultural and global awareness outcome. The definition of performance criteria and rubrics, collection of documents, as well as the assessment and evaluation of evidence for technical-learning outcomes is the province of technical departments (although many departments use the same artifact collection and assessment methodology that will be described).

The process of rating submissions to RosEval has followed the same basic methodology since the system was initiated in 1998. Rose-Hulman faculty members (usually up to 14 each year) are hired as portfolio raters. Attempts are made to involve faculty from many different departments to ensure objectivity in rating and broad-based familiarity and participation in the process. Raters work together for two days and are compensated for their work. The rating session coordinator, usually a member of the faculty who has had a long association with the project, facilitates the process and assigns pairs of raters to rate student submissions for a particular outcome. For example, a faculty member from mechanical engineering and a faculty member from chemistry may work as a rating pair to assess the student files submitted for the communication outcome. The rating process consists of four steps.

- First, portfolio raters review the rating rubric associated with the learning outcome. Each year, raters review the rating rubric and the comments of faculty who evaluated the same outcome in previous years. As part of its training, the rating team discusses the rubric while comparing it to student documents that were rated during previous rating sessions. The purpose of this is to ensure calibration between the two faculty raters as well as between the current faculty raters and each previous year's faculty-rater team. Calibration like this helps ensure consistency in ratings from year to year.
- Second, RosEval requires that each rater team rate a set of three shared documents against the established rubric. Raters answer "yes" or "no" for a single rating question: "Does this document meet the standard expected of a student who will graduate from Rose-Hulman?" Student achievement is measured as either "yes/pass" or "no/fail." Raters also have the opportunity to mark the document as "yes/pass/exemplary" to designate student submissions that represent superior achievement for a particular outcome. To ensure consistency in rating between the raters, RosEval uses an interrater reliability (IRR) process. When raters read and evaluate the set of three shared documents, their ratings must agree. If their ratings are not identical, RosEval prohibits them from continuing with the rating process. Raters then discuss their ratings, checking their evaluation against the rating rubric for the outcome; they then come to an agreement on how they will evaluate the shared document set. IRR is a key component of RosEval; it ensures that raters look for the same qualities and features in order to rate documents. This helps the faculty raters to calibrate their ratings against each other and ensure consistency in ratings.
- Third, if the raters agree in their IRR, RosEval then allows them to proceed with a set of 10 documents, with each rater reading and rating a different set of 10 documents. As the faculty members assign ratings to documents, RosEval records their ratings for each document. The system also introduces a shared file for every 10 documents in order to check that the raters have maintained their IRR. Failure to rate the shared document identically will cause the system to stop the raters so that they can recalibrate their evaluation before moving on to another document set. Thus, IRR continues to validate ratings throughout the rating process.
- Fourth, the raters can provide comments about the rating session or about the student submission in the comment boxes. In addition

to the work of rating, faculty raters also record the rubrics they used and collect sample documents to provide next year's raters with material for calibration. They may also suggest changes to rating rubrics or learning outcomes, although revisions must be reviewed and approved by the Commission on the Assessment of Student Outcomes (CASO) before they are implemented into RosEval.

The issues of reliability and validity are important to note here. The methodology we adopted for our project relies on an integrative approach to portfolio scoring. Rather than working independently, portfolio evaluators "work together to construct coherent interpretations, continually challenging and revising initial interpretations" (Moss and Lyons 1998). This approach is most applicable for faculties who are using portfolios for the purpose of examining an overall program, rather than individual students. The IRR method used is a consensus estimate approach, defined by Stemler as "based on the assumption that reasonable observers should be able to come to exact agreement about how to apply the various levels of a scoring rubric to the observer behaviors." While we recognize the inherent advantages of the consensus estimate method (Stemler identifies these as a "strong intuitive appeal," "easy to calculate," and "easy to explain"), we also acknowledge its drawbacks.

Conclusion

The call for accountability in higher education continues to be heard in the US and abroad. In a climate like this, assessment strategies will be increasingly important in identifying effective educational programs. The chorus for accountability, however, appears to be met by a competing set of voices—faculty in higher education who express exhaustion and frustration with having to maintain assessment systems within their own institutions even as they conduct research and teach. As a recent study of the impact of the ABET Engineering Criteria and the focus on outcomes assessment has shown, the criteria expanded the definition of engineering competencies to place much greater emphasis on "professional skills, such as solving unstructured problems, communicating effectively, and working in teams" and "shifted the basis for accreditation from inputs, such as what is taught, to outputs—what is learned" (Lattuca et al 2006). These two changes were expected to be transformative: According to Lattuca et al, "Program changes would reshape students' educational experiences inside and outside the classroom, which would in turn enhance student learning" (2006). But these changes have come with a cost, and time will tell how sustainable these costs will be.On the campus of Rose-Hulman, however, we have taken the sustainability issue and used it to calibrate our assessment efforts. RosEval has proven to be an effective and efficient tool for our purpose of documenting students' learning for accreditation. We use the data in all engineering programs on our campus to document student achievement in program accreditation and institutional accreditation. As we move into the next accreditation cycle (site visit in 2018), we have made changes to our student learning outcomes, but the data-collection method and its assessment methodology will remain the cornerstone of our efforts.

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11. A TOOL TO MEASURE ENGINEERING STUDENTS' DESIGN STRATEGIES AND ABILITIES

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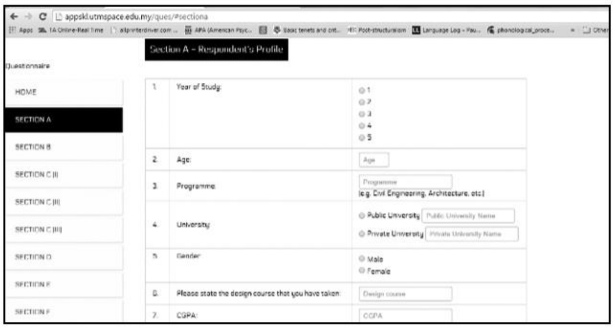
Introduction

Malaysia is moving from service-based industries to knowledge-based industries to achieve Vision 2020. This is also in line with innovation-led economy and globalization. Hence, there is a pressing need to transform the current engineering education system to meet the ever-growing roles and responsibilities of contemporary engineers. Design is central to engineering activity because students can apply the theoretical knowledge into practice. Students' engineering design knowledge and abilities are unknown when they enroll into the engineering programs. These engineering programs are either too low or too advanced for the students' design abilities. Hence, dropout rates in the engineering programs escalate each year. The invention is an online questionnaire which will assist in determining students' engineering design knowledge and abilities. It will guide engineering faculties in identifying suitable candidates for their engineering program through the scores obtained by the students. The scores will determine the students' level of engineering design knowledge. This will function as a mechanism for the faculties to filter the candidates' knowledge of engineering design and reduce the number of dropouts from the engineering program.

Picture of the product

Can be accessed via http://goo.gl/XYMZ8V



Engineering Education and Design at a Glance

The educational criteria outlined by the Accreditation Board for Engineering and Technology (ABET, 2000) has clearly stated that engineering graduates are expected to possess the following characteristics:

3f : an understanding of professional and ethical responsibility.

3h : the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

3j : knowledge of contemporary issues

Engineering education should not just produce competent and skillful engineers. It should also prepare them to acquire innovative and critical thinking skills which are guided by noble values, parallel with the National Education Philosophy that emphasizes the development of holistic, technologically and scientifically strong individuals, with good design ability. Outcome 3c of ABET EC 2000 also outlined that: Engineering graduates must have an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.National Academy of Sciences (2005) in its publication of *Educating the Engineer 2020* claims that future engineers need design skills as well as analytical skills to survive in the workplace. Nevertheless, researches on design have not brought about significant transformation on engineering education and practice as the findings are very recent and not widely accepted by engineering professionals.

Design is central to engineering activity because students can apply the theoretical knowledge into practice. It is also a fundamental aspect of engineering and is important in preparing students for industrial demands. Design can be defined as the process of making and creating new objects and also called the end result of a creative process, either as an article, paper, presentation, modeling, or in the form of real objects. Engineering design is the process of devising a system, component, or process to meet desired needs. It involves a decision-making process, in which the basic sciences, mathematics and engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process is the establishment of objectives and criteria, synthesis, analysis, construction, testing, and evaluation.

Educational Problems and How this Innovation Solves the Problems

An engineering design course is challenging in nature of which the students need to be focused, creative, enthusiastic and tactful when they design. Knowing students' design strategies and abilities is essential in helping the student to excel in engineering design course. However, there has been no standard assessment tool which can be used to measure students' design strategies and abilities. Realising the crucial needs for the engineering students to master design skills**,** an online questionnaire was developed to determine the engineering students' design strategies and abilities. The questionnaire can be accessed via a website where students need to fill in the related questions. Based on a scale given, students will know the extent of their engineering design strategies and abilities. In the end, they would be able to know their strengths in designing and identify the areas which they might have to improve.

Basis of the Innovation

In order to develop this innovation, a preliminary study was conducted to determine the components of engineering design education, specifically the engineering design abilities and strategies that characterise engineering design education for the future. A pilot study was also carried out to profile the engineering design ability and strategies in terms of design thinking skills, problem-solving skills, meta-cognition, creativity and innovation, generic skills and attitude of civil, electrical and mechanical undergraduate engineering students. Survey, interviews, observations and document analysis was employed to measure the components mentioned above. To invent the online measurement tool, the methodology used was qualitative and quantitative approaches that seeks to evaluate the design ability and strategy of engineering students. The process of inventing the online measurement tool is shown in Figure 1.

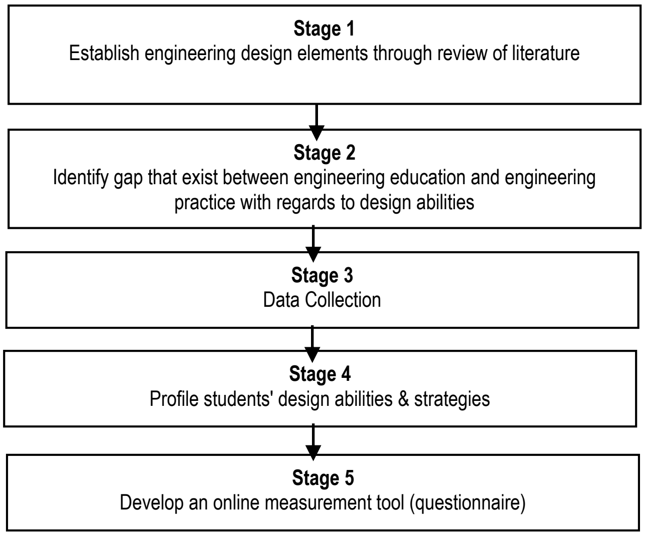


Figure 1: Process of Inventing a Tool to Measure Engineering Students' Design Strategies and Abilities

The primary data was collected via the following methods:
1. Expert/Stakeholders' interviews to determine engineering design elements.
2. Survey on students' perception of their engineering design abilities.

How Can the Instrument Measure Students' Design Strategies and Abilities?

The online survey instrument is designed to measure students' design strategies and abilities. When a student finished answering the survey, the system will yield scores. Based on a scoring procedure developed, the scores will indicate their design strategies and abilities. The scoring procedure is shown in Table 1. The scoring procedures are divided into two categories;

a) Sectional – scores according to each section (B, C, D and E)
b) Holistic – scores inclusive of all sections (total scores)

a) Sectional Scores

b) Holistic scores are yielded based on the overall scores of all sections (total scores)

Innovation Features / Capabilities

- The online questionnaire was developed using a combination of PHP and MySQL database for acquiring and storing the data collected.
- The data that is stored and collected in the MySQL table would be tabulated and calculated by a PHP script which would then display the appropriate results on demand to any administrator that wishes to do so.
- The administrator can access the data that he/she needs without having to know any programming or coding.

Degree of Inventiveness

- This online questionnaire can also be employed as a filter mechanism for selecting engineering candidates.
- Texas Higher Education Board (THEB) has a similar survey which addresses only a number of general competencies and involves current engineering students in Texas. The survey aims to improve curriculum planning and course relevance for future students. Compared to our innovation, THEB survey integrates the students' competencies with workplace needs and identifies the emphasis of

certain competencies in their program. However, in terms of the items on identifying design strategies, our innovation offers a more detailed survey as it incorporates generic skills and other items related to students' design strategies and abilities.
- This online questionnaire profiles students' design knowledge and abilities and provides a useful database for the faculties

How effective is this Innovation?
- Users such as university administrators and engineering curriculum developers will be able to identify the profile and level of engineering students' design ability.
- This invention has potential for commercialization
- Quick response to the users
- Low cost
- Effective questionnaire handling
- Wider application especially in terms of number of users and the various context of engineering programs
- User friendly

The Duration of the Innovation Has Been Used

This innovation was developed in 2012 as a research instrument. A total of 300 engineering students from different universities all over Malaysia have used this instrument.

Contribution of the Innovation

Generally, this innovation would be useful for the academics who teach Engineering Design and engineering students themselves. It can also be used to profile the engineering design ability and strategies in terms of design thinking skills, problem-solving skills, meta-cognition, creativity and innovation, generic skills and attitude of undergraduate engineering students. Specifically, the contributions are:
- Researchers or faculty administrators no longer have to administer the questionnaire manually.
- If the administrator allows it, the candidates who answered the online questionnaire would be able to identify their level of design ability a few seconds after completing it.
- As the script is fully responsible for the calculation and tabulation work, the data will be readily available to the administrator who does not require prior knowledge in programming or coding.
- With this invention, upon a lecturer knowing his/her students' level of design ability, he/she can guide the students based on the strength they possess and address the area of which the students can improve. This will eventually improve the students' level of design abilities.

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SECTION	SCORES	DENOTATION
B	90 and above	The student has demonstrated an excellent understanding of the engineering design skills expected of him
	61 - 89	The student has demonstrated a satisfactory understanding of the engineering design skills expected of him
	31 - 60	The student has demonstrated an average understanding of the engineering design skills expected of him
	30 and below	The student has demonstrated a poor understanding of the engineering design skills expected of him
C	140 and above	The student has revealed extraordinary knowledge on the application of the design strategies before, during and after completing the design project
	90 - 139	The student has revealed appropriate knowledge on the application of the design strategies before, during and after completing the design project
	41 - 89	The student has revealed basic knowledge on the application of the design strategies before, during and after completing the design project
	40 and below	The student has revealed poor knowledge on the application of the design strategies before, during and after completing the design project
D	50 and above	The student's awareness on the generic skills essential in completing his design project is exceptional
	30 - 49	The student's awareness on the generic skills essential in completing his design project is adequate
	11 - 29	The student's awareness on the generic skills essential in completing his design project is predictable
	10 and below	The student's awareness on the generic skills essential in completing his design project is very low
E	130 and above	The student possesses high awareness on the design activities which promote successful completion of design projects
	81 - 129	The student possesses satisfactory awareness on the design activities which promote successful completion of design projects
	31 - 80	The student possesses basic awareness on the design activities which promote successful completion of design projects
	30 and below	The student possesses very low awareness on the design activities which promote successful completion of design projects

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12. ENGINEERING-BASED TEACHING AND LEARNING SOFTWARE – MICRO GAS TURBINE (MGT) FLOW

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Introduction

Engineering teaching at higher learning institution is still broadly confined to traditional classroom teaching style. Although teaching and learning (T&L) has evolved from blackboard and chalk to the present more advanced multi-media based power point slides, the fundamental knowledge of engineering still requires illustration of simplified system model to explain the complex engineering system. For example, in the field of mechanical engineering study, T&L of the complex spark ignition engine utilises simplified Otto cycle to illustrate the working mechanism. To visualise the working principle of a steam power plant, idealised Rankine cycle is adopted. Previous experience shows that not all students can grasp the idea where a simplified cycle can represent the whole complex system. Further, for students who understood the basic cycle, their understanding of the system is still limited due to the lack of hands-on training and laboratory session. The classical way of learning the subject involve solving the cycle using a predefined structured equations systematically. This has resulted in students memorising the structured steps and formulas in solving questions instead of encouraging them to think critically and innovatively.

With the aim to make engineering study more interesting and effective, an engineering-based software known as Micro gas turbine Flow (MGT Flow) is developed. This engineering software is used for T&L of a gas turbine system. The software was designed for first or second year undergraduates of mechanical engineering discipline who are required to study power generation system as part of the compulsory module, i.e. gas turbine, under the subject called *Applied Thermodynamics.* This software is written using MATLAB and designed with an interactive graphical interface. The main function of the software is to simulate a gas turbine cycle under isentropic and actual conditions by taking into account the thermodynamic properties of gases at different temperatures. Another major feature of the software is that simulation of gas turbine system occurs "live", where on-line display of operating conditions (such as pressure, temperature, air flow rates etc) in the system is available that allows students to "visualise" or "feel" to gain a better understanding of the system. Students can alter the input during *live* operation and instantaneous correction to the conditions at various points of the system will be shown in the display.

This software has been used as an educational tool to complement conventional T&L in classroom. Effective use of multimedia for teaching can be appealing for the tech-savvy Gen-Y. Instead of the one-way channel lecture delivery, students get to experience the simulated "hands-on" learning of a gas turbine using the software. Questions can be designed from the perspective of an operation engineer that requires students to diagnose the problems using the software and propose suitable a solution backed by calculations. This role-playing increases students' interest and increases self-confidence if they can solve the problem. Problem-based learning using the software is effective in provoking students' innovativeness and critical thinking. Further, by allowing them to engage with peers in discussion can lead to the improvements of generic skills such as communication, team working that is in line with the outcome-based education principles emphasised in the current context of higher learning education.

Actual implementation of the software has been conducted in University of Southampton, Malaysia Campus. A list of questions related to the topic (gas turbine) has been designed for students to solve. They are required to use the MGT Flow software to solve the problems given. Some of the devised questions require students to use the software to validate their answer. The students are given sufficient time to solve the questions and the answer sheet is to be submitted by the end of the session. They are allowed to discuss and share ideas during the session. The submitted answer sheets are graded as part of the course assignment.

The feedback questionnaire is designed to evaluate students' perception and experience on the software. The overall reception on the software is very positive. About 80% of respondents think that the subject has become more interesting with the aid of this software. This is because the use of MGT Flow compliments the traditional classroom approach that enhances students' understanding on the principles involved in gas turbine. The MGT Flow question was designed to be a "problem-based learning", where students can engage in discussion with peers and engage in problem solving from more than one perspective. This "hands-on" experience mimics the actual engineering problem faced in the industry. Hence, it is not surprising that 86% of the respondents think that the software is relevant to industry. Another interesting finding is that 95% of the students are willing to explore and use technical software, and 89% express their desire to use technical software to aid their studies. Considering that the group of respondents are tech-savvy, post-90s generation, they can easily adapt to software-based learning compared to conventional lecturing style.

The overall user experience and software functionality is evaluated in the questionnaire. 84% of the respondents opine that the software is intuitive and user-friendly. This shows that the simplicity and easy usage appeals to their need. However, due to the technicality involved, in particular, the concept of Brayton cycle, 65% of the students require more guidance, and about 80% require more time to explore the functions of the software. This indicates that perhaps time was a constraint during the hands-on session. Hence, for future application, more time and guidance could be given to students to understand the software prior to answering technical questions. Another improvement to be made is the graphical layout, as 62 % of the respondents opine that the software is attractive and user-friendly. Overall, about 80% of the respondents think that engineering subject will be more interesting with the compliments of technical software. 78% of the respondents would recommend the software to peers while 79% think that the software has made them realised the importance of e-learning.

Although MGT Flow was developed in Universiti Teknologi Malaysia, the trial run was conducted at University of Southampton, Malaysia Campus to ensure an unbiased result and fair assessment of the software. Successful implementation of the MGT Flow software in classroom shows the potential of engineering-based software as a T&L tool. At present, there is a lack of engineering-based tool in the market used for T&L. Engineering teachings at local universities are mostly confined on power point, marker and whiteboard teaching. This style of teaching is lecturer-cantered and limits interaction between students and lecturer. On the other hand, MGT Flow reverses the role in T&L where students themselves have first-hand experience of simulating the gas turbine system, and subsequently solving problems using the software. The students can explore the software at their own pace, triggered by the self-generated questions during the process. Further, the use of engineering software can inspire students to develop similar tools to assist in solving problem and design.

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13. THE POTENTIAL OF QR CODE, SCREENCAST AND EDPUZZLE TO PRODUCE ONLINE VIDEO TUTORIAL FOR STATISTICS

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Introduction

Blended Learning is one of the pedagogical approaches for 21st century learning skills that had been highlighted in the Malaysian Higher Learning Institution. It integrates face-to-face with online learning interaction. Hence, this teaching approach is focusing on the degree of technology usage in teaching and learning.However, learning tools and strategies are needed by lecturers to implement this approach in teaching and learning process. They need a learning object (LO) that is suitable for their teaching objectives. In order to do that, they need to consider their target groups who have different levels of cognition. Besides that, lecturers also need to think of activities to be conducted in class that will engage students in learning.

Problem Statement

A basic statistics course is offered once a year in the Department of Cognitive Science, Institute of Teacher Education, and International Languages Campus (ITEILC). Students are compelled to take this course during their foundation year. This course aims to develop skills in basic statistics, to organize, analyze and interpret data accurately. Students also learn about Normal Distribution and computation of measures of central tendency, dispersion and descriptive data. In addition, students could identify the correlation between two variables. ICT skills are also integrated into teaching and learning session.Theory acquisition and practical experience gained during the course could be applied in daily life.

This course is mandatory and contains theory and practice. In the theoretic module, students have to learn basic concepts of statistics. In the practical module, students will learn to use functions in Microsoft Excel and Statistical Package for Social Science (SPSS) software to find values for mode, median, mean, range, variance, standard deviations, quartiles and correlation coefficient.They also need to know how to plot graphs such as histogram, bar chart, pie chart, stem-and-leaf and box plot.

The lecturers were facing problems when teaching this subject. They were given only six hours to teach students to use both the software to plot the graphs and to find the values of statistics stated earlier. They did not have enough time to show to students the features of the software. During the hands-on activities, they also had difficulty in monitoring students' performance as the students had different levels of ICT skill. Furthermore, they had difficulty motivating the weaker students to learn ICT. On the other hand, students are facing problem too when learning to use a new software. For example, they are having difficulty in memorizing the steps in using the software. Furthermore, they prefer a teaching and learning mode where they can learn anywhere and anytime that they want.Therefore, two problems have been identified in teaching statistics are time constraint and lack of interest using the software.

Online Screencast Video Tutorial

The main focus is on the creations of LO for students to apply statistics knowledge using Microsoft Excel and SPSS. A teaching strategy, which is called Flipped Classroom is proposed by the researchers, to assist lecturers to implement Blended Learning in the classroom. Self-paced learning concept is embedded when designing this LO.This LO integrated three main components: screencast technique, quick response (QR) code, and EdPuzzle. The final product is the online screencast video tutorial which is uploaded to the website.

A screencast video is a video tutorial which records the actions taking place on the computer screen using a special software. Students will be engaged with this video because they can visualize all the steps that had been highlighted in a procedure. They can also watch this video at their own pace and select any part of the video if they want to watch a particular procedure. A special software called Camtasia Studio is chosen to produce this video. The screen recorder is a tool to record the screen. During editing, special visual effects (such as callouts, zoom-n-pan and title clips) and recorded audio can be embedded into the video.Hence, this video tutorial is very effective and engaging. Besides that, EdPuzzle is also embedded in the video. This is a freeware software which can embed quizzes in the video and is needed as a part of the assessment.

The QR code is used to overcome problems faced by students such as difficulty in memorizing web addresses for the video clips. They were also having difficulty when using mobile devices which have a small size screen for typing text. When using a mobile device which has a small size screen, they faced problems in editing the text. The students, who are the y-generation, prefer to use their mobile devices for learning. Thus, the QR code is selected to be embedded in this LO. It is a matrix barcode which is capable to encode and decode data at a rapid rate by using mobile devices. It can contain an URL, telephone numbers and text. It can be scanned with a camera and a software (QR code reader) found on most mobile phones. Once the QR code is scanned, website video tutorial would be posted quickly. The QR code is a medium that permits learning to take place inside and outside the classroom. Thus, it facilitates mobile learning (m-learning) environment that is a current learning trend.

Repository for Online Screencast Video Tutorial

The collections of the online screencast videos can be accessed at www.camtasia2u.com. This website is developed by a team of researchers in the year 2013 as a repository of online screencast video. After one year, more tools were added to the website such as creating QR codes for every video that has been uploaded to the website. The total members for this website is about 169,000. Training had been delivered by researchers to lecturers from university and Institute of Teacher Education (ITE). Besides that, training was also given to teachers from primary and secondary schools in Malaysia as well as the trainee teachers in ITE. The team of researchers also produced a book entitled "Mudahnya Camtasia" in 2013, to assist readers in producing the screencast video. Besides that, this screencast technique has been embedded in videos that are used as supporting material for a new subject in primary school in Malaysia since 2014. The subject is called ICT Year 4. One of the researchers had been selected as an author of the textbook. Finally, the application of EdPuzzle is selected to add quizzes to the video.

Steps In Producing Online Screencast Video Tutorial

There are 11 steps to produce the LO that we had proposed earlier. The first step is to select the content for the video based on the learning objectives. Then, the storyboard for the video is designed. Next, the screen is recorded using Camtasia Studio software. After this has been completed, the video can be edited by adding visual effects. Before producing the video, testing should also be done. After producing the video, quizzes can be added to the video by using EdPuzzle. Before obtaining the embed code, the video must be tested again. The next step is to obtain the embed code from EdPuzzle and insert the code in the website (www.camtasia2u.com). Once the video is produced, the QR code will be generated and can be downloaded. This code can be printed and distributed to the students before they come to class.

The Principles

The underlying principles used as a basis of the innovation are Blended Learning, Flipped Classroom Model and M-learning. Flipped Classroom Model consists of two parts: delivering instruction online outside of the classroom and doing homework in the classroom. In class, students are given a task to test their understanding of the statistics concepts from the video.We had tested a screencast video tutorial to a group of 19 students from ITEILC. The QR code is printed with notes that are given to students as handouts. They should scan the code to get access to the screencast video tutorial. In class, they are given assignments by their lecturer where they have to find the values of statistics using Microsoft Excel or SPSS. They have to present their findings at the end of the class.

The Findings

The researchers received good feedback from lecturers and students. The lecturers agreed that the video tutorial helped the students to learn the new concept or skill. In addition, they agreed that the video tutorial can provide information in a format that is easy to learn and the content of the video tutorial is very useful for the students to learn statistics. Meanwhile, the students commented that they were very interested to learn how to apply statistics in ICT using video tutorials because they could visualize the steps in using the software. They also mentioned that they were able to access the web page for video tutorials via QR code.Therefore, they would like to integrate m-learning in their daily life. Hence, the integration of paper-based and online screencast video through the QR code for basic statistics learners is an effective mode of teaching and learning to facilitate m-learning. This mode of teaching together with the flipped classroom model is a student-centered approach and should be applied in teaching basic statistics.

14. RESPONSIBLE INNOVATION: ENGINEERING ETHICS EDUCATION USING A NEW JAPANESE HYPOTHETICAL CASE

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Introduction

The authors of this presentation have been engaged in engineering ethics education (E3) at Kanazawa Institute of Technology (KIT), one of the largest private technological universities in Japan since 2004. At KIT, only six professors teach engineering ethics to about 1,800 students every year. To conduct this massive E3 by a small number of faculties, we have developed and introduced innovative methods to our E3 course. This presentation aims to give an overview of the current situation of E3, and to demonstrate how E3 is conducted at KIT.

Today's society is highly dependent on science and technology. Besides that, it should be science and technology that lead us to innovations which tackle great challenges such as global warming. To let innovation be realized, engineering is indispensable. To let innovation be responsible, ethics should play a crucial role. In order for would-be engineers to realize that it is their duty to hold social responsibility, E3 is therefore considered to be an important element in engineering education.

It seems that the notion that E3 is crucial for engineering education is shared by many countries where accreditation authorities of engineering education such as ABET (Accreditation Board for Engineering and Technology [in the USA]) and JABEE (Japan Accreditation Board for Engineering Education) demand engineering education institutions to incorporate engineering ethics in their curricula. For example, JABEE demands engineering education programs to demonstrate that students have "Understanding of the effects and impact of engineering on society and nature, and those of engineer's social responsibility (engineering ethics)." This means that many of them (have to) offer compulsory courses to teach engineering ethics to their students.

Ethics courses in E3 are different from those in the humanities curricula; that is, they are required to be more practical than theoretical. From a practical point of view, the important objectives of E3 are to let engineering students realize that ethical judgment ability is essential in their engineering activities, and to let them acquire skills to act ethically. Ironically, the more recognized the importance of E3 is, the more practical difficulties we faced when we conducted E3. One of the roots of the difficulty is about efficiency: how to conduct a large-scale E3 program with limited manpower. It is often the case that the number of faculty members who are in charge of ethics courses in E3 is quite limited, and/or that they are engineering faculty who are not specialized in ethics. Introduction of innovative educational methods is an answer for us to conduct E3 efficiently with limited manpower.

KIT was founded in 1965 as a private university with a single college. Since it was established, KIT has been continuing educational reforms and is now one of the largest technological universities in Japan with four colleges (College of Engineering, College of Informatics and Human communication, College of Environmental Engineering and Architecture, College of Bioscience and Chemistry), with 7,400 enrolled students, 350 faculties and 300 staff. KIT is well known for her commitment to E3 that is rooted in one of three founding principles, "to create well-rounded citizens with good character" (others are "to be innovative" and "to promote industry-university collaboration").

The course "Science and Engineering Ethics" (SEE) has been offered since 2006. Currently, it is a compulsory two-credit course for junior students. Approximately 1,800 students are divided in about 30 classes; 50-80 students per class, and about 15 classes are offered in one semester. Six professors are in charge of the course, which means that each of them is responsible for about 5 classes or 300 students a year on average. One lecture runs for 90 minutes, and there are 14 lectures, followed by a final examination on the 15th week and one wrap-up on the 16th or the last week of a semester. There are six paper-based assignments, three E-learning assignments, three in-class group discussions and one final examination.

For the first two years, there were more paper-based assignments and no E-learning assignments. It was more time-consuming and less efficient not only for professors but also for students; it was obvious that this situation was not sustainable. Introducing an E-learning tool could be a good solution to alleviate the difficulty to improve educational efficiency. However, E-learning is not a panacea to solve all teaching and learning problems and can sometimes make things even worse. E-learning systems with poor contents such as "video lecture via internet" hardly improves learning efficiency and could even reduce students' motivation. What was required was something that would promote students' awareness of improving ethical skills, and that could improve not only teaching but also learning efficiency.

To satisfy the requirements, we not only introduced an E-learning system specially designed for E3 but also reformed the structure of SEE itself. The E-learning system we introduced is named "Agora" developed by three Dutch technological universities in Delft, Eindhoven, and Twente. KIT has been involved with the development project since 2005, and fully implemented to SEE in 2008. At the same time, SEE was reformed to prompt students to study outside classrooms. This approach is currently known as "active learning" and "inverted classroom." The correlation of scores between Agora assignments and final examinations demonstrates that use of Agora in SEE improves students' understanding; that is, those who eagerly tackle the Agora assignments tend to get better scores in final examinations.

Another innovative achievement for E3 is the creation of a new case material for E3 to cope with the acceleration of globalization. It is widely recognized that a method called 'case method' is highly effective in E3 to achieve educational objectives. In Japan, Gilbane Gold, a famous hypothetical case developed by NSPE (National Society of Professional Engineers [in the USA]) has been commonly used. Although it is a good case, its "American" characteristics do not fit perfectly with Japanese contexts such as social status of engineers, business culture and so on, which are different from those in the USA. The differences are not major, but they are significant enough to not be ignored or made light of. We therefore developed a new case in tune with Japanese contexts, Solar Blind in 2009, which was translated in English in 2012. Using both Gilbane Gold and Solar Blind, we are now able to effectively introduce global contexts in E3.

Solar Blind is a hypothetical case that fits in with Japanese contexts, developed by some faculty and students of Kanazawa Institute of Technology. The outline of Solar Blind is as follows. A young Japanese engineer is facing an ethical dilemma as a leader of a development team for an innovative product, Solar Blind, an indoor easy-to-use solar power generation system. His team is in charge of designing a control unit, the key component of the system. One day, in the last stage of the development, he encounters an overheating problem: when conducting a test, a person who touched the overheated control unit had a slight burn on his/her hand. He and his team try hard to find out the cause of the overheating; however, despite their effort, it seems to him that he is unable to find a solution before the release date of the product to the market. He suggests postponing its release date; the company decision was quite opposed to his suggestion.

Solar Blind is attracting many people who are involved in E3 all over the world. In conclusion, it can be said that at KIT we have achieved successful innovation in E3; that is, we adopted "active learning" and "inverted classroom" methods by introducing an E-learning system "Agora" and the creation of Solar Blind so that large-scale E3 could be conducted not only efficiently but also effectively as well as sustainably.

15. EDUCATION INNOVATION PRODUCT “MOBILE LEARNING” FOR DPB3013-PRINCIPLE OF MANAGEMENT IN POLITEKNIK MERLIMAU

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Introduction

Teaching and learning process is an important element in the education industry. ICT practices has brought copious supporting material for teaching and learning process. However, we are still tied to models of teaching and theories that have relationship in educational psychology. This innovation is based on the production of social learning theory, which is supported by the theory of legitimacy. Social learning theory is an extension of the traditional behavioral learning theory. The social learning theory is developed by Albert Bandura (1986) and received a large part of the principles from behavioral learning theories, but gives more emphasis on the impact of the behavior of signals, and the internal mental processes.

In social learning theory, we will use external reinforcement explanations to understand how internal cognitive learning and human behavior depends on the observation of the individual against another individual or symbolic models like television and so on. The basis of social learning theory developed by Bandura (1977) has highlighted that an organization needs legitimacy if they run activities in accordance with social expectations (Nature 2006). Legitimacy is a dynamic concept as it relates to the social environment that is constantly changing. Theories of legitimacy attempt to explain social responsibility and disclosures made by looking at the values and norms, culture and attitudes of society (Parsons 1956). Any changes in the organization of activities that affect the environment must be communicated to the local community (Parsons 1956). Therefore, the implementation of mobile learning applications through legitimacy theory can show how lecturers or teachers that show concern for social values by applying an effective medium and appropriate student environment with social change. This is to ensure that students receive the appropriate benefits to the changing of the education environment.

Product of Innovation-Mobile Learning

Mobile learning applications is compatible with smartphones and other mobile devices such as tablets that use the Android operating system and Apple app. Students and lecturers can interact and carry out various activities through these applications without considering the limitations of time and location. Mobile learning application is a teaching and learning support material for the convenience of lecturers who teach the course DPB3013 Principles of Management at the Polytechnic. Technological developments and the mobile devices used by the students should be given the space and opportunity for educators to utilize in order to diversify tools and teaching aids respectively.

Mobile Learning Innovation products are diversifying teaching and learning patterns including the use of notes channeled through smart phone users and can be directly responsible for reducing paper consumption and use of LCD projectors. Users, especially students want to carry out exercise or assessment through their mobile phones and this enables such activities to be carried out beyond the class. Students can take advantage of their time with suitable activities. Additional course materials will be continuously updated from time to time so that it is in accordance with the current syllabus. Students should be able to communicate with each other or with their lecturer by using a chat room facility provided through this application. Students can conduct this activity smilar to other social media such as WhatsApp, Instagram and others.

Users are connected with a direct link to the lecturer’s blog, feedback systems and delivery of assignments directly to lecturer’s email. The easy access can improve the desire and urge among students to learn outside the classroom. The current education system supports a wide range of information technology that can contribute to the education industry where the use and preparation of teaching aids concerned meet the requirements and needs of the course syllabus in all levels of education. This application is able to assist students in improving the level of interest, focus and so encourage them to understand a particular field of study.

Related research issue

The variety of teaching methods applied in an educational institution will change the face of the delivery and impact on the performance of not only students, but also affect the delivery of innovation and creativity of teachers themselves. Teaching and learning are not as conventionally practiced, where it occurs in the classroom alone, but should be in line with current developments in information technology facility itself.

The level of awareness of teachers about carrying out activities outside the classroom, especially in Politeknik Merlimau, is very low. Therefore, these applications can be used free of charge or purchased at cheap rates and the methods of use can be diversified. The use of smart phones and the low charges on internet data network usage was also a motivating factor for us to create mobile application and assess the likelihood of its use. Based on direct observation, it was found virtually the entire student population has a smartphone and its use is limited to mere entertainment elements. These problems prompted the researchers to look at the effectiveness of the delivery of lectures and other activities in on-line teaching and learning from the student's perspective.

Impact on the use of Innovation Product-Mobile Learning

TAHAP KECENDERUNGAN PENGGUNAAN APLIKASI TELEFON PINTAR (LEVEL OF KEENESS TOWARDS USE OF SMARTPHONE APPLICATIONS)								
BIL	ITEM SOALAN	KEKERAPAN PERATUSAN					SKOR MIN	TAFSIRAN
		STS	**TS**	**TP**	**S**	**SS**		
1	Saya menggunakan aplikasi telefon pintar untuk menyemak emel dan melayari laman web. (I use the applications in my smartphone to check emails and surf the internet.)	3.6	5.1	2.9	67.4	21	3.97	Tinggi (High)
2	Saya mencari bahan-bahan rujukan akademik menerusi telefon pintar (I search for academic references using my smartphone.)	-	-	12.3	61.6	26.1	4.14	Tinggi (High)
3	Saya hanya menggunakan telefon pintar bagi tujuan laman sosial sahaja (I use my smartphone only in socializing websites.)	13.8	5.8	32.6	37.7	10.1	3.25	Sederhana (Medium)
4	Saya menggunakan aplikasi telefon pintar untuk hiburan bermain permainan secara online (I use the applications in my smartphone for entertainment and to play online games.)	0.7	23.9	14.5	43.5	17.4	3.53	Sederhana (medium)
5	Saya menggunakan telefon pintar untuk semua urusan akademik, hiburan dan lain-lain. (I use my smartphone for academic, entertainment and other purposes.)	4.3	8.7	12.3	40.6	34.1	3.91	Tinggi (High)

Table: Mean analysis of the variables level of interest

The table above shows the analysis of the variables level of interest in the use of smart phone applications. The mean score for the items 1, 2, and 5 are in the high level of 3.91 to 4.14, while the mean score for item 3 and 4 are in the medium level of 3.25 to 3.53. Items that have the highest mean score was item 2 with a mean score of 4.14 where 87.7% of respondents referred to academic materials through a smartphone. This shows that the students use their smartphone to an advantage in teaching and learning for helping them search for information and references for learning.

TAHAP PENERIMAAN BERKAITAN APLIKASI *MOBILE LEARNING* DALAM KALANGAN PELAJAR (LEVEL OF ACCEPTANCE OF MOBILE LEARNING APPLICATIONS AMONG STUDENTS)								
BIL	ITEM SOALAN	KEKERAPAN PERATUSAN					SKOR MIN	TAFSIRAN
		STS	**TS**	**TP**	**S**	**SS**		
1	Saya gembira dapat menggunakan aktiviti pengajaran dan pembelajaran menggunakan aplikasi mobile learning ini. (I am happy that I can carry out teaching and learning activities using the mobile learning application.)	0.7	8.0	27.5	34.1	29.7	3.84	Tinggi (High)
2	Saya tidak gemar menggunakan telefon pintar untuk tujuan pengajaran dan	8.0	9.4	21.0	44.9	16.7	3.53	Sederhana (Medium)

	pembelajaran. (I do not like using my smartphone for teaching and learning purposes.)							
3	Saya lebih memberi tumpuan khusus di dalam kelas secara khusus untuk mendapatkan bahan-bahan akademik berbanding pendekatan mobile learning. (I give more attention in class to receive academic material compared to using mobile learning.)	5.1	3.6	11.6	63.8	15.9	3.82	Tinggi (High)
4	Saya memuat turun nota, mendapatkan maklumat terkini,membuat latihan serta berhubung dengan pensyarah secara peribadi menggunakan aplikasi mobile learning (I download notes, access current information, do exercises and contact the lecturer privately using mobile learning application.)	0.7	-	12.3	66.7	20.3	4.06	Tinggi (High)
5	Saya faham *mobile learning* merupakan alat bantu mengajar yang membantu pelajar semasa ataupun diluar bilik kuliah. (I understand that mobile learning is a teaching aid that helps students learn in or outside of class.)	-	15.2	13.0	47.1	24.6	3.81	Tinggi (High)

Table: Mean analysis of the level of acceptance of applications

The table above shows the analysis of the level of acceptance of applications related to mobile learning. The mean score for each of the items 1, 3, 4 and 5 are in the high level of 3.81 to 4.06, while the mean score for item 2 are in the medium level of 3.53. Item 4 obtained the highest mean score of 4.06 where 87.0% of respondents reported they downloaded notes, recieved the latest information, did assignments and contacted the lecturer personally with mobile learning. It shows students are always aware of mobile learning applications as the lecturer will continuously update the mobile learning application from time to time.

TAHAP IMPAK / KEBERKESANAN BERKAITAN *MOBILE LEARNING* DALAM KALANGAN PELAJAR (LEVEL OF IMPACT/EFFECTIVENESS OF MOBILE LEARNING AMONG STUDENTS)								
BIL	ITEM SOALAN	KEKERAPAN PERATUSAN					SKOR MIN	TAFSIRAN
		STS	**TS**	**TP**	**S**	**SS**		
1	Pendekatan mobile learning menambah minat saya untuk belajar. (Mobile learning approach improves my interest in learning.)	-	-	11.6	58.7	29.7	4.18	Tinggi (High)
2	Pendekatan *mobile learning* mengurangkan penggunaan kertas secara langsung menjimatkan kos terlibat. (Mobile learning approach reduces the use of paper thus, reducing the overall cost for learning.)	-	8.0	8.7	59.4	23.9	3.99	Tinggi (High)
3	Pendekatan mobile learning amat membosankan. (Mobile learning approach is very boring.)	-	18.8	5.1	53.6	22.5	3.80	Sederhana (Medium)

4	Pendekatan *mobile learning* membolehkan saya belajar tanpa mengira waktu dan tempat. (Mobile learning approach enables me to learn without time and location boundaries.)	-	0.7	0.7	76.1	22.5	4.20	Tinggi (Medium)
5	Pendekatan Mobile Learning memudahkan saya mendapatkan bahan rujukan,maklumat dan berhubung dengan pensyarah pada bila-bila masa. (Mobile learning approach makes it easier to access references and to contact the lecturer at any time.)	-	-	-	77.5	22.5	4.22	Tinggi (Medium)

Table: Mean analysis of the effectiveness

The table above shows the analysis of the effectiveness of mobile connection leaning. The mean score for each of the items 1, 2, 4 and 5 are in the high level of 3.99 to 4.22. Item 5 received the highest score with a mean of 4.22 which indicated that 100% of respondents agreed that mobile learning enables them to search for references and information and enables them to contact the lecturer at any time. Obviously here, the students maximize the use of mobile learning applications for teaching and learning purposes which has become the latest trend in education in higher learning institutions.

Discussion

The discussion focused on the impact and effectiveness of mobile learning for students. Many students indicated that learning with mobile application improves the teaching and learning process. This app improves their interest in learning, allows access to records and reference materials regardless of time and place and can be connected to the lecturer at any time. According to Vavoula and Sharples (2002), mobile learning allows teaching and learning to take place without limitation of location and time. The development of mobile technology allows the learning process to not be limited to the physical walls of the classroom. With the wide range of mobile devices and tablets available, the learning environment becomes more interactive, stylish and attractive. Therefore, the mobile learning applications give positive impact on the students in the DPB3013 course.

16. DEVELOPMENT OF A GRAPHICAL USER INTERFACE USING LABVIEW AS A MEDICAL IMAGING LEARNING TOOL

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Introduction

Image-processing can be described as any signal processing for which the input is an image. Some images have defects such as noise or blur which needs specific processing to improve the image. There are several categories of image processing which includes enhancement, restoration, segmentation, registration, compression and pattern recognition. For a photographer, the use of image-processing technique is important to enhance the contrast, brightness, edges, sharpness or smoothing. In medical application, a radiotherapist uses image processing to conduct analysis and restore the region of interest. The image to be processed can be either a coloured image, a grayscale image or a black and white image.

Thermogram image is a coloured image, produced by the thermal camera. The colour distribution in the thermogram is based on the heat distribution. Light colours indicate the hot region of heat distribution and dark colours indicate the cool region. Thermograms are used in various applications such as in military, building inspection, firefighting, and search and secure mission.

Nowadays, thermograpy is a popular technique used in medical application to diagnose abnormalities in the human body. The technique is very popular as it is a non-invasive and non-contact medical imaging technique, safe and therefore is not harmful to humans. Thermotherapy has a high potential in the future of medical application as it can be used in early detection of skin cancer, pain management, burn depth assessment, fever detection, SARS, fracture, internal injury, and also arthritis. On top of that, thermal imaging is also able attain the heat distribution of a large number of people in a short period of time.

There are many software that are available to process images and the difference between these software is the methods used in image-processing and the final product of the process. Usually a programmer uses several methods of image-processing to process an image. These series of image-processing methods are called image-processing algorithm.

The growth of image-processing softwares nowadays has become more complex and complicated. Learners and students take a long time to learn and understand how the final image would look like from each image-processing algorithm. This is because the final image is different from the original image after undergoing several processes. For a random normal user, they need to know the type of method that is used by any available image processing software to be able to understand the whole image process.

Another problem that arises during the analysis of the final image is that it is difficult to measure the dimensional characteristic of an image from just 'eye-balling'. The area of the region of interest, major axis length and minor axis length are some examples of the dimensional characteristics that a user usually needs to know from an image, which cannot be measured by just 'eyeballing' the image. Thus, it requires a supporting tool to assist them in measuring those dimensional parameters.

Teaching Innovation

The objective of the project is to develop a graphical user interface (GUI) which is able to be used as a medical imaging learning tool to help interpret, analyze and display images that have undergone several image processing. The GUI is also able to compare the image differences between two or more image-processing algorithm.

The main process of the GUI is in the image processing technique that allows user to choose between two techniques which are the basic conventional technique and the thresholding technique. The basic conventional technique comprises of methods that include edge detection, morphological process and heat region segmentation and is able to provide the gradient approximation of the image intensity function. In the thresholding technique, a user is able to select the desired temperature range by setting the minimum and maximum temperature and the image will be updated each time the user changes the chosen methods.The final results show the final image resulting from all the image processing methods and the percentage area of interest.

Conclusion

The GUI can be used as a medical imaging learning tool to learn basic and fundamental techniques used in image-processing algorithm. The developed GUI is helpful in helping user to interpret and analyse medical images such as thermogram more easily.

With upgraded and latest versions of LabView, the GUI can be improved by having more image processing algorithm by implementing more functions of Matlab Script for various image processing techniques. This will make the GUI more interesting when comparing the resulting image with different image processing techniques. Besides being used as a learning tool, the GUI can be proposed to be used in hospitals for clinical purposes to detect diseases such as H1N1, internal body fracture, arthritis, and other diseases and abnormalities related to heat.

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17. INNOVATIVE DESIGN OF SCALED HYDRAULIC ENGINE DYNAMOMETER FOR TEACHING AND LEARNING

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Introduction

Engine dynamometer is used to measure engine performance by giving a load to the tested engine. The conventional designs of the engine dynamometer is called dry friction which uses a mechanical breaking device with a belt or frictional material made by rubbing the rotating shafts or drum spun [1-4]. Basically, engine dynamometer is designed using hydraulic pump and engine where both of them are in couple condition [5]. The pump is located in line with output shaft and rotates simultaneously to generate pressure to the fluid. This development of engine dynamometer is used to investigate future engine performance.

Research Methodology

The engine dynamometer in this study was developed by final year students and is used for teaching and learning at the Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka (UTeM) and collaborated with Green Technology Vehicles Research Group (G-TeV) Laboratory, UTeM. This product was initially developed from foundations [6] and are given as below.

Torque, τth, (N.m) at pump's shaft is directly related to pressure, Pb (kPa) across pump as shown in Eq. (1),

$$\tau_{th} = \frac{V_d \cdot P_b}{2\pi} \qquad ...(1)$$

where the Pb is the pump pressure when the load given to the engine, Vd is pump displacement when pressure acting on cylinder.

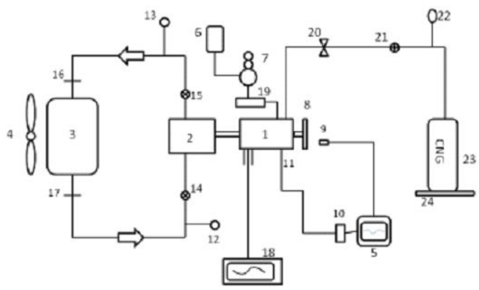
Engine power, $\dot{W}$ can be determined by using Eq. (2),

$$\dot{W} = \frac{2\pi\tau_{th}N}{60} \qquad ...(2)$$

where N is engine revolution per minute (rpm) or also called the engine speed. In order to investigate engine fuel efficiency, there is a basic method to measure fuel consumption from fuel mass flow rate. Mass of fuel will be measured when the engine start given load corresponds to the time. Therefore, specific fuel consumption can be interpret as Eq. (3),

$$\text{b.S.F.C.} = \frac{\dot{m}}{\dot{W}} \qquad ...(3)$$

where $\dot{m}$ is the fuel mass flow rate and $\dot{W}$ is the brake engine power. The schematic diagram and actual setup for experiment purpose on this product shown in Figure 1 and 2, respectively.



No.	Description	No.	Description
1	Engine	13	Pressure gauges
2	Hydraulic pump	14	Control valve
3	Hydraulic tank	15	Control valve
4	Cooling fan	16	Thermocouple
5	Combustion analyse	17	Thermocouple
6	Fuel tank	18	Gas analyzer
7	Fuel burret	19	Fuel pump
8	Crank angle disc	20	Flow rate gauges
9	Crank angle decoder	21	Pressure regulator
10	Amplifier	22	Pressure gauges
11	Pressure sensor	23	CNG tank
12	Pressure gauges	24	Weight scale

Figure 1: Schematics diagram for experiment setup

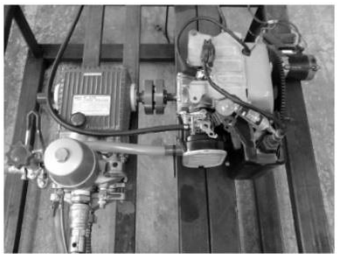


Figure 2: Actual figure of Engine dynamometer

Results and Discussion

From the experiment, data was collected and analyzed as shown in Table 1. All the data gathered were calculated from the pressure gauge reading as the pump pressure that act as the engine load. By using basic equations as mentioned previously, pump pressure can be transformed as the engine torque and can be used in the calculation to achieve the engine power.

Engine Speed (rpm)	Torque (Nm)	Power (kW)	b.S.F.C (g/(kW·h))	AFR (λ)
1000	4.87	0.51	3.898	1.12
1500	5.54	0.87	2.544	0.98
2000	6.39	1.34	1.916	0.97
2500	8.44	2.21	1.428	0.95
3000	8.13	2.78	1.187	0.94
3500	8.85	2.97	1.009	0.97
4000	8.02	3.36	0.829	1.04

Table 1: Data collected from engine experiment

Figure 3, shows the engine power value as the engine speed increased. The engine power increased as the engine speed/revolution increased. From the data, the maximum power was obtained at engine speed of 4000 rpm which is 3.33 kW. Figure 4 shows the engine torque which were calculated from the back pressure value that had been measured. The graph shows that the maximum torque value for the engine is 8.85 Nm at 3500 rpm and curve start to shows the engine torque decreasing at 4000 rpm. Figure 5 and 6 below shows the brake specific fuel consumption and the air – fuel ratio versus the engine revolution [7]. The brake specific fuel consumption indicates how much the fuel had been used in order to get maximum brake power, showing that the fuel consumption decreased as the engine speed increased. As the engine started to control the efficiency, the data can only be taken at 4000 rpm. The air and fuel ratio (AFR) data shows that there are some changes to ratio as the engine speed increased. A high air ratio should give a better fuel consumption as the engine speed increased.

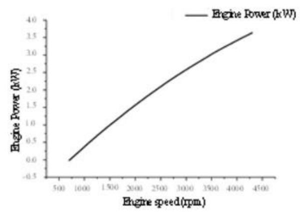


Figure 3 Effect of engine power at different engine speed

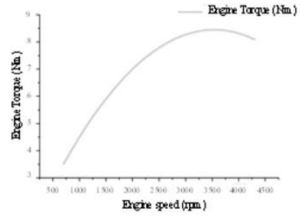


Figure 4 Effect of engine torque at different engine speed

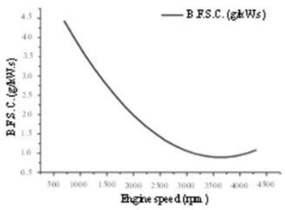


Figure 5 Effect of brake specific fuel consumption at different engine speed

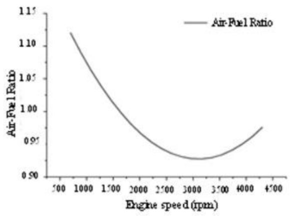


Figure 6 Effect of air fuel ratio at different engine speed

Conclusion

In conclusion, this products was developed by final year student at Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Malaysia and it was been used last two semesters. The product has been tested to investigate the engines performance and finally it has a potential to use in future for a big scale study.

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18. LEARNING REFLECTION EXERCISE

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Introduction

Students performing poorly in the Introduction to Materials Science course indicates poor mastery of the learning outcomes. One of the ways to improve the students learning is to ensure learning is achieved in every lecture. Although traditional lecture is perceived as passive learning method and less effective in ensuring learning is achieved, appropriate interventions can alleviate the issues faced. One of the ways to improve students' learning is by introducing a reflection activity at the end of each lecture. According to David Kolb's learning theory, reflection is one of the crucial thought processes involved in learning. In his theory, Kolb suggests that learning involves four thought processes from experiencing, reflecting, generalizing and testing. A student needs to reflect on what have been presented during lecture to seek connections and gain clarity of the lecture materials.

Teaching Innovation

This reflection exercise has been implemented and practiced in the Introduction to Materials Science course at Universiti Teknologi PETRONAS since 2009. At the end of every lecture, students were given a reflection sheet that contained several short but key questions pertaining to the learning outcomes for the lecture. Students were also asked to provide their feedbacks on their learning, problematic topics and quality of teaching. The questions posed in the exercise acted as a platform in the students learning process to reflect how much students grasped the concepts presented. Students inadvertently are being informed of their own learning attainment for the particular lecture.

Conclusion

The innovation introduced has improved students' performance as they are more motivated during lecture and are informed of their understanding of the lecture materials. The immediate feedbacks provided by the students were invaluable source for the instructor to incorporate into the next lecture to prevent escalating any teaching issue that would impair learning. Apart from ensuring the learning process took place effectively, the reflection exercise served as students' attendance record which avoided the situation of false attendance signing.

19. TEACH LESS LEARN MORE WITH EZYSTATS3Q MODEL APPS

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Introduction

In the 21st century of the economy and knowledge driven world, the essentials of learning must prepare the students and the workers to be able to triumph in the global skill race to compete in the aggressively competitive current society (21st Century Skills, Education & Competitiveness, 2008). 21st century skills which are supposed to be acquired by the product of education (students) are a mixture of the professional development skills which are currently in high demand among the employees. A product of an education institution is expected to possess digital age literacy skills, high intellectual capital, interactive communication skills and quality assurance sense in working (Metiri Group, 2000). In general, a graduate of a university should have the ability and willingness to learn new skills, is a responsible person, can work as a team player, value cultural diversity, can access and assess information, creative and can negotiate his or her skills (Department of Labor, 2000). In order to ensure the development of such 21st century skills in education, a plethora kinds of teaching, learning and assessments should be implemented in the system which are beyond the paper and pencil examination. Inquiry-based instruction, active learning and formative assessment practices are some of the educational innovations which can be initiated. According to the Quality Assurance Agency for Higher Education (2011), formative assessment brings the purpose of assisting the learners to learn excellently by giving feedback on students' performances and providing suggestions on how they can improve. The assessment for learning pursues an innovation of strengthening the teaching and learning to effectuate substantial learning gains (Black & Wiliam, 1998).

Teaching Innovation

In fact, the Singapore Teach Less Learn More (TLLM) vision is a welcome beacon directing us toward what education needs to be - preparation for life. Indeed, the TLLM vision, is embodied in three simple but extraordinarily powerful categories - one each for dimension, (1) Why We Teach, (2) What We Teach, and (3) How We teach. Preparation for life involves broadening rather than narrowing the curriculum, developing character, multiple intelligence including emotional intelligence, and employability skills, including thinking skills and teamwork skills. The emphasis in "Teach Less, Learn More" is where the emphasis in education must be if our students are to be successful in the 21st Century. If a teacher wants to cover as much curriculum as possible, the teacher should stand in front of the class and talk fast, not pausing to have students interact. The teacher will cover more of the curriculum that way. The only problem is that the students will not. For students to acquire important content and skills, they must process, explore, think, and interact among themselves. Hence, at some point of time, the teacher should stop talking and lets students interact with each other and with the curriculum. If a teacher teaches with words, learning stops when the lesson is over. If a teacher has students learn from their experiences, they become life-long learners. This is particularly important at a time when the change rate is accelerating and much of what a student learns in school is outdated within five years after graduation. If we do not instill a joy in learning, we have not created a life-long learner. We have created a student ill-prepared for the 21st Century change rate. In fact, teachers in Singapore noted that the "Teach Less Learn More" policy encourages them to be more innovative in their teaching approaches. However, they said that, as a result, they are spending more time to prepare their lessons compared to the past.

In both Asia and North America, schools are driven by statistics and measurements that guide many of the decisions made about how to improve and excel. In fact, EzyStat3Q Model Apps is a hands-on guide to lead university students and researchers to learn the tricks of statistics quickly. Statistics may be viewed as an intimidating subject for students in the varsity and a stumbling block for researchers to complete their research. Nevertheless researchers at Harvard University view statisticians as one of the most promising job for the next ten years. Professor Xiao-Li Meng from Harvard University emphasized that ". . . the sexy job in the next ten years will be statisticians. People think I'm joking, but who would've guessed that computer engineers would've been the sexy job of the 1990s?" The ability to take data-to be able to understand it, to process it, to extract value from it, to visualize it, to communicate it-that's going to be a hugely important skills in the next decade, not only at the professional level but even at the educational level for elementary school kids, for high school kids, for college kids. Because now we really do have essentially free and ubiquitous data. So the complimentary scarce factor is the ability to understand that data and extract value from it." Henceforth, statistics should be seen as your chance for happiness. Based on that note, this sofware, EzyStat3Q Model Apps was developed with i-spring, flash, lecturemaker and multimedia PowerPoint to maximize the versatile features of the Apps. Educational principles such as inquiry-based instruction, active learning and formative assessment which emphasized on the development of 21st century skills have also been integrated into the development of this learning apps. The Apps has the advantage of making the learning of statistics easy by introducing 3Q models namely quick notes, quick steps and quick tables in the system. User friendly and interesting lessons which integrate materials from PowerPoint, Word and SPSS software make it easy to ramp up on the latest gadgets: i-phone, i-pad, surface and laptop. One only needs to follow along and can quickly learn how to do statistical analysis and create great looking tables guaranteed to impress and to succeed in research grant applications and postgraduate studies.

Impact

Students become active learner with apps and able to share knowledge and collaborate learning with learners and lecturer in the on line discussion and forum. The apps allows students to learn on their own pace at any time and any where. Multimodality concept adopted also allows students to learn statistics from printed material, interactive multimedia PowerPoints and versatile social media apps. This practical, impressive and fast-paced guide has the potential to be commercialised locally and internationally.

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20. BLOSSOMS: BLENDED LEARNING APPROACH THAT HELPS DEVELOP TEACHERS' AND STUDENTS' HIGHER ORDER THINKING SKILLS (HOTS) IN STEM.

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Abstract

According to the OECD's Programme for International Student Assessment (PISA) 2012 and Trends in International Mathematics and Science Study (TIMSS), Malaysia performed in the bottom third for reading, mathematics and science, below the international and OECD average. Malaysian students have lagged behind the performance of their counterparts in the region. Due to this, BLOSSOMS (Blended Learning Open Source Science or Math Studies) project has been introduced, as one of the many initiatives to comprehend the issue. BLOSSOMS is a collaborative project between MIT, UTM and MoE; launched in January 2013. This project not only creates interactive video lessons for STEM classes in high school but at the same time, aims to increase teachers' content knowledge. Meaning, teachers will have to develop their higher forms of thinking while constructing BLOSSOMS lessons. The video lessons intended to enhance the teaching of STEM lessons by the lively video presence of experts in the field. Students in the classroom setting would watch segments of a BLOSSOMS video (4 to 6 segments), no segment lasting longer than 5 minutes. Then after each segment, the in-class teacher would guide or facilitate the students through an active learning exercise building from the video segment and provided by the experts in the video. After the learning objective is accomplished, the video is turned on again for another short segment. This iterative process continues until the exercise is over, usually lasting a full class session. The segments of the video are designed to explain complex STEM concepts, by relating them to real-world situations. Students have to engage in active learning activities, such as discussion, problem solving that promote analysis, synthesis, and evaluation of STEM content. This very much promotes a social constructivist approach to learning (Vygotsky, 1978). Research have proven that BLOSSOMS able to: (1) enhance students' thinking, gives a sense of accomplishment and the excitement in learning science and mathematics which, involved solving real-life problems (Mahmood et al., 2013); (2) able to improve higher-order thinking skills (HOTS) in learning the topic of computer topology (Zain, 2014); (3) able to increase teachers' content knowledge in STEM and move them away from their traditional teaching, based on the syllabus and textbooks (Abdullah et al., 2014). BLOSSOMS video lessons are used in a number of schools in Malaysia e.g., Sains Kuching Secondary School, Muar Science School, Kubang Pasu Science School, and Alam Shah Science School. In UTM, one of the videos entitled "Is there a connection between computer network topologies and a Malaysian wedding?" is used every semester in the Telecommunication & Networking course (SPM1012). Teachers who used the video find it helpful for effective teaching (Abdullah et al., 2014). Also, they found that students become more engaged with the subject (Zain, 2014). In conclusion, the teachers agreed that BLOSSOMS aims is not to replace them with technology but assists in maintaining control over the learning environment – encouraging students to think creatively and critically while participating in active, experiential learning.

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21. VOCBLAST: A VOCABULARY MOBILE APP FOR LEARNING ENGLISH FOR SPECIFIC PURPOSES (ESP)

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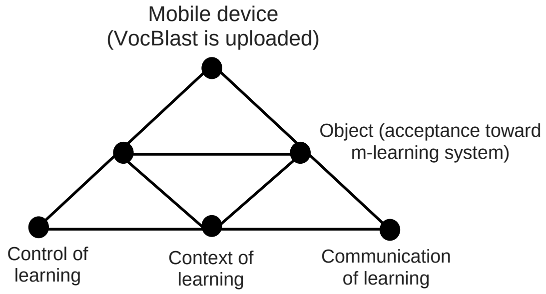
Introduction

Mobile learning has emerged as a powerful platform for learning. Studies also have shown that mobile learning is able to improve students' learning (Hwang & Chang, 2011; Martin, F., & Ertzberger, J. (2013).Hwang, Wu & Ke, 2011; Liaw, Hatala, & Huang, 2010). A report prepared by the Educause Center for Analysis and Research in 2013 revealed that 45 percent of the students at tertiary level education used mobile devices while 37 percent of them used smartphones in their daily routine as students. With this statistic in mind, it brings a major challenge for educators to recognize the benefits that the devices can bring to students. Focusing on the learning of vocabulary, questions have been raised about how mobile applications (abbreviated to apps) that are uploaded in the devices may assist students in enriching their vocabulary. In the literature, a study conducted by Steel (2012) reported that the dictionary apps may assist learners to check and refer to the words they did not understand. A study that was conducted by Hong, Hwang, Tai and Chen (2014) found that the use of EVL@S improved students' ability in storing the vocabulary they have learnt. Students may also learn English spelling; in particular LINE APP, as demonstrated in Shih, Lee and Cheng's study (2015). It was found that the use of the mobile app promoted a positive learning environment for its users. The use of Word Learning-CET6 in a study by Wu (2015) revealed that its use enabled medical students to obtain direct and indirect learning of specialized words in medicine. In Malaysia, a mobile app, namely I-MMAPS was useful for users who attempted to speak a basic level of Iban language (Chachil, Engkamat, Sarkawi and Shuib; 2015). Thus far, it can be evident from the previous studies that the contents of the words selected by the previous research focused on English vocabulary in general. Only two studies dealt with the use of mobile app to learn specialised vocabulary (Chachil, Engkamat, Sarkawi and Shuib, 2015; Wu, 2015). This indicates a need to understand how mobile app integrating engineering vocabulary may benefit engineering students. Therefore, the innovation, namely, VocBlast is developed to critically examine the mobile app in assisting engineering students in learning specialised vocabulary in engineering.

Educational Theory

Activity Theory that was developed by Engeström (1999) and Liaw, Hatala, & Huang (2010) was used for the innovation of VocBlast. Six (6) components, namely subject (learners), tool (mobile devices), object (acceptance toward m-learning systems), control of learning, context of learning and communication of learning was involved in discussing the theory. In the theory, the learners were identified as the users of VocBlast. They used an operating system manufactured by Apple Inc. or iOS to run the mobile app in their mobile devices. Students' participation to use VocBlast is defined as their acceptance toward m-learning system in that they are able to access the mobile app at any time and location they prefer. Yet, the teachers set the control of how the learning takes place. Therefore, certain regulations were outlined by the teachers in that groups are assigned and each member should take turns to play any of the game in VocBlast, VocBlast can only be played outside the class hour and each group must complete playing all the games and levels. The context of learning is defined by the quality of system functions and physical context. Since VocBlast does not require a wireless connection, the system functions are not the issues when students are assigned to play the game. However, the limited number of iOS users is the hindrance for physical context. To rectify this problem, an iPad mini is provided to the group that is assigned to play VocBlast. Once the group has completed playing the game, the iPad mini is passed to the next group. Finally, all the processes that students go through in playing VocBlast generates communication of learning. This is when they share the knowledge derived from the vocabulary integrated in VocBlast in terms of its meaning, context and spelling. The Activity Theory is shown in Figure 1.



Teaching Strategies

VocBlast was used in Semester II and Semester III 2015/2016 sessions. Approximately 60 degree and diploma students were involved in surveying the usability of VocBlast as an instructional supplementary material for engineering students. Five of the total numbers of students were interviewed in a focus group discussion. The average age of the students (consisting of male and female) in both semesters was 20 years old.

Meanwhile, the content for the mobile app, namely VocBlast was formulated by the English lecturers teaching in Universiti Malaysia Pahang (UMP). The app was not used directly to teach specialised engineering vocabulary to the students, yet, they were assigned to play the game during their free time. As the procedures in playing the game, all members were required to gather at one location at an agreed time. They were also assigned to play at least two games in VocBlast. When playing the game, a logging book was used to record the name of the player and the game (Game 1, Game 2 and etc.) and sub levels (Sub level 1, 2 and 3) that he/she has selected to play. The duration in collecting the data to identify the impact of VocBlast lasted for four weeks in each of the semesters. This was due to the fact that each group that consists of five members needed to take turns in completing all the games in the app. It was recorded that each group played at least one hour to one and a half hours when they were assigned to play with the app. Once they have completed the game, they were required to fill-in the survey forms informing their perceptions of the use of VocBlast in enhancing their specialised vocabulary.

Impact

Overall, this work contributes to the existing knowledge in the field of mobile learning. It also enhances our understanding of students' motivation of using mobile learning. Finally, these data suggest that the use of mobile app for vocabulary learning may promote positive attitudes toward m-learning among students at tertiary levels.

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22. ACADS: AN EDUCATIONAL CARD AND BOARD GAME FOR BUILDING SENTENCES

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Introduction

The innovation; AcadS, extends the use of board and card games. Traditionally, card and board games are played separately and people may view that playing these games are merely for entertainment. However, existing research recognises the critical role played by board and card games in teaching and learning. For the former, a board game, namely Highway Code taught pupils in the secondary school concerning road safety as it was depicted in Gray, Topping & Carcary's (1998) study. A board game also improved young learners' numerical knowledge and therefore enabled them to practice it when classroom activities were performed (Ramani, Siegler, & Hitti, 2012). On the other hand, card games could be used to teach discussion skills to English as A Second Language (ESL) learners. In a study conducted by Reese and Wells (2007), the use of The Conversation Game enabled students at the tertiary level to learn common phrases that were helpful for participating in seminar-style classes. Moreover, the Picture Card Game in Lightbown and Spada's (1994) study enabled primary six pupils to focus on form when learning ESL. It can be seen from the previous research that all the studies focused on using either board or card game to teach learners certain skills and subjects. AcadS, however, is developed to promote fluency in the use of English among the students in higher education by playing both; board and card games. Thus, this innovation attempts to show that the combination of card and board games may improve students at the tertiary level especially in their writing skills.

Educational Theory

Cooperative learning theory supports the innovation of AcadS in that students learn when they are put in small groups. In playing AcadS, students are grouped into four to five members and help one another in restructuring and correcting the sentences formed by their fellow group members. Everyone needs to be interested and put their effort in teaching and learning with one another. Although the teacher may facilitate the learning, members may ask for help from each other as well.

Teaching Strategy

AcadS improves its players learning attitude when it is able to promote enjoyable and entertaining learning experience among pupils in upper secondary schools, students at tertiary level and adult learners in English training sessions to build sentences. This is due to the game exposes students to real learning opportunities as it encourages, entertains, and teaches students to build sentences in and outside the classrooms. When playing AcadS, the language literacy and skill can be fostered due to the material is able to help students in focusing and expanding their attention span trying to complete the game. Playing AcadS also improve students' social skills; in particular verbal communication skills in that players need to share, wait and take turns playing the game. In conducting training, AcadS can be used to help trainers in keeping the "energy" running the sessions.In terms of implementation of AcadS, it has been used by the students in English classes in University Malaysia Pahang for Semester I, II and III Session 2014/2015. It was also used as a language learning material in the English training session for students taking Diploma in Computer Systems Management (Level 4) at FELDA Prodata. A small number of secondary school pupils were also involved in playing AcadS to determine its usability.

Impact

AcadS enhances our understanding that conventional games are still relevant in the academia. Although technology is used widely in this millennium era, conventional methods combining board and card games should not be seen as obsolete methods for learning. AcadS, therefore, promotes fun in learning as students play and learn at the same time.

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23. GOOD PRACTICE OF POSTGRADUATE SUPERVISION IN BUILT ENVIRONMENT FIELDS

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Introduction

Doctoral research is a process of creating a new knowledge. Its endpoint is a thesis that clearly illustrates the novelty of the research in its conclusion supported by chapters of problem statement, literature, research methodology, and results and discussion. Good supervision generates a good thesis which means that supervision of a PhD study is a process. In this paper, the authors would like to share their experience on effective supervision for PhD candidates in the fields of built environment at Universiti Teknologi Malayisa. The mode of supervision pertains to PhD research in three fields of built environment, namely, architecture, landscape architecture and urban planning. Within these fields, we divide the mode of study into four types: exploratory, explanatory, experimental and descriptive. From the record of Graduate Student Management System at Universiti Teknologi, from 2012 to 2015, most of the studies are a mixture of explanatory and experimental types. As such the supervisory practice can be applied to fields of social sciences and humanities.

Teaching Innovation

We apply andragogy of adult learning theory by Knowles (1970s) in supervising PhD candidates. It means that the approach is collaborative learning where the supervisors are more or less equal to the candidates. A supervisor is behaving like a car instructor sitting beside the candidate who is driving the car. He poses the right questions that trigger the candidate to conduct the next step in his study. The questions are relevant to the candidate's research objective and scope of study. Steps taken by the candidate are part of the process of research, hence, each step is a forward move in his PhD study. This mode of supervision respects adult learners. We have practiced this supervisory mode at Greenovation Research Group since 2007 to more than 35 PhD candidates at the Faculty of Built Environment. The process of postgraduate study supervision is categorized into three phases: preliminary, intermediate and advanced.

Preliminary phase is the research conceptualization involving problem definition, construction of theoretical framework and review of literature. Students who are in their first and second semesters are required to participate in weekly gathering to present their reading log on the articles or chapters that they have reviewed and synthesized. The gathering is held at Greenovation laboratory which comprised of four professors (headed by the first author) and 16 to 20 PhD and 3 to 5 master candidates per session. Each presentation lasted a maximum of 12 minutes followed by a 10 minutes discussion. It enables the students to get feedback from their supervisors and fellow students, and permits them to know what subject to further review, latest development of research area, methods and parameters of study, and theories associated to the student's research. These are the materials for the construction of their research proposal. At week 14 to 15 of second semester, PhD candidates are required to defend their proposal to an evaluation panels assigned by the faculty. Hence, the preliminary phase prepares the students to produce a good research proposal. Upon passing this defence, the student can proceed to their data collection stage.

Intermediate phase is assigned to students whom are collecting data and analysing them to generate results. Generally, this happens in third and fourth semesters of the PhD journey. In the weekly gathering, they explain on how they collected their data either in the field, laboratory or archival records. They elaborate on the procedures of data collection on what was accomplished or what has not. They explained the parameters or variables that have measured and the research objectives that they aimed to answer. For those who collected data using more than one method and multi-source, they are advised how to triangulate their results derived from the major method to the minors and vice-versa. For those who have completed their analysis, they present their results in tables and figures. Supervisors and fellow students will pose questions on their interpretation of the results. The questioning session extends the presenter view and understanding on paralleling his findings with the past studies that he had reviewed during the research conceptualization stage.

Finally, at the advanced phase that is in fifth and six semesters, students whom are writing their chapters are encouraged to present their draft chapters. The basic chapter format include Introduction, Literature Review, Data Collection and Analysis, Results and Discussion, and Conclusion. Usually it begins with presentation of Results and Discussion in which the study results are written in the order to answer the research objectives. Using figures and tables, the presenter discusses how he derived them and what his interpretations, the findings. Questions are posed to them whether their findings affirm, modify or reject the theories or underpinnings described in Literature Review. In other words, this phase correlates the new findings of a PhD study with those of the past studies, thus illustrating extension of boundary of knowledge. Upon completion of reviewing the Results and Discussion, this phase proceeds to review the Conclusion of the draft. Here lies the novelty and originality of the study that expands the theoretical framework of a subject and adds new practical implication in the field of architecture, landscape architecture or urban planning. It also explains the inter-relationship between the three fields suggesting that research in built environment is always interdisciplinary. Lastly, in this phase, students are exposed to how to defend their thesis in a viva-voce.

Conclusion

The practice of weekly group discussion at Greenovation Research Group resulted in a majority of the students to complete their thesis at the end of the sixth or seventh semester that is within the graduate-on-time duration as stipulated by Ministry of Education Malaysia. The largest percentage (68%) of them attained B1 Grade that is passed with minor corrections. This is far better than the average performance of PhD graduates at Universiti Teknologi Malaysia that is only 26% passed with B1 Grade in 2014. The authors posit that this practice can be emulated to other disciplines in Social Sciences and Humanities.

24. TOOLS TO SELECT SUPERVISOR FOR FINAL YEAR PROJECT

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Introduction

Research methodology and pre-project is closely related to Final Year Project. It is compulsory for all students to take this course before they carry out the Final Year Project. There are two parts in this course. The first part is aresearch methodology class where students are exposed to various aspects of research including types of research, method of literature review, research design, results and analysis, writing of thesis and journal and also presentation skills. The students will also be exposed to the problem solving methodology, decision-making and data collection process. This helps to prepare the students for the Final Year Project. The second part of this course is called as pre-project where students will conduct a literature review under the topic given by their supervisors. At the end of this course, the students have to submit a proposal report for their final year project.

How do the students get their supervisors? This is based on what the students prefer. Previously, the students were asked to find their supervisors on their own where they would meet the academic staffs to find out the topics offered by the academic staffs. Should a student decide to undergo the project under the topic offered by an academic staff, and the academic staff agreed to be his supervisor, then, the student would fill in a form. The form must be signed by the academic staff who has agreed to be his supervisor. The form is then submitted to the Academic Office. However, this procedure has a drawback in that some academic staff supervise too many students. This situation has caused some other academic staff not to have any students to be supervised. Furthermore, too many students being supervised by an academic staff may lead to the academic staff being unable to check the report properly, and thus, poor final year project reports are produced.

Teaching Innovation

In order to minimize the situation whereby some academic staff having too many pre-project students, a program was written by using Visual Basic for application. This program is used by the students to select their supervisors. First, the coordinator of the pre-project has to decide the limit or the maximum number of students that can be supervised by an academic staff. For instance, the limit or the maximum number of students that can be supervised by an academic staff is three students. Thus, if an academic staff has been selected by three students, then his name will not appear in the list of prospective supervisors. The students select their supervisors by highlighting a name in the list of prospective supervisors. By not having his name appear in the list of prospective supervisors, students are unable to select him. In this way, no academic staff may have more than three students which is the limit set by the coordinator.

This program also allows the students to change their selection of supervisors. For example, a student who has selected Mr A to be his supervisor has changed his mind where he now, wants Mr B to be his supervisor. The program will then, cancel the student's name under the previous supervisor who is Mr A and record the student's name under a new supervisor who is Mr B. The program simultaneously updates the new number of students being supervised by the previous supervisor, Mr A. In fact, the program has the ability to cause Mr A's name which does not appear in the list of prospective supervisor as he has reached the maximum number of students allowed to be under his supervision, to reappear once one of his students cancels him from being his supervisor.

This program also allows individual limit of number of students being supervised by the academic staffs. For example, the maximum number of students allowed to be supervised by each academic is three. However, there is an academic staff who requests to have only two number of students, Thus, the program can be set to limit this academic staff to have not more than two students under his supervision while the rest of the academic staff remain to have not more than three students to be supervised.

This program is also designed to keep track the time any student begins to use it and record his activity. For example, a student may select his supervisor for the first time, or he may change his supervisor or even do nothing when he enters this program and exits without doing anything! The students are also able to check who their supervisors are, in case they forget or want to confirm that their selection of supervisor has been recorded.

The program immediately saves the data once a student finishes selecting an academic staff to be his supervisor. The selection process only takes two minutes for each student as it is a very simple program. The students are given three days to use this program to select academic staffs to be their supervisors. After that, list of students' names and their corresponding supervisors that they have selected is posted and can be reached via a link provided in the facebook of the students representative. Academic staffs are informed through e-mail.

The system that is introduced successfully controls the number of students that can be supervised by each academic staff. There is a reduction in the number of academic staff that have no student to supervise and no academic staff that have too many students to supervise. The system also allows every student to select an academic staff to be his supervisor. Before the introduction of this system, a few students were unable to get a supervisor and thus, the coordinator had to assign academic staffs to become their supervisor.

Conclusion

Another system that has been practised in the research methodology and pre-project course is the evaluation of the pre-project on its suitability and scope. Each student is assigned with an evaluator who is an academic staff who is not his supervisor but is an expert in the research area of the project the student will undergo. Every student must meet his evaluator and bring his proposal to the evaluator. The student will present his pre-project to the evaluator and he will be interviewed by the evalutor. Then, the evaluator will write comments and suggestion in a form and submit it to the coordinator. The copy of the filled form is later, forwarded to the supervisors so that actions can be taken to improve the final year project that the student will undergo during the following semester. Students who do not meet the evaluators will fail the research methodology and pre-project course. What is hoped from the two aforementioned systems is to produce good quality projects and reports.

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25. SELF-DEVELOPMENT TEACHING MODULE

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Introduction

The new transformation of technical and vocational education has led to changes in the aspect of facilities, curriculum and teaching materials being used in Vocational Colleges. Nowadays, the teaching and learning process at Vocational Colleges is based on module. Due to the absence of standard academic module, novice teachers are required to develop modules for the purpose of teaching and learning and this scenario has created many problems. Novice teachers lack the skills to develop or produce teaching notes. Furthermore, they depend too much on hand-outs or textbooks given by the Ministry of Education as their teaching resources and students exercises. Some teachers take the initiative to utilise the internet as to avoid the need to produce own materials. Therefore, this effort was carried out in view of the strong demand for the development of modules, particularly for Vocational Colleges in order to overcome the issue of lack of standardized teaching materials for technical and vocational subjects taught at the colleges. In addition, the task provided students with the exposure and experiences in developing teaching modules which should give them many advantages as future teachers. Hence, applying the development of teaching module in the assignments of undergraduate education students can enhance their skills in developing modules which is useful especially for those who will be teaching at Vocational Colleges. Consequently, the integration of developing self-development teaching modules as part of the assignments for Faculty of Education undergraduate students has given them the skills they need to become competent technical and vocational teachers.

Teaching Innovation

Thus, the self-development teaching module was implemented as one of the assignments to students of building construction program at Faculty of Education, Universiti Teknologi Malaysia as an effort to expose them to the methods and process of developing teaching modules. The courses involved were Domestic Piping (SEM 1 2014/2015) and Building Services (SEM 2 2014/2015).This assignment was given to the students the first week when the semester started. The students were given 12 weeks to prepare, design, develop and test their modules. The module content was based on discussions with expert teachers and should reflect the syllabus set by the Technical and Vocational Education Division. It was to ensure the validity of the developed content. In developing the modules, students should follow a few learning theories and models such as ADDIE model, Sidek's module construction model, cognitive load theory, Sharifah Alwiyah's module construction model, and Shaharom model. Most self-teaching modules are designed based on the same principles and according to Mayer (1998), the self-teaching module components consist of 8 components. The first component is instructions on how to use the modules, followed by statement of objectives and aims, lists of pre-requisite skills, lists of learning objectives in forms of achievements, pre-diagnostics tests, lists of tools and other sources needed, teaching activities in sequential forms and lastly post-test control.

In addition, this module also possesses a number of criteria to ensure its effectiveness such as having easy and accurate instructions and suitable to be used by students of different levels of achievement. Furthermore it must contain adequate number of exercises with various elements of assessment. The self-development module also must consist of important structures which can ensure systematic and orderly delivery of content. It is developed using a systematic structure consisting of title or subject statements which display the structure of the curriculum grid module. There is also a manual on how to use the module which gives references on the symbols used, aims of lessons and prerequisites skills and knowledge which are stated clearly. In addition, general teaching objectives are written at the beginning of every unit along with list of equipment and resources that should be used together with the module. References and teaching activities are also included in the module. Various aspects need to be considered during the development of the module since it should be able to give positive impression to potential students. Thus, the module has been developed through several stages before it is suitable to be used by students. The modules should have the following characteristics namely; for designing the modules are complete basic, promote self- learning, concern for individual differences, have statement of objectives, relations, flows and possess optimum knowledge structures, use various media sources and approaches. Furthermore, information in the modules should also provide feedback at different levels of students' progress such as feedback on the immediate reinforcement, feedback on the active participation of students and control strategy for evaluation. The modules went through an evaluation stage whereby their validity and reliability were tested. In addition, all the modules were sent for plagiarism check using the Turnitin software. Finally, students were asked to obtain copyright from UTM. Thus, evaluation of the assignment on Module Development was based on a set of rubrics which assess the modules' quality, content, design and language. Experts' feedback was also being considered in the evaluation process.

Impact

Based on the students' feedback at the end of the semester, the developments of the modules have created positive impact among undergraduate students. This task has trained them to become skillful in producing their own teaching resources. In addition, Vocational College teachers also benefit from the development of the modules since the Department of Technical and Vocational Education only provides syllabus to the teachers. Each teacher prepares his or her own lesson and this scenario has resulted in inconsistencies in the presentation of teaching content among teachers at Vocational Colleges. The practicality and benefits of the modules is proven when the teachers at Vocational Colleges are interested and willing to buy them from the students. In addition, reference discrepancy in the use of resources for teaching can be solved as there are various resources available in the module. The ability to develop teaching modules is a prerequisite among technical and vocational students from Faculty of Education, Universiti Teknologi Malaysia since they will be future teachers at Vocational colleges. There is also the potential to commercialize the teaching modules especially among the high quality ones. Undoubtedly, the use of self-development teaching module promotes uniformity and systematic teaching and learning process. In addition, teachers can take advantage of the training content in the module as a resource to carry out assessment. In addition, there will be no inconsistency problem with the content of the final semester questions prepared by teachers. Furthermore, module development can help fellow teachers who have difficulties to deal with technology as well as those who believe that application of technology in classroom is expensive and unreliable. In conclusion, the skills to develop self-teaching module are beneficial to future teachers in order for them to create quality teaching resources.

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26. KNOWLEDGE- DRIVEN AND SOCIAL ENTREPRENEURSHIP BASED CO-CURRICULUM: FROM UITM TO THE WORLD

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Description of the Engaged Initiative/Project and its Uniqueness

We are change makers made up of students and lecturers from University Teknologi MARA. Malaysia. Having taken up the challenge of providing clean water and meeting the community needs of Kampung Ampel, Cambodia we engaged in various social entrepreneurship and fundraising projects and conducted three humanitarian missions to Kampung Ampel, Cambodia within the period of two years. Our aim is to build an enduring relationship with the community in need, while meeting their needs in a sustainable manner. We promote community engagement projects and community based research that will spread awareness of the water crisis in developing countries. This mission has helped us be the voice of people who live on less than a dollar a day and our motto is "Everyone is a change maker."

The Community Networking Unit, UiTM in 2013 and 2014 undertook two international humanitarian missions to Cambodia, the Waqf Telaga Kemboja and Ibadah Qurban and Aqiqah as well as several humanitarian & fundraising projects with the Rohingya refugees and orang Asli. The student initiated missions were in collaboration with MERCY Malaysia and Al-Il'tisam Relief Program (ARP), local NGO's with established record of involvement in various local and international projects. The various projects mobilized university students and academicians, professionals in the field of mechanical engineering, building conservation, education and medical care for the sole purpose of improving the community quality of life and eradicating poverty.

The **innovative** elements in these co curriculum projects are:

- The missions were student initiated and student led, thus leadership and student engagement were par excellence. This meant that students must conduct needs assessments and sufficient research before embarking on the projects.
- The projects were knowledge driven and based on social entrepreneurship. Students and faculty members participated in voluntary humanitarian projects involving water assessment, water management, risk management, education and fund raising. Everyone must network and raise funds and the University provided no financial assistance.
- It was compulsory for all participants to attend induction training

and collaborative meetings with NGO's that enlightened them on youth volunteerism, social entrepreneurship and networking with professionals.

- The projects provided an opportunity for the university to embark on poverty eradication and knowledge transfer projects, thereby conducting its third function of public advocacy and community engagement in a sustainable manner.
- The projects are serious philanthropic enterprises, requiring community engagement, feedback and continuous interaction. We propose moving away from the one off, short term service learning towards a sustainable and long term relationship with the community.

Multiple benefits of knowledge driven and social entrepreneurship based co curriculum:

1. It is a more effective and meaningful method of service learning when students are in the driver's seat.
2. Youth grant makers develop language and planning skills, mathematical and budgeting skills. Project management improves their critical thinking, problem solving and public speaking prowess. All these aid youth development and enhance graduates' employability.
3. Philanthropic work empowers youth to take charge and initiate charge, providing them the opportunity to be a giver and not a taker. By involving youth in philanthropic deeds, as adults, they continue to give and serve civil society (Agard 2002). Many of the participants have graduated and are now actively involved in philanthropic and social work such as feeding the poor and providing flood relief aid.
4. Such projects provide safe, secure environments for youth and opportunities to develop and grow. Working with NGOs and members of society helps them to forge positive relationships with adults and peers, establish connections with community and improve their capacity to lead.
5. We propose the concept of youth philanthropy promoting a cultural shift, away from viewing youth from a deficit perspective, to a culture of viewing youth as assets to the community and society as a whole.

Summary of the measurable outcomes

Mission 1, September1-5, 2013 Waqf Wells for Cambodia, Construction of 36 fresh water wells at a cost of RM54,000.00, assessment and rehabilitation of Baitul Rahim Mosque, one of the original mosques built in 1914, Donation of RM10,000 for the completion of Baitul Nur Mosque, distribution of 400 hygiene kits, distribution of zakat and financial aid to religious teachers and the poor, makeover of village school, production of travelogue and visual audit of the village.

Mission 2, October 10-15 2013 Ibadah Qurban and Aqiqah, The qurban and aqiqah of 104 cattle valued at RM203, 840.00, Eid ul Adha feast for 1000 people, free circumcision for 50 boys, free medical checkup for the elderly, Smart solat workshop for children and fardu ain classes for women, and analysis of water samples by the Faculty of Applied Science, UiTM.

Mission 3, 27-31 May 2014, Upgrading and monitoring of fresh water Wells, Operation Lice (Ops Kutu), 2 series of Smart Solat workshops for Kids , Distribution of clothes and prayer mats, First Malaysia & Cambodia Sports Telematch , Science is Beautiful Workshop for Children, Prototype of Mechanical Water Pump, Aqiqah and Feast for 500 people and the First Malaysia and Cambodia Qasidah Concert.

We hope we have been able to make a difference to the village of Ampel, Cambodia and will continue to be their voice.

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27. THE EFFECT OF PROJECT BASED SERVICE LEARNING ON THE SELF-EFFICACY

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Abstract

The purpose of this study is to explore the effects of Project-Based Service Learning (PBSL) on engineering students' perceived self-efficacy. Though engineering education in Korea somewhat lagged behind other fields in implementing PBSL, a few engineering programs have started to run PBSL recently. Service learning has risen as one of the education methods, which is defined as "a course-based, credit-bearing educational experience in which students participate in an organized service activity that meets identified community needs and reflect on the service activity in such a way as to gain further understanding of course content, a broader appreciation of the discipline, and an enhanced sense of civic responsibility" (Bringle & Hatcher, 1996). Applying PBSL to engineering fields is growing in popularity because engineers with strong technical skills coupled with an understanding of how to apply engineering in service to the community and the greater good are able to provide great benefits to society (Lima & Oakes, 2014). There have been significant increase in perception of personal empowerment to make changes in society through PBSL. PBSL can help engineering student attitudes and identity changes.

In Korea few researches demonstrating the positive effect of PBSL yet, especially on self-efficacy, augment the necessity to scrutinize its effect. The community Service Self-Efficacy Scale (CSSES) used in this study is indebted to Reeb et al. (1998). Results from this study show that students who have participated in PBSL program demonstrate more positively perceived self-efficacy than the control group. The more students are satisfied with PBSL class, the more they feel they can help in promoting equal opportunity and social justice. Student participants reported that they feel confident to help communities in need. PBSL experiences can benefit community members as well as student participants. The community partners engaged in PBSL feel very satisfied with the outcomes even though it was unfamiliar to them. Despite the salutary effect of PBSL on students' self-efficacy, however, students pinpointed necessity of more flexible curricula and coaching project management, and time management for improvement of PBSL in the future.

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28. FUZZY LOGIC BASED CGPA INFERENCE TECHNIQUE FOR HIGHER EDUCATION ACADEMIC ASSESSMENT

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Introduction

Academic success in higher education is said to be correlated to student academic backgrounds from their secondary school. This is apparently true as most of them are facing difficulties to achieve good academic performance in higher education probably due to being unfamiliar with the university system, environment and underestimating the education system. The student drop out from higher education can be as early the first academic semester in university due to incompetence to understand the contents of the course offered, and the assessment system that is based on the Cumulative Grade Point Analysis (CGPA). The first semester is a very significant period for students in higher education to plan and achieve the expected academic performance upon graduation. Even though explanations are provided during the induction week, students are still incapable to imagine the assessment system as they have never been exposed to such system that actually determines their performance. Several works on the academic records recognized that there is a need to assist the students to predict their future estimated grade they could obtain based on several core courses registered. It is expected that the system will inherently teach and train students to be more responsible in pursuing better academic results in higher education.

Teaching Strategy

Technology has transformed the way of teaching and learning rapidly for both instructors and the students. Both of them are now familiar with active learning, cooperative learning, and other techniques as well as those that suit different situations. Since the 90's, most of the education field especially in science and mathematics have adapted constructive learning in building up student competencies in the field. The proposed system uses fuzzy logic approach as a method to estimate the students' academic performance in higher education upon their graduation based on some core courses in electrical and electronics engineering. This technique fell under constructivism theory that applies the previous student academic records which shows some academic performance patterns to define the probability of CGPA upon student graduation.

The idea came from the experiences gained based on the students' academic performance which has generally shown similar patterns that students' achieved in a number of semesters. The field of electrical and electronics covers a lot of courses that affects the students' understanding through clear communication along with skills development, practise and continuous motivation. Students consistently seeks information and reasoning on what they have achieved and what will they benefit from it. As a result, they will need to develop their own strategies to pursue the best on their academic performance. As the courses offered are often inter-related to each other, the students needs to master it, organize it and then estimate their performance based on the cognitive information attained previously. These procedures which are complex and non-linear indirectly teach the students to be independent and has the ability to act accordingly based on their study conditions experienced in every semester. However, not all students can predict their academic performance in a short time especially during their first and second years in university. Hence, there is a demand to create a system which can include and relate courses performance, and at the same time model the outcomes in a way to describe that performance in certain courses can directly affect their academic results. The constructive knowledge gained from those courses will assure that students will have better results during their graduation.

As contructivism is a learning theory, the system which applies the experiences, the academic records, and learning environment attempts to behave as an inference system to assist student in their academic progress. Besides giving advices on how the students could obtained by referring to their specific semester academic performance, the system offers technical suggestions that a student can rely to. It will also be an alternative solution for them to observe what will happen in near future if getting unexpected results in a specific semester. More interestingly, the proposed system is not only limited to the use for first year student, but also applicable for 2nd year and 3rd year students in electrical and electronics engineering. This will help students pursue their interest and has specific purposes of their future employment with proper knowledge and skills on electrical and electronics engineering.

Actual result	Fuzzy result					
	Trapm	Accuracy (%)	Gauss	Accuracy (%)	Trimf	Accuracy (%)
3.54	3.46	98	3.6	102	3.59	101
3.8	3.48	92	3.62	95	3.61	95
3.51	3.46	99	3.64	104	3.67	105
3.87	2.05	53	3.5	90	3.57	92
3.78	3.46	92	3.33	88	3.58	95
3.77	3.07	81	3.37	89	3.24	86
3.84	3.48	91	3.43	89	3.61	94
2.92	2.05	70	2.71	93	2	68
2.87	2.05	71	2.38	83	2	70
3.33	2.05	62	2.93	88	2	60
3.15	2.05	65	2.97	94	2	63
2.95	2.05	69	2.74	93	2	68
3.67	2.05	56	2	54	2	54
3.54	3.48	98	3.45	97	3.54	100
3	2.74	91	2.67	89	2.96	99
3.46	2.05	59	3.48	101	2	58
Mean of Accuracy		78		91		82
Possibility		Lowest		Highest		Middle

Practical Reasoning through Selective Courses

Our approach analysed eight main courses in the field as the input and then predicts the CGPA upon graduation. These courses are among the main courses in electrical and electronics engineering agreed by the faculty member based on their experiences, and knowledge. In constructivism theory, the instructor is now only responsible to facilitate the discovery made by the students that teach them about the consequences of having specific academic results in each semester. The system only provides the outcomes if certain results are obtained, but the students need to respond effectively to guarantee better academic results upon their graduation. This can be realized through a series of action plan that student needs to work on. In addition, there always exist obstacles during the processes. However, corrective actions can overcome these if they are properly considered through the stages.

The design stage has includes some experiential data which have been collected randomly from previous academic record of student grades covering five different batches to validate and compare the predicted result. It inherently includes various student learning styles and requires student reflection on what they achieved. The proposed system is built to process the grades then produces the estimated Cumulative Grade Point Average (CGPA) as the output. Preliminary results depicted that the results can be applied to every student even though they probably have different academic backgrounds before their admission to university. Interestingly, it was also found that the estimation result can also be inferred upon student completion on their first year study by only calculating four courses as the input.

The proposed technique offers several advantages to a student such that a student can plan better their study by targeting the best grades they could obtain on several courses to pursue excellence academic results. To realize this, student should proactively make their own strategic plan on what they should focus and achieve as soon as they understand the simulated scenarios. Only then, they can gain better academic performance and this could also result in shorten their study in university as well as reducing the financial cost. Furthermore, the system can indirectly train the student to be more independent and think wisely in making decisions. If a student life-long learning skill has been developed, then the human capital is increased and finally generates higher economic growth. Moreover, if these behaviours are well-equipped to the students, they should be able to develop and prepare themselves effectively for job recruitment. Subsequently, stakeholders will have better workers, higher graduate employability rate and finally helps to improve the economic growth.

Results and Discussion

This research has been developed into two stages which during its initial stage, the program was fully developed through Matlab Simulink and Fuzzy Logic Toolbox. The results are then being analysed and tuned to infer the best possible estimation for the CGPA through 6000++rules. It was then improved from 6000++ rules to only about 270 rules to execute the system. The second stage presents the system being designed using Java Platform. Both models suggest that Fuzzy Logic can be applied to estimate the student CGPA upon their graduation.

Table 1 assessed the overall performance of the proposed system considering those eight core courses as the inputs.

Table 1: Comparison of performance for sixteen different students for four inputs

As demonstrated above, the best membership function is the gaussian membership where the performance has higher accuracy than the other two available membership types. From a number of simulation analysis being carried in this research, there is a possibility that other memberships could also be the best solution. It depends on the how the system tunes the membership function and how the rules are being constructed. The proposed system generally applies the minimum mark grade that the student obtained for the courses. As a result, the estimated CGPA is showing the lowest CGPA that a student could get upon their graduation.

Conclusion

The developed system is a new approach for the academic performance prediction or estimation which is systematically based on the experiential data on course grade performance. The proposed system has been proven to be capable of inferring the students' academic results about their CGPA upon their graduation. Thanks to this system, the students can plan their studies effectively and at the same time could improve their performance by selecting the proper courses and aim for the best grades especially on the mentioned eight main core courses. This is very important as most students, especially the new students, are not used to the university academic system and have to face the same problem each new semester. Besides, the system aids the university and community as well to develop the individual student skills and competency especially on the leadership skill, higher self-esteem, and good responsibility. More importantly, the proposed system supports the Outcome-Based Education through affective behavior that a student inherited during the implementation of this system and generates human capital excellence.

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29. STEM SUSTAINABLE EDUCATION AND INNOVATIVE RECYCLING TECHNOLOGY

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Abstract

The lack of interest among lower secondary students to pursue their studies in science stream in upper secondary school and on to university is a challenge to the education system. Furthermore, student achievement in science and mathematics subjects, which slightly decreased at lower secondary school level also give a negative reputation. The educational philosophy of Malaysia National Science Education is "science education in Malaysia fosters a culture of science and technology with a focus on the individual development of competitive, dynamic, robust and resilient and able to master the science and technology skills" (Ministry of Education (KPM), 2010). In line with this philosophy and strive to provide the human resources of developed countries, the Ministry of Education has targeted the science and arts student ratio of 60:40. Fatin et al. (Undated) discussed about the cause of decline of student participation in science and also expressed about the possible implementation of STEM education in Malaysia in order to overcome this situation. It is intended to attract students to learn science and mathematics because life is increasingly dependent on technology. The interest of learning science and technology should be nurtured among students as early as early education. The attraction of learning science and mathematics also depends on the process of teaching and learning. A better approach is if the subject being studied may be associated with students' life activities. Issues that are closest to the student's life are environmental problems such as waste generation. With this problem, the sutainable solution can be done with STEM knowledge through innovation recycling technology. Therefore, this study aims to develop a model of STEM sustainable education through innovation technology in recycling at university and secondary school level. This model will be associated with the theory of science, technology and engineering subjects. It attracts, and at the same time can improve their concerns of the care of the environment and enhance students' thinking to a higher level of invention. Zaini (2010) related the low-carbon world state on climate change has a significant impact on the concept of technology and economic progress. The impact of climate change is linked to the phenomenon of natural disasters such as floods, droughts, erosion and other natural disasters. Energy saving technologies, recycling and green building are the innovative technologies needed to tackle these problems. Therefore, students need to be exposed to environmentally friendly technologies such as recycling technology in creating interest and their love for science and technology. Education is an important component that could influence and shape the practice and culture of caring for the environment. Based on STEM educational needs with regard to environmental and sustainable development, particularly in the engineering field, efforts are being made to develope STEM educational model that has been implemented in accordance with the sustainable development concept. Sustainability is environmentally friendly (reduces environmental pollution) and can reduce costs and increase revenue. Environmental education in STEM needs to be provided to students to imbue them with the concepts of environmental stewardship and sustainable design. More importantly, it is their responsibility to ensure that their decisions and actions are taken in the interest of environmental preservation. STEM sustainable educational model should coincide with the needs and requirements of the current Malaysian educational system. Shahrom et al (2012, 2013 & 2014) have discussed about how environmental education and sustainable development can be served through recycling activities in the higher education system in Universiti Kebangsaan Malaysia. The component of innovation and creativity can have a profound impact on the science presented to students through recycling technologies.

Keywords: Engineering, Innovative Recycling Technology, STEM, sustainable education

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30. USING ACTIVE LEARNING AND COOPERATIVE LEARNING APPROACHES IN TRADITIONAL LECTURE-BASED ENGINEERING CLASS: A CASE OF DYNAMICS COURSE

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Introduction

In recent years, like any other higher education provider, we face a challenge in sustaining the interest of students who are diverse with a variety of needs and purposes. Furthermore, there is a global trend to move from traditional lecturer focused teaching and learning to student centred learning where the role of the lecturer is to be a facilitator and coach of the learning environment(Tryggvason and Apelian 2012). The stakeholders, specifically the employers expect the graduates to have skills in teamwork/collaboration, critical thinking and problem solving which requires adjustment on the way we conduct the teaching and learning process in higher education. In addition to these factors, we should also look into how students learn. The innovative teaching and learning practice presented here tries to address these challenges.

Most of the students in traditional lecture based class are passive during teaching sessions. Even in tutorial classes, lack of student engagement is an everyday problem. It has been proven in educational research literatures that one of the factors in successful learning is by doing which have higher retention rate compared to listening or reading. Thus, we employed instructional methods that promotes student engagement (i.e. active learning and cooperative learning) that allow students to become active and engaged. In active learning, the student learn by doing whereas in cooperative learning they learn by doing with others. The other aspect of cooperative learning is peer teaching where the team members teach each other.

Reflecting on our teaching and student performance in the previous years for Dynamics course, we noticed that our students had difficulty in retaining the concepts they learnt for a long time and attaining all learning outcomes of the course. Dynamics is a 3 credit hour core course in Mechanical Engineering Programme for second year second semester students at Universiti Teknologi PETRONAS. On average, there are about 100 students in the lecture class and the tutorial class is arranged with a maximum of 30 students per session. In the previous years, we used traditional lecture-based methods in the teaching and learning process. Currently, we are using active learning methods for our lecture class and cooperative learning for the tutorial sessions. We noticed that active learning and cooperative learning techniques increased student's engagement and participation in the learning process. Our experience and practices in adopting these innovative teaching methods are described below.

Teaching Innovation

In active learning the students are engaged in the learning process through activities. Research shows that active learning leads to better student attitude, improved student thinking and writing, improved retention of materials, and motivates student to further study and become lifelong learners (Prince 2004). A recent study conducted on undergraduate science, engineering and mathematics courses shows that there is significant improvement in student performance using active learning methods compared with traditional lecturing(Freeman, Eddy et al. 2014). With these advantages in mind we adopted active learning approach in our lecture. Among the variety of active learning approaches in the literature, we implemented Think-pair-share and concept questions(Felder and Brent 2009).

Our tutorial sessions in the past include selected activities to be done in class where the students are expected to solve problems. Mostly, the students come to tutorial session to get the solution for the tutorial problems and their attendance was poor. To overcome this and improve student engagement, we use cooperative learning approach by forming cooperative group that remain throughout the semester. Cooperative learning has been defined in the literature as a structured form of group work where students pursue common goals while being assessed individually (Johnson, Roger T. Johnson et al. 1998, Prince 2004). The team was formed based on their grade in the pre-requisite course (Statics) where each time have high, medium and low achievers. While solving a given problem as a team, the participants maximize their own and each other's learning. In performing the activities, individual accountability, positive interdependence and promotive interactions are the key pillars of the team. Regular assessment of team functioning was conducted in our practice. A previous study by (Herrmann 2013) shows that when cooperative learning was introduced in tutorial sessions, students increased their in-class participation which is similar to what we observed in our tutorial sessions. In addition to nurturing the problem solving skills of the students, cooperative learning eliminates competition and promotes working together which results in shorter learning time while developing social skills and teamwork. Even though a comparative study was not conducted in the implementation of the cooperative learning approach in our classroom, previous study by (E. Asyali, Saatcioglu et al. 2005) shows statistically significant increase in positive interdependence in teams, team processing and individual performance in a teams.

Changing from traditional lecture based class to student centred active learning approach requires constructive alignment. In constructive alignment we systematically align the teaching/learning activities, as well as the assessment tasks, to the intended learning outcomes(Biggs and Tang 2011). In our previous practice, the course contents and assessments are aligned with the learning outcome. When we implement the new approach, student engagement in the learning activities and the assessment methods has been revised to incorporate the new active learning approach and aligned to the course learning outcomes.

Implementation of active learning process requires longer preparation time and careful planning. We prepared the lecture material to suit active learning approach according to bookend procedure with concept tests(Smith 2000). All exercises were planned to be completed in less than three minutes. If the problem to be solved requires more time, we decomposed them into sub-problems where the lecturer guides the students step by step. In the exercises during lecture, we use think-pair-share where we pose the problem and have students work on it individually for a short time; then have them form pair with their neighbor and reconcile and improve their solutions; and finally we call on few individuals randomly to share their responses to the whole class. Even though these approaches take more time and it has become more difficult to cover the syllabus, it include individual thinking which leads to greater learning. To address the issue of time, we prepared a number of guided learning activities where the students can practice on their own. All lecture materials were posted on e-learning one week before the lecture with concept questions at the end. The students have to read and attempt the concept questions before they come to class. We introduced a five-minute paper to assess the progress of the active learning every fortnight towards the end of the lecture. Relative to what we had in traditional lecture based classes, we noticed improved student engagement and interest during lecture with almost full attendance.

The tutorial questions suitable for cooperative learning approach were prepared and posted on e-learning one week before the tutorial session. The team acts as peer study group outside class. Each team has maximum of 5 members and there are 6 teams in one tutorial session. The room is equipped with three white boards and round tables for each team suitable for group discussion. One lecturer and two graduate assistants facilitate the tutorial session. One representative from each team will discuss with the whole class. Towards the end of the tutorial session, there will be a quiz which each team member will solve individually, then solve the same problem as a team with 50% individual and 50% team mark distribution. After completing each major topic (4 in total) the team has to revise and submit a closure review in poster format. The assessment of the closure review consists of peer review and by the lecturer. Thus, while working within a team, the students are assessed as an individual by their teammates which enhances individual accountability(Herrmann 2013). The posters will be displayed in the tutorial class and helps the students to learn from other teams' reviews and compare with their team poster. In addition to this, we introduce "Dynamics Clinic" fortnightly where the students can come and consult the lecture. This gives chance to the students to get clarifications where they miss from the lecture, tutorial and team learning activities.

Impact

Overall, the outcome of this implementation is good and encouraging. The students' feedback was also positive. One of the limiting factor we observed was time required from the lecturer. We found out that implementation of active learning and cooperative learning requires good planning and preparation in addition to commitment and belief. Making the students aware of the new approach and convincing them to work hard and adapt to the changes is also important. The students who join the course during add and drop after the briefing needs special attention to assimilate to the system. A continuous quality improvement approach where we reflect-plan-apply-evaluate is in place to assess the outcome of the implementation in a cyclic manner. We would like to implement the active learning and cooperative learning methods described in this paper in other courses as it has significant impact on student learning, engagement and performance. It is worth mentioning that cooperative learning leads to teamwork/collaboration in problem solving which is one of the attributes of higher education graduates sought by the employers.

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31. TEAMS THAT TEACH AND LEARN USING STEERED MODULE (TELUS MOD) IN CIVIL ENGINEERING COURSES

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Introduction

In Universiti Malaysia Pahang civil engineering program, it appears that the current students show a learning behaviour which is too dependent on lecture contact hours. Most students do not realize that actually almost 70% of the notional learning hours should be student's own individual self-learning hours. Still, very few students learn individually on their own, but yet it is hard to ascertain this claim. Therefore, this practice presents an introduction of team-learning methods to student with aim to help them in appreciating their individual self-learning hours into team learning. This team use the TELUS MOD that will requisite them to learn with each other and also teach each other without direct supervision from instructor. These include the aim to help poor performing students to improve their study.

Approximately 70% from notional learning hours must be conducted by the students themselves apart from the lecture contact hours. It is an unproved fact that even if the lectures implement active learning to students during lecture, if those 70% of self-learning hours are neglected by the students, there are possibilities that they are still on the road to become passive learners. To monitor students on their own individual learning hours is something that is quite impossible to do by the instructor in the end. There is a need to reform the homework for student rather than giving conventional assignment and project.

This practice has a goal to apprehend this by developing a steered semi inquiry-based module that helps students to teach and learn among themselves without supervision from instructors. It was based on inquiry method where the approach relies on the idea that real understanding and learning require active restructuring on the part of the learner; integrating new knowledge with previous knowledge and beliefs, identifying and resolving contradictions, generalizing, making inferences, and posing and solving problems (Hanson, 2006).

For some students, they claim that studying alone is much better for them to gain knowledge and skills. However, facts show that learning in groups have many advantages than learning individually in college (Biggs & Moore, 1993). Studies show that one of the advantages of studying in groups is that the students will be exposed to alternative perspectives and develop critical thinking skills (Fong, 2010).

Team learning also helps improve social skills by peer discussion and argumentation (Jaques, 1991). To achieve this, studies have shown that a well-structured assignment, instructor-formed groups and relevant course content are all very important for the success of team learning (Fong, 2010). With those past studies, this practice of learning was conduct to apply a learning method called'Teams that Teach and Learn using Steered Module' (TELUS MOD) that involve excellent and poor academic student for continual civil engineering Structure Analysis.

'I hear and I forget, I see and remember, I do and I understand' summarize the significance of active learning during lecturer contact hours. With TELUS MOD, the practice also aims for the quick learner to reach the level 'I teach and I master' since this module will encourage them to help the slow learner in developing their knowledge. This aim is supported by Fong (2010) that engineering students enjoy team learning because it grants them opportunity to discuss and interact with others. This later becomes incentive for their learning as they receive encouragement and support from team members.

The goal of this practice is to enhance students' own learning process through the steered module (TELUS MOD) that help them to study with their peers. The teams itself will be led by good performing students so the effect of learning and teaching in the team will be achieved. The specific objectives of this practice are:

- To develop a well-structured module for continual structure analysis subjects that are Engineering Mechanics, Mechanics of Materials, Theory of Structure and Structural Analysis.
- To improve students' performance by evaluating course outcomes results.
- To evaluate the performance of TELUS MOD based on program effectiveness and performance of Course Outcomes.
- To study the effect of team learning through solicit student's feedback on the subject of learning in small teams on their individual learning hours.

Teaching Innovation

This learning method was conducted in the Faculty of Civil Engineering and Earth Resources of University Malaysia Pahang. In the Civil Engineering Degree, all students are required to take the four continual Structural Analysis courses that are Engineering Mechanics, Mechanics of Materials, Theory of Structure and Structural Analysis. The courses are arranged with requisite to each other begin with Engineering Mechanics. Previously, team learning assessment is insignificant feature in those courses but student have to form teams to finish some assignment and a project depending on the course.

Corresponding to that, TELUS MOD was embedded in the course of Theory of Structure from Semester 1 2013/2014 and Mechanics of Materials for Semester 2 2013/2014 to develop the practice of this method. Students were grouped based on their performance in the previous Structure Analysis course to develop a healthy distribution between good and poor performance students. The course was run normally as student progress with TELUS MOD on their own. By the end of each semester, questionnaires are distributed to students to evaluate the level of achievement of this TELUS MOD practice. Evaluation of achievement is based on the data obtained from these questionnaires and the end results of student's final grade.

This evaluation has six factors of TELUS MOD itself that was reviewed toward the outcome of TELUS MOD. Those six factors are 'Team Management', 'Peer Support', 'Leadership', 'Interaction', 'Mentor-Mentee Self-assessment' and 'Mentor-Mentee Effort' base on student's own perceptions. These factors were associated with the factors of 'Program

Effectiveness and Performance'. Spearman's correlation coefficients were used to evaluate whether there are significant correlation between student's views of TELUS MOD toward the outcome. All evaluated factors were found to be significantly correlated to TELUS MOD outcome accept the factor of 'Leadership'. It is due to the evaluation combine Mentor perception together with Mentee perception where their view is different toward the implementation of TELUS MOD.

Reviewing the evaluation of TELUS MOD in Theory of Structure only, based on the course and the previous prerequisite course final grade, 25.5% student managed to improve their grade, 45.5 % managed to sustain the same grade while the other remaining 29.1% failed to sustain the same grade. This is the percentage on the semester where TELUS MOD was embedded in the course. In the previous semester where TELUS MOD was not embedded, only 7.55 % managed to improve their grade, 56.6 % managed to sustain the same grade while the other remaining 35.85 % failed to sustain the same grade. This shows a promising improvement in performance of Course Outcomes as one of the factors being evaluate as 'Program Effectiveness and Performance' when TELUS MOD is applied.

Impact

The application of TELUS MOD has demonstrated that the feat of learning in team can help in improving individual student but this depends on many factors. By assessing the effectiveness of team learning through student's own perceptions, it is believed TELUS MOD application has achieved its goals.The results help enhance the understanding on team learning using steered module and how it can improve students' knowledge toward structural analysis generally as well as understanding engineering students' level of learning outside of lecture hours. This understanding can be used in improving students' learning performance for the entire period of civil engineering course. Additionally these learning effects of guided study group are crucial to be considered for further development of the steered module itself.

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32. PROJECT-ORGANIZED PROBLEM-BASED LEARNING (POPBL) IN AGRICULTURAL BASED STUDY

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Introduction

Project-Organized Problem-Based Learning (POPBL) is an instructional methodology that has been widely applied. POPBL incorporates the development of students' soft skills and promotes creative and critical thinking. In this study, a POPBL teaching technique has been implemented in the agricultural course, "Farm Practices: Crop Production", to achieve the learning outcomes of the course. It is difficult to achieve some learning outcomes of this course using traditional or conventional teaching approach. The learning outcomes include leadership skill, teamwork skill and entrepreneurial skill (able to market their products). With the conventional teaching practices (CTP) the students were only being exposed to hands-on skill without triggering their critical and creative thinking for better outcomes.

POPBL has been implemented for the past thirty years (Hussain & Rosenørn, 2008). Initially adopted from Problem-Based Learning (PBL) (Uziak et al., 2010), the basis of POPBL implementation mimics the PBL model, which contains three important components: problems to be solved, project orientation and team work (Du and Jensen, 2010). An important characteristic of POPBL is that students are responsible for their learning. POPBL have mainly been applied in engineering courses such as in Electrical Power Systems Engineering (Hosseinzadeh and Hesamzadeh, 2012), Switching-Mode Power Supplies (Lamar et al., 2012) and Wind Energy (Santos-Martin et al., 2012) or hardware related subjects as in Programmable Logic Design and Computer Architecture (Kellett, 2012), Analog Electronic (Mohamed et al., 2012). However, successful POPBL implementation has not been used much in teaching and learning in agriculture related field work. Therefore, POPBL was implemented in the Semester 1 Session 2011/2012 and Semester 1 Session 2014/2015. To evaluate the impact of POPBL in the course, a comparison between the attainments of outcomes were made for Semester 2 Session 2012/2013 (CTP) and Semester 1 Session 2014/2015 (POPBL).

Underpinning Theory of POPBL Implementation

The underlying theory for POPBL is the constructivist-sociocultural approach of understanding learning and education (Kolmos & de Graaf, 2007). The theory emphasises three learning principles which are cognitive learning, collaborative learning and contents. The cognitive learning principle is a central principle for the development of motivation. Learning is organized around problems and will be carried out in projects. The collaborative learning principle is in the team-based problem solving where learning process is a social act through dialogue and communication. Students learn by sharing knowledge and collectively build the knowledge. The contents principle is related to interdisciplinary learning which is not bounded by one single subject.

The underlying principle that triggers the initiative to use POPBL to solve the learning problem in this course was the constructivist principle as well. Specifically, it is related to constructive alignment (Biggs & Tang, 2007). Constructive alignment stated that both the teaching and learning activities and the assessment tasks should support the development of the intended learning outcomes among students. In this course, the teaching and learning activities must be able to achieve the learning outcomes as stated earlier and the assessment tasks given must be able to tell if the learning outcomes have been achieved at the end of the teaching and learning activities. To see if outcomes can be attained using POPBL, the technique was implemented for 2 semesters.

Description of the Course and Student Profile

Two different teaching techniques had been implemented in the "Farm Practices: Crop Production", a required course for Bachelor of Science of Horticulture (BSHort) and Bachelor Science of Agricultural (BSP) under the Faculty of Agriculture, Universiti Putra Malaysia (UPM). Total credit is 1 (0+1), which consist of 51 hours face to face teaching for 14 weeks. The course is arranged and designed so that by the end of the course, students should be able to achieve the following learning outcomes LO(s):
LO1: To demonstrate the methods of crops planting,
LO2: To organize the technique of planting and managing the crops and
LO3: Leading and working in a group basis to produce and market crop yield.

The observation was carried out in Semester 2, Session 2012/2013 and Semester 1, Session 2014/2015. Total number of students from these 2 classes were 53 and 47, respectively. Semester 2, Session 2012/2013 of class was delivered using a CTP where the students only had to do hands on agricultural activity which is basically practiced in commercial fruit production farm. Students were only required to produce a report in a group of 5-6 members based on the activity that has been done. The CTP assessments consist of Quiz 1 and Quiz 2 during week 6 and week 12, respectively, with a total of 25% mark for each quiz. Another 50% mark came from peer evaluation (10%), attendance (10%) and practical report (40%). All the accumulated score contributed to 100% of total grading.For the Semester 1 Session 2014/2015, POPBL was implemented. Students were divided into 10 groups with 4 to 5 members in each group. Throughout the implementation of POPBL, each group was given a special project and topic to be observed. Three main assessments were performed throughout the semester. During the three phases of assessments, the complexity of problems in the case study was equal. This was to ensure that students were exposed with real farm environment and knowledge are synchronized to the planned curriculum syllabus and theory that has been taken earlier or during the concurrent semester. This course was carried out in the open field and covered the topic of germination, crop management, harvesting, postharvest handling and marketing activity. The POPBL implementation contributes 25% to the continuous evaluation phase 1 (Week 2 to 7) and phase 2 (Week 8 to 12) which were judged by facilitators who are lecturers and field staff (10%) and peer evaluation (10%) At the end of the semester, student came up with complete data collection and report in the form of reflective journal based on the project and task given, which amounts to 30% of the course grade. All the accumulated score contributed to 100% of total grading for the POPBL.

Impact of CTP versus POPBL

The effectiveness of teaching and learning using CTP and POPBL methods was analysed. Result of study was discussed in the context of POPBL teaching technique to achieve learning outcome of the subject and how far the innovation can give impact to higher education learning compared with the CTP. To check the capability of students to produce and market the product, yield of product and marketable yield for both of semester were recorded. Mean of all data collection was calculated and compared.

Result of the final grade showed that POPBL is highly applicable for agriculture field study. About 60% of students from POPBL class scored grade 'A' compared to 35% of student from CTP class. Based on the conducted survey and our observation, it was realised that the students' achievement in POPBL class depends on several factors such as prior background program, student participation in handling project activities, and motivation towards ensuring the success of the project based on hands-on experience. In terms of capability of students to produce and market the product, the result shows that the POPBL class was able to produce 492.28 kg of sweet potato yield. With the selling price of RM7/kg, they managed to collect a total profit of RM 2512.80. On the other hand, the CTP class did not produce any yield and generate any profit.

Therefore, students undergoing POPBL successfully achieved the learning outcomes. We observed that students were highly motivated to finish the project as they could see the impact of different treatments applied to different groups on the specific project given to them. The students improved their soft-skills (communication between teammates and planning) as well as their technical skills such as solving the real-field problem, designing the structured solutions, packaging the product and developing marketing strategy. With this successful outcome, it is our hope that our experiences on POPBL implementation in the fieldwork for agricultural students could motivate ourselves as well as other lecturers in applying POPBL in our teaching and learning activities.

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33. VIEW: A 3D VIRTUAL LEARNING ENVIRONMENT FOR INTRODUCTION TO MULTIMEDIA SUBJECTS USING COOPERATIVE LEARNING APPROACH

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Introduction

Rapid advancement of technology can simplify and speed up communication processes. The development of information and communication technology (ICT) for instance, has allowed various learning activities to be conducted virtually. Some of the activities that have extensively exploited such a technology are cooperative and collaborative learning, in which ICT can strongly support the vital elements of the learning activities. The elements of these activities are interaction and communication between students, which are often carried out in a two-dimensional virtual learning environment (2-D VLE) by utilizing Web 2.0 applications such as chat rooms, online discussion forums, social networking sites, and blogs. Despite being extraordinarily capable of supporting online learning activities, ICT has several drawbacks. The technology is limited to text-based communication; it provides less support in the use of nonverbal communication to convey messages; and it provides users with limited tools to collaborate. These limitations make the applications inferior in supporting communication and interaction hence the learning activities performed in a VLE are considered very limited and not realistic since they are executed merely through text conversations or discussions without any other forms of interactions. Several problems have emerged from these limitations, particularly on students' interaction, participation, motivation, satisfaction dan sense of presence. Therefore recently, a three-dimensional virtual learning environment (3-D VLE) or a virtual world has been utilized as a platform of online learning as it possesses potentials in supporting online and virtual learning. However, 3-D VLE is still new in Malaysia, especially at Universiti Teknologi Malaysia (UTM), although it is very beneficial for online learning and especially for distance learning programs. Therefore, this study was conducted as a kick start in bringing 3-D VLE into the teaching and learning in UTM. Moreover, we also studied the benefits obtained through its application. At this moment, this study was only conducted in one of the UTM SPACE diploma classes which is Introduction to Multimedia (DPT3163) class.

Teaching Innovation

Therefore, a 3-D VLE called (Educational Virtual World) was developed in this study to be used as an online learning platform to carry out several learning activities. The learning activities on the other hand, were constructed in the form of cooperative learning. In terms of development of ViEW, the Open Wonderland application has been used to develop the 3-D VLE. Open Wonderland is a java-based, open source virtual world application that provides tools to the developers to construct a 3-D VLE based on their demand. We used some existing objects in the Open Wonderland to build the environment. In addition, we also build some of 3-dimensional objects using the Google SketchUp software, such as a main building, meeting rooms, chairs, tables and so on. We ensure that the design of the built environment is suitable for cooperative learning activities. In terms of structuring cooperative learning activities in ViEW, we have implemented Johnson & Johnson's (1999) cooperative learning theory and Salmon's Five-Stage Model of Learning in Second Life (2010). This is to make sure that the learning activities would run smoothly and also ensure that cooperative learning really occurred in the virtual world. The development processes takes more than six months to complete. ViEW that has been completely developed were then placed on a Faculty of Education server to enables it to be remotely accessed by other computers. Then some testing phases were carried out to make sure ViEW can smoothly function before it was used in the class. Furthermore, the pilot testing was also conducted among expertise to validate the content and design of ViEW.

ViEW was officially employed in the DPT3163 classroom during the 2nd semester of 2013/2014. Before the start of the learning activities, each student was assigned into a group. Each group was coded with a unique colour, name, and logo, and each participant was given his or her own workstation with a computer and a headphone. The workstations of participants from the same learning group were located at different sections to avoid any direct communication and interaction between them. Afterwards, the first training session was conducted to make sure that the participants were familiar with ViEW and that they learned how to do basic things in the environment such as navigating the world, changing the camera views, customizing the avatar, as well as inserting and manipulating objects. The second training session was held a week after. Then for several weeks, a cooperative learning activity in ViEW was carried out. Each session allocated approximately 90 minutes and covered different topics. During the learning session, every group was encouraged to use all tools provided and also utilized all the communication channels supported by ViEW. Scores of individuals and groups have been awarded to the students based on their presentation of the discussion, exercises and quizzes. So far, all the learning activities in ViEW were only conducted in a computer laboratory, not remotely as we feel that it was better to carry it out in the laboratory at this early stage of its application. So that we can gather some useful input before we began to implement it for real distance learning.

Impact

There were three forms of evaluation conducted in this study in order to examine the impact of cooperative learning in ViEW towards the students. There were the evaluation in terms of academic performances, their interaction and communication while they were learning in ViEW, and also their sense of presence in ViEW and satisfaction towards the approach. In terms of evaluating students' academic performances, several methods have been used. The first is through a weekly quiz scores, which scores obtained by the majority of students were encouraging in every week. The second method is through pre and post test which covered all the topics learned by the students in ViEW. Statistical analysis showed that there are significant performance improvements between students' scores in pre and post test. While interaction and communication of the students were evaluated by analyzing the recorded video of the learning activities using the content analysis technique based on a coding scheme which is related to cooperative learning. The results of this analysis indicate that the frequencies of seeking input and contributing about the tasks and also technical matters among the students were high. Therefore it shows that majority of the students were active during the learning process and none of them was a sleeping partner. In terms of satisfaction and sense of presence, it was assessed through questionnaires that were distributed to the students upon completion of all learning activities. Based on statistical analysis that has been carried out, the findings showed that scores of social presence, place presence and co-presence were high, thus showing that the students can feel that they were really in the virtual world along with their friends. From the interview conducted with several selected students, they were satisfied with the cooperative learning in ViEW. They feel that learning in 3-D VLE was enjoyable and has great potential to be further implemented in all subjects.

From the positive and encouraging findings obtained in this study, it shows that ViEW has a bright future in our country educational field. It can also be expanded as a learning platform for other subjects such as history, science, language learning and so on. Moreover, further research into it can also make ViEW beneficial as an online learning platform for distance learning provided in UTM and other institutions. Thus it can have a major impact on the field of higher education in Malaysia if its usage is extended.

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34. EFFECT OF VIRTUAL ENVIRONMENT COURSEWARE IN LEARNING ENGINEERING DRAWING

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Extended Abstract

Technology is a product and outcome of engineering and science. It is also application of knowledge of humans by manipulating and modifying nature to meet their needs. These changes can be achieved by transforming and improving the usage of tools, materials and techniques which have their effect on humans and other living creatures as well. Today's technology would not be the same as yesterday and would not be better than tomorrow. Every single day, there will be some improvement on technology which most likely affected on engineering industries (Raymond and Albert, 2009). Thus, the requirement of the industries on engineering graduates constantly changes. Possessing technical skills solely is not enough for engineers in the workforce where most of them using trial and error technique that seem to be effective in the industry (Colwell, 2010). Employers or industries are not only seeking those who are technically skilled but also possess non-technical skills as well, thus making them marketable graduates (Low, 2006; Lee, 2003; Woodward, Sendall, and Ceccucci, 2010).This requirement does not mean that the technical skills are not important, but non-technical skills are additional skills required by engineering graduates for 21st century skills of engineers.

To become an engineer is not difficult, but to be a competent and professional engineer is a tough endeavor. In order to become one, Hasna (2008) reported that engineers must contend with endless societal and technological transformation due to the rapid development. In today's modern world, industries need to compete with each other in order to survive in the global market. Thus, employers are seeking graduates who are able to work immediately after being hired (Azami et al., 2009), and of course, they still require some training before they can perform the job. Nevertheless, the training is not very time consuming and the employers do not need to spend a large sum of money for the training program. In addition, an undergraduate degree status without equipped skills is not the main requirement to get hire. Instead, industries are hiring graduates who have concrete knowledge for both skills since they require a shorter period for training to become effective and efficient engineers (Walther and Radcliffe, 2007). On the other hand, engineering professional body, Board of Engineers Malaysia (BEM) had come out with a list of 10 generic skill attributes which become a guideline to every engineering graduate in Malaysia in order to produce better and competitive engineers.

According to Kolmos, (2009), the solution for the new requirement of skills of undergraduates in engineering education is by implementing problem-based learning (PBL) or project-based learning (PjBL). Both methods emphasizes on student-centered learning and negate traditional approach which is more teacher driven. PjBL and PBL show favourable characteristics which provide motivation and are suitable for the development of non-technical skills. Nevertheless, these two approaches of learning is confusing and people misjudge both methods to be the same thing. The fact is, as the name is different, so is the method. As for PjBL, it is likely to be correlated with engineering and science field, whereas PBL is also implemented in those fields, but is originated from medical and other professional preparatory training (Chakravarthi and Haleagrahara, 2010). This statement is supported by Perez et al. (2010), which stated that PjBL was established in the engineering field to provide experience for engineering students, which is able to promote life-long learning and cognitive abilities. Furthermore, project works are able to retain students in engineering program (Richardson et al., 1998) and able to improve their motivation to learn future material (McKenzie, Pelliccione and Parker, 2008).

Perceptions of industries toward engineering graduates nowadays do not meet their expectation. Graduates produced by the universities do not possess and meet the requirement of the industries because they lack skills especially non-technical skills such as communication, problem solving, leadership and team working (Nair and Patil, 2008). As the world is moving forward, gaps between expectations and perceptions can be wider if universities use the same approach in teaching. Such problem can be perceived from the perspective of engineers in the industries towards engineering education which asserted that engineering education should put more emphasis on communication skills, leadership and management skills and must put a lot of effort in order to nurture interest towards engineering profession among undergraduates (Mustafa et al., 2008). Kamsah (2004) in his research stated that current engineering graduates are not deficient in technical capability or their knowledge but they are deficient in their soft skills which are important for them to work collaboratively and to use their technical abilities. PjBL seems the best method for engineering education in teaching and learning nowadays, and it is proven that it is effective to develop skills among engineering graduates. The purpose of this study is to investigate effectiveness of PjBL in engineering education at higher institution level in Malaysia. The research project was developed to investigate the use of PjBL on student's satisfaction and the effectiveness of this teaching and learning method in order to increase student's non-technical skills.

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35. CREATIVE STRATEGY LEARNING MODEL (CSLM)

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Extended Abstract

Creativity is regarded as an abstract and complex construct; however, with proper guidance, creativity can be developed, taught and learnt. In order to assist students to better develop their thinking skills and creativity, students can be guided to strategize their learning experiences that entail them to think and use their creative cognitive abilities. A new learning model was developed by associating strategic thinking taxonomy and creative thinking model termed Creative Strategy Learning Model (CSLM). CSLM is able to assist students experience learning in a new way when they are made responsible of their tasks, which also include them to continuously monitor, evaluate and amend their work, and this is functional within the cognitive, affective and psychomotor domains. The Creative Strategy Learning Model (CSLM) brings together the strategic thinking and creative thinking processes. It puts emphasis on the importance of a systematic instructional process to assist students to cognitively strategize their learning for better learning performance and creativity enhancement. The model purports that there are four main continuous stages namely Learning, Metacognition, Verification and Outcome.

CSLM proposes that in any learning process, it should start with Learning, a stage where information is acquired and knowledge is constructed. This is a significant phase because this will determine the quality of the learning outcome. However, this process does not stop at this stage. CSLM purports Metacognition as the second stage. At this stage, students' learning is strategically and continuously guided, monitored and evaluated. One way teachers can do this at the cognitive level is by asking students to answer critical questions on their tasks. In this way, students are required to reflect on their own cognitive processes, assess the outcomes of their task and work on to change and improve their work. The third stage of the CSLM is Verification. At this stage, students' works are assessed especially taking into consideration its creative values. The Verification stage is therefore a stage where students need to judge and value their work, and verify that they have achieved the objectives of the learning process. Outcome is the last stage of the CSLM. This is where the final product of the learning process is produced. This is not the end of the learning process; outcome of this process can be the new knowledge constructed which can be utilized for other learning processes. To make the learning experience continuous, e-learning platforms namely Moodle and Edmodo can used as a platform to implement this learning approach in teaching and learning. Through this, both students and teachers are able to constantly communicate, and students can be strategically guided and creatively assessed through the four main processes.

CSLM is implemented at every phase of a specific task. To write an essay for example requires several phases, and CSLM is utilised at every phase. At each phase, when students submit their task, they will also need to answer questions posted by the teacher. This is the Metacognition stage, where the questioning aims to assist students to critically think of what they have submitted and how to improve the task. The teacher will provide remark and assess the creativity of students' tasks by referring to how students answer the questions. Students can review their tasks based on the teacher's remarks and the creativity score. Essentially, it is the creativity score that encourages students to redo their tasks. Students however need to ensure that both their tasks and how they answer the questions can be improved, and this helps them to think at a higher level.

The effectiveness of the CSLM is measured through 1) students' academic performance after the CSLM is employed in the during process, 2) continuous improvement in students' works from one stage to the next, 3) level of creativity in students' works tested through a creativity measurement tool, and 4) students' and teachers' perceptions of the new learning model. CSLM has been tested with students at schools as well as students at tertiary level investigated in writing and speaking courses. Through this study, most participants agreed that CSLM is able to assist them to strategize the completion of tasks and learning, and enhance their creativity. For one, the strategic questioning during the Metacognition stage was able to guide students to critically think of their tasks, how they can approach each task and improve them. Students were generally able to apply higher order thinking skills. Additionally, the creativity check becomes an indicator of students' creativity level, and this helps them to enhance the creativity of their tasks. With the emphasis on creativity and higher order thinking skills as among the essential skills required to propel and transform human capital development, the community and nation, CSLM is therefore potentially important to help educators assist their students become better leaners and individual.

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36. MILE@EDU: A STUDENT-CENTRED LEARNING PLATFORM FOR PROBLEM-SOLVING AND COLLABORATIVE LEARNING

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Extended Abstract

There is a need for the development of a student learning system that provides a current and holistic approach towards student learning. A learning platform that provides students with "digital portfolios" will allow them to keep track of their learning materials in all their classes. The use of archive portfolios will help to retrieve and recall the students' works so that it could be easily accessible in later years. This will allow a seamless integration of student work, from formal learning to collaboration to reflection, culminating in a database for portfolio presentation and a systematic timeline of student learning process throughout their academic career.

The purpose of the MILE@EDU project was to integrate the use of Web 2.0 tools with effective pedagogy to create a learning environment that takes advantage of the social skills learnt by these students and use them to enhance their learning experience. Therefore, the Multimedia Integrated Learning Environment (MILE) was created to facilitate the learning process among learners in a private university in Malaysia utilising the available and accessible technology. While it is possible to use public access service providers like Blogger, Tumblr, Wordpress and others, the purpose of this Telekom Malaysia (TM) R&D Berhad funded project is to develop an in-house learning system for the students in Multimedia University (MMU). The concept behind MILE is to allow

student-centred learning to take place beyond the walls of the classroom and in their homes, and enable their learning experiences and outcomes to be captured. This project-based approach to learning enables students to explore, document, cooperate, collaborate and problem-solve their learning process.

It consists of four components: multimedia learning objects (The Pillars), a web-log application (Orion), a virtual classroom (Orycle), and an eportfolio (Olympus). The Pillars serve to provide learners with media-rich content and was developed based on sound instructional design. It enables self-directed learning and allows for an individual constructivist approach to learning. Orion is the platform for educational journals, allowing learners to share experiences with one another through the articulation of their learning experiences. It fosters a cooperative and collaborative learning environment in which the student and teacher form a learning community. Orycle provides audio-video connectivity between students and teachers beyond physical classrooms. It allows flexibility in facilitating learners and sharing teaching materials. All these components provide the learner with the ability to learn on their own as well as in groups and to be facilitated by the lecturers outside of the classroom at their own pace and time. And Olympus provides students with an e-portfolio output for presentation purposes in the classroom or to potential employers.

The MILE@EDU project is driven by a need to facilitate a change in the educational landscape in Malaysia by providing a learning environment using both individual and social constructivist approaches. While the multimedia learning objects known as The Pillars allow the students to learn the content of the classroom, the web-log application allows the students while working in groups to communicate, reflect, and share their thoughts and work-in progress with their group members, class, teachers and tutors, and the virtual classroom extends teacher student connectivity beyond the physical classroom. Thus, allowing a learning community to be created and maintained within the classroom, physically and virtually. The uniqueness of this project is that it was developed based on a framework called the E-Quad (copyright pending) - Engage, Enhance, Empower & Enjoy. In other words, it addresses the areas of Social (Engage), Cognitive (Enhance), Technical (Empower) and Affective (Enjoy) respectively. The platform is a repository of student work and media artefacts, stored safely on local servers for easy retrieval. It provides a holistic learning experience by allowing learners to engage in interactive content, collaborate and share with peers, and reflect on their work. It builds a community of learners who are in constant connection with their lecturer and classmates outside of the classroom. Last but not least, it is developed using sound educational pedagogies such as authentic learning, problem-solving learning, and collaborative learning, and inculcates constructivist learning skills into students.

The MILE@Edu system captures their learning experiences and provide a digital trail of their academic life in learning institutions. Consequently, the MILE@Edu system provides the vehicle to realise the following benefits:

1. Supporting coherent management of a variety of achievements and pieces of work. These can be restructured and viewed in different ways for different purposes, for example, for reviewing learning, planning future learning, or providing evidence for an award or an employer;

2. Helping learners take control of their learning and their lives, by reflecting on their activities and planning future directions;

3. Providing a learner-centred rather than course-centred view of learning;

4. Giving appropriate views of achievement and learners' work to appropriate people, for example, the learner, teachers, mentors, careers advisers, potential employers, educational institutions to whom the learner is applying;

5. Facilitating a wider variety and more authentic forms of assessment;

6. Providing continuity through a learner's lifelong learning as they move between learning providers;

7. Encouraging reflection on practice and linking this with MQA's learning outcome standards; and

8. Linking learners' achievement and work with the skills required by their employers, helping to identify learning needs and "close the skills gap".

The MILE@Edu system supports its existing environments to provide students a holistic learning path, from creating content to displaying and presenting their output for presentation and employment purposes, as well enabling teachers to continually assess and evaluate their learning processes. The potential for commercialization of this system is high, and MMU is currently employing MILE's Orion (the blogging system in MILE@Edu) and Orycle (the virtual classroom in MILE@Edu) in the MMU MMLS system for the i-university initiative.

The MILE@EDU project also supports the National Agenda highlighted by the Ministry of Education to increase the use of ICT in education and to address the lack of 21st century skills in graduates today. This project was shared during the MOHE's Best Practices Seminar and has been published in MOHE's Pelan Strategik Pengajian Tinggi Negara (National Strategic Plan) in 2013. The project which focuses on blended learning, project-based, and group-based approaches to learning has been used locally in Multimedia University, Inti University and also internationally in Inje University (South Korea) for both undergraduate and post-graduate courses. This project has also been identified to be accelerated through TM IX.

In terms of recognition, the MILE@EDU project is a TM R&D funded project that has won several awards in research innovation exhibitions such as ITEX2014, PECIPTA'13 and ICICM'13 and was selected as a finalist in the E-Learning category for APICTA 2014. The outcomes of this project has also been published in 8 ISI/SCOPUS international refereed journals, and international conference proceedings.

In conclusion, the MILE@EDU platform is an innovative user-friendly learning platform for students that marries web and multimedia technologies with content and educational pedagogies. It was developed using proven research-based methodologies for enhancing the student learning process, presents an authentic and group-based solution to improving student motivation and engagement, provides lecturers a platform to monitor and assess student progress, and is a repository of their creative media artefacts for continual reflection and improvement. It has been in implementation since 2010 and has achieved very positive results from students, thus providing encouraging and supporting evidence of the effectiveness of this system.

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37. PROBLEM BASED LEARNING THROUGH MOBILE APPLICATION

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Extended Abstract

Thinking skills involve the manipulation of knowledge rather than memorizing the input is defined as High order thinking skills (HOTS) [7]. This thinking skills require comprehension, analysis, synthesis, application, and evaluation. HOTS involves more than just receiving a knowledge but further action in cognitive thinking is required so that students will achieve deeper understanding on the learning material, create new knowledge, solve the problems that require more than one possible answer, create original material, or make decisions [6].

The formal lecturing that is still applied in most teaching is a conventional learning method that only offers the formal learning environment. This formal learning shows weaknesses when it does not promote higher-order thinking skills, dependent on teachers, lack in students' engagement, and student are bored. Therefore, the researchers developed a mobile app to change the formal learning environment into informal learning environment.

The advantage of using mobile learning is that it is a flexible tool where students can learn anytime and anywhere. M-learning encourages a self-paced learning environment where students could learn anytime and anywhere according to their own preferences [8]. In addition, most students prefer to use mobile devices as a new tool for learning because the devices are portable and can be accessed anywhere [10]. Mobile devices provide learning on the go and is independent of time and space [9].

Many researches that were done by scholars have shown positive results of using mobile learning that offers flexibility in learning. A research that was done shows that, 90.1% of 374 lecturers agreed that mobile learning offers more flexibility to students and teachers.1 Another research done also agreed to mobile learning usage because it provides freedom to manage their learning time.12 and students can learn during leisure time such as before sleeping and travelling on the bus.3

As the learning process for postgraduate students is no more a spoon feeding approach, students need to expose themselves in social constructivism learning which is student centred learning. Constructivism is a theory of learning which student not only receive and store knowledge given by the teacher but they are constructing new knowledge as well.2 The HOTS Flash application was developed based on constructivism theory where students will construct their own knowledge after a series of learning. This theory will link the facts with the students understanding. Inductive method of reasoning is a process of transformation of specific knowledge to general knowledge. In a guided inductive discovery lesson, hereafter called the inductive approach, the students, not the teacher, state the generalization following their examination of specifics.7 In this research, the researchers have implemented higher order thinking levels into the learning process through the mobile application software. Interactive multimedia program will develop students with high order thinking. Substantial levels of higher-order thinking can be supported and maintained by approach of multimedia program based on a situated learning environment [5] .In the application software, the learning design is constructed based on problem solving skills approach where users have been asking questions related to the course content but using Higher-Order Thinking question levels. Critical thinking process and utilizing learner collaboration among students can be developed through problem-solving technique.11 In the process, students construct new knowledge and understanding where they are able to make decisions through their deep understanding of the topic area.4

The mobile app is one of the technology that can create learning variation. This variation is important because it can create a change of learning style according to technology changes based on the current curriculum. From this point, the researchers take the appropriate instructional design so that the growth process of mobile app will be more systematic and structured. In addition, the mobile app design should be planned carefully so that it is an interactive and interesting application.

The research design used in this research is descriptive analysis in quantitative design to evaluate the usefulness HOTS Flash app in the learning. A questionnaire is used as the instrument to collect the responses according to research objectives. The questionnaire was distributed to the respondents by online medium which is Google Docs form.

This research was conducted to develop HOTS Flash application and test the system functionality and usability to a group of users. The HOTS Flash application was developed based on constructivism theory where students will construct their own knowledge after a series of learning. In this research, the researchers implemented knowledge of constructive theory with problem based learning approach into the learning process through the mobile application software. In the application software, the learning design is constructed based on problem problem-based learning approach where users have been given a few situations that follow with questions related to the course content using Higher-Order Thinking question levels.

The samples consisted of 16 students, who are enrolled in MPPP 1223 (Authoring System) course in semester 1-2014/2015 and another 10 students in semester 2-2014/2015. They comprised of full time students and part time students who are in the first year of study in Master program. All of them have mobile gadgets such as mobile phone and tablet computer with Android Operating System. Their gadget has been installed with HOTS Flash application to test the acceptance part of this study. The questionnaire was given to the respondents in the classroom. The questionnaire has two sections, Section A and Section B. Section A consisted of demographic background of the respondents that asked about the gadget model, category of student, the skill level of using Adobe Flash Professional, the frequency of using application based on education, and the purpose of using a gadget.

Conclusion

From this research, the results showed that the approach applied in this mobile application have encouraged students to be able to construct knowledge based on the learning process when using this application. The programming skills of creating an animation using Adobe Flash Professional level is related to the understanding of the students when dealing with the errors or problems faced in the process of making the animation work and how the students can identify why the errors appear in the first place. Finally, relating the problems with the basic theory or process involved in learning.

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38. SPARKING CREATIVITY AND ENHANCING LEARNING OF CHEMICAL ENGINEERING STUDENTS IN UNIVERSITI TEKNOLOGI PETRONAS (UTP) VIA COOPERATIVE LEARNING

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Extended Abstract

The chemical engineering program in Universiti Teknologi PETRONAS (UTP) has attracted many bright students, locally and internationally. There are two enrolment per year, of which there are around 100 to 150 students registered per intake. Each of the academic staff in the chemical engineering department teach one course each, and to meet the Engineering Accreditation Council (EAC) requirement, these students are often divided into two groups. Yet, the class is still considered a big class, and usually, there is always a tendency of the lecturers to teach the students in a traditional way, i.e. via one way communication and one man show.

One of the learning theories that can enhance learning is known as cooperative learning. Cooperative learning is an instructional method where students are placed in small groups so that they work together to maximize their own and each other's' learning [1]. Cooperative learning is also claimed to reduce the occurrence of unpleasant situation in a group work [2]. Many world renowned engineering education specialists recommended the use of cooperative learning and this confirms the effectiveness in cooperative learning in higher education [2]. This is supported by another study, which suggested that the students dropped out the college are mainly for two reasons: failure to establish a social network of friends and classmates, and failure to become academically involved in the class [2]. Many researches on cooperative learning were carried out in US, and the impact of cooperative learning can be classified into four aspects: i) Academic Success, ii) Quality of Relationships, iii) Psychological Adjustment and iv) Positive Attitude towards College Experience.[2]

Cooperative learning can be adopted formally or informally [1]. The introduction of active learning in the classroom for example is an informal cooperative learning strategy. The students will work in pairs for a few minutes after 10-15 minutes lecture to achieve a joint temporary goal, as assigned by the lecturer in the class. In one lecture hour, an informal cooperative learning session can be introduced up to 4 times, with each session lasting for up to 4 minutes.[2]

A formal cooperative learning is a more structured activity, in comparison to the active learning [2]. Five essential elements that must be embedded in a structured cooperative learning are: positive interdependence, face to face promotive interaction, individual accountability, teamwork skills and group processing [3]. These elements shall promote the group to become a high performing cooperative learning group, and effectively learn.

Based on the index of learning styles survey made in January 2015 and May 2015, using an instrument developed by Felder and Solomon (1992) [4], of four batches of chemical engineering students in UTP, majority of the students are found to be active learners, sequential learners as well as sensing learners. This suggest that an active learning strategy such as cooperative learning [1], should be adopted to ensure the students can sustain their interest in the classroom, via the collaborative and cooperative nature of classroom activities.

In addition to the findings from the index of learning styles survey made for the students, our students generally complained that they could understand the lecture, but often unable to solve the problems given to them. Thus, combining this scenario with the old teaching style, the students can get easily bored with the courses, and practically, are not really learning.

By observing this particular gap, it is brought to our attention, the course instructors of Kinetics & Reactor Design (KRD), which is offered to the 3rd year 1st semester students, to initiate a collaborative and cooperative learning activity together with the students. The main aim of this activity is to promote peer to peer learning and improve the performance of the students in this particular subject. In semester May 2014, 11 students out of 176 students failed this subject and the average score is C+. Thus, it is important for us to ensure the students can learn better via cooperative learning strategy, hence improving their performance in this course.

Our innovation is the integrated group project for this course, of which the students are tasked to deliver two projects. The students are required: i) To create a creative project, such as preparing a teaching module, song writing, or developing board game that demonstrated their understanding of the subject matter, which must consist the element of higher order thinking (HOT) and ii) To solve an open ended problem in a team, which is related to reaction engineering course. The output of these projects are showcased in each group e-portfolio. Three pillars of cooperative learning i.e. positive interdependence, promotive interaction and individual accountability are addressed in each stage of the project. Communication between the instructor and the students is made via social media such as facebook.

In the early semester, the students were asked to conduct two surveys, which consisted of index of learning styles and personality plus [5]. These are important i) to understand the nature of the students in general, ii) to assist with group dynamic. The grouping for the students

are done in the following criteria, which is a modified version from the one developed by Felder and Brent [1]

i. A group of 5-6 students
ii. A mix of high CGPA and low CGPA students
iii. A mix and balanced ratio of males and females
iv. A mix of ethnics
v. At least one international student in each group (UTP has almost 30% international students from overall students' population)
vi. At least three out of four personalities (choleric, melancholic, phlegmatic, sanguine) are represented in the group

Each project were given approximately 4-5 weeks to be completed. The course instructor will be the subject matter experts to evaluate the following using the rubric created, which covers i) Content , ii) Depth and iii) Creativity. The demonstration and the presentation of the creative project is required to be recorded and posted in YouTube, and this shall be embedded in their e-portfolio. This project gives 20% of overall coursework marks out of 50% allocated to the students.

The e-portfolio of the students must consist of the following elements: i) Biodata of the group members and their aspirations, ii) Reflection and summary of what the students had learnt, iii) Group Project Report with the video. The overall winner for all is also awarded with some special gifts.

This integrated cooperative learning activity addressed several things, namely i) Assisting active students to learn better, ii) Instilling high order thinking among the students and iii) demonstrate the values of teamwork. The students found that these activities engaged them in learning, sparked their creativity as well as improved their performance in the final exam.

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39. E-SITE INVENTORY

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Extended Abstract

Site inventory is an important stage of studio-based design project where it is a process of determining the elements and existing condition of a particular site that will give impact to the later design proposal (Russ, T. 2009). Site inventory is a compulsory stage in a particular site design project. In any design project, inventory of the site is always needed in order to justify the proposed adjustment of the site where these justification need to be based on certain analysis and evaluation of the inventory (Steiner, F. 2008). Design-based studio courses of built environment schools and faculties mostly use student centred learning (SCL) and problem based learning (PBL) approach in conducting their studio project work. This will involve site inventory task as part of the design process. By using both SCL and PBL approaches, site inventory task will be carried out where through thoughtful inventory it may improve the current condition and environment of the site.

Current practices of site inventory in design-based studio courses (which includes architecture, landscape architecture, town planning, surveyor and etc.) were carried out by students using many different tools. Students normally need to bring their cameras, GPS handhelds, note books and hardcopy maps which resulted in too many tools to handle on site. Handling these many tools sometimes bring difficulties to the students in carrying out their site inventory where they face problems of unorganised and inaccurate site inventory task. Furthermore, the current practices do not allow the site inventory task to be monitored closely by the lecturers and verification of data collected on site are hardly verified by the lecturers.

Hence, this research has developed an e-site inventory mobile application version 1.0 to encounter these many problems. This all-in-one tool mobile application was developed to provide user-friendly and intuitive mobile apps for site inventory tasks. It allows user to accurately collect location (x, y coordinate), capture images, insert notes and draw rough sketches of information and ideas during data collection on site by using one tool such as smart phones or tablets. These four functions work well and have been tested on site and it has successfully assisted students in data collection.

Students of Year 2, Year 3 and Year 4 of Bachelor of Landscape Architecture, Universiti Putra Malaysia were used as respondents to test this mobile application. This tool was used in their design-based studio courses where students used e-site inventory mobile application version 1.0 for their site inventory task project. This site inventory task project were assigned by lecturers online using this mobile applications and then students were asked to carry out their site inventory task by just using their smart phones or tablets that were installed with e-site inventory mobile application version 1.0.

The result of this test shows that respondents only brought one tool during their site inventory task. By using this only tool (either smart phone or tablet) installed with e-site inventory mobile application version 1.0, the students carried out their site inventory which includes capturing images, taking notes on maps and collect locations accurately and in a well organised manner. Respondents were also observed to not have difficulties handling too many tools on site which helps them to move around on site easily. The development of e-site inventory mobile application version 1.0 has improved how the site inventory task is being conducted. This mobile application has successfully facilitated the site inventory task of design-based studio courses where students were equipped with current technology while on site. This e-site inventory mobile application is an all-in-one tool which is marketable and has the potential to be commercialised not only for academic purposes but also suitable to be used by design consultants/firms and site surveyors.

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40. STUDENT ENGAGEMENT THROUGH INTEGRATION OF FLIPPED CLASSROOM AND PROBLEM BASED LEARNING APPROACHES FOR CLASS OF REPEAT STUDENTS

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Extended Abstract

In outcome based education (OBE), student learning time (SLT) is normally divided into face-to-face contact hours, guided non face-to-face learning time and time for self study. This SLT should represent the engagement time of each student for a particular course. The issue is, do the student engage their time with the course and how does the lecturer play the role to ensure the engagement really transpired throughout the semester?

Teaching programming subject to first year students in computer science programme is a challenging job. The subject is the core content of computer science programme and is being offered in the first semester of study at university level. The subject's content involved the ability to comprehend real problems, analyse it by clearly defining the input, process and the output. Then, relate the input, process and output logically and finally producing the solution. The detail step-by-step sequences need to be translated into programming code using any appropriate programming language such C, C++ or Java. The process of debugging, compiling and executing the code will develop students' technical skills in using the programming code. From understanding the problem, analysing it, translating it to the programming code, execution and finally, producing the solution, require problem solving skills with logical thinking (cognitive element) and also technical skills (pshycomotor element). It also involves some elements of soft skills in writing the programming code, formatting and style.

The students who come from different background give more challenges in ensuring the subject goals are achieved as targeted. Some students come from foundation or matriculation programmes while others are diploma holders. The result shows 35-45% of them failed thire first attempt in the programming techniques course.

Several issues and problems has been pointed out from the feedback of the lecturers – thinking or problem solving skill ability, the issue of transition period to tertiary education level from school/pre university learning style and also some attitude problems.

Handling classes of repeat students of this type of course give an opportunity for the lecturer to explore several approaches to ensure these students are able to achieve the expected outcomes and same level of position with their batch. As repeat students, the prior knowledge of this course exists in their minds through previous semester learning activities, assessment and others. This opportunity is used and manipulated with the application of flipped classroom and problem based learning approaches among these students throughout the semester.

The objectives of this study are (i) To identify appropriate teaching and learning activities or approaches to handle a class of repeat students. The approaches are flipped classroom and problem based learning; (ii) To encourage the students to increase the student engagement to the course with the aim of the result at least 70% (grade B and above).

This study involved the class of Programming Techniques course on Semester II 2011/2012, Semester II 2013/2014, Semester I 2014/2015 and current semester for Semester II 2014/2015. All classes involved bachelor degree students except for Semester I 2014/2015 which consist of diploma students.

The initial teaching and learning approach as applied in many conventional education practices begins by giving a lecture of the theory, concept and principle of a particular topic. Then, it is followed by some examples and students are given some tasks to be completed by themselves or will be discussed or experimented in tutorial or lab session.

For this study, the initial idea of flipped classroom is adopted from the Centre of Teaching and Learning, University of Texas at Austin Website. It starts with (1) identifying where the flipped classroom learning model makes the most sense for the course. For this study, the learning material is using problem based learning approach. (2) Spending class time in engaging students with application activities accompanied by feedback. (3) Clarifying connections between inside and outside of classroom learning. (4) Adapting materials for students to acquire course content in preparation of class. (5) Extending learning beyond class through individual and collaborative practice.

The flipped classroom activities are assisted with the existence of techonology such as learning management system, Web 2.0 learning application, mobile device etc. The flipped classroom is an iniative of content delivery which encourages students to lead the learning process rather than the products of schooling (Bennett et. al., 2013).

The new teaching and learning approach begins by a discussion of a particular problem or case study in the context of the chapter that the student will learn. Then providing the solution by introducing the concept and/or the principal of that particular chapter. The discussion of the solution can be led by individual students, a group of students, interaction between students and lecturers or solely from the lecturer. The problem is given prior to the class through the e-learning platform. The involvement of students will create engagement in learning the subject where increased involvement in the class activities will lead to better engagement. This approach is related to the student engagement development between students and lecturer to achieve the expected outcome in each session. Consequently, this learning activity falls under the deep learning approach rather than at the surface learning approach (Trigwell (1999), O'Neill & McMahon (2005)).

A series of problems and case studies have been introduced based on the related chapter. Most of the new problems presented covers previous chapters' content since the progression the course should involve all the prior knowledge where students can solve more complex and advanced problems. The engagement among students and lecturers also occurred via social network application which is currently available. The combination between flipped classroom and problem based learning is also related to the learning pyramid (National Training Laboratories, Bethel Maine) which classifies that learning by discussion, learning by doing and teaching others contribute to 50%, 75% and 90% respectively of the average student's retention rate.

In the experimentation, the first study is conducted with 60 students where the result of the previous semester is at 40-45% of failure rate of this subject. At the end of the semester, the overall result shows 70% of students have passed the course while another 18 students (30%) still failed the course. From the 42 students (70%) that passed the course, 17 students got the result for B (70%) and above while 22 students got below that B. The result shows significant improvement of student performance where the engagement gives more motivation to learn this subject.

The second experimentation of this study involved only 17 students. The smaller number of students allowed for more attention of each student's performance throughout the semester. The result at the end of the semester shows 100% of students passed this course and 13 of them got B and above. More engagement with students due to their small number leads to better performance among the students.

For the first experimentation, the mean and standard deviation of the result are 56% and 16% respectively while 78% and 11%, respectively for the second implementation.

As a conclusion, in many education concepts, the learning involves the curriculum of a particular course, the pedagogy involves delivery of the curriculum and finally, the evaluation of the course is the comprehensive measurement to indicate the achievement of students as well as for the lecturer. As discussed above, this study is focused on the pedagogy or activities in delivery of the curriculum. **The innovative idea presented is the integration of problem based learning and flipped classroom approaches to repeat students. This approach appears to give significant impact of their achievement compared to conventional practices.** The commitment, passion and motivation among the students and led by the lecturer are the mandatory elements to ensure successful implementation.

The study also has been implemented for 25 diploma program students in Semester I 2014/2015. The result shows high similarity with the first implementation of bachelor degree students.

Keywords: student engagement, flipped classroom, Problem based learning, class of repeat student

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41. DEVELOPING EFFECTIVE STUDENTS COMMUNICATION IN ENGINEERING MATHEMATICS

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Background

The Malaysian workplace needs graduates with employability skills such as critical thinking, problem solving and ability to communicate. In 2006, Universiti Teknologi Malaysia (UTM) has integrated these goals in undergraduate education but studies at UTM have indicated that the goals have not been translated into successful implementation. In this presentation, we will share how we had implemented an integrated approach which addressed students' knowledge, thinking, problem solving and generic skills, in particular, communication. We had developed a framework which was used to guide our instructions in Engineering Mathematics I since 2009/2010 session, in Engineering Mathematics II since 2010/2011, and in Differential Equations since 2012/2013 session. The same strategies were implemented in Malaysia Japan International Institute of Technology (MJIIT, UTM KL) in Engineering Mathematics III for the 2011/2012 and 2013/2014 sessions.

Development of the Teaching and Learning Strategy

We had referred to various theoretical perspectives in mathematics education which described understanding, thinking, learning, and teaching (Skemp, 1987 & 1993; Gray & Tall, 1994 & 2001; Schoenfeld, 1985 & 1989; Engineering Council, 2000 & 2012; SEFI, 2011) of mathematics at the tertiary level. These findings aslo gave explanations on aspects of cognition as well as reports on the viability and consequences of various kinds of instruction. Based on these works, we developed a pedagogical approach that supported meaningful mathematical learning and devised strategies to achieve given learning outcomes. However, in designing classroom instruction and activities, we refer mainly to the theory on mathematical thinking expounded by Mason and his colleagues (Mason, 2002, Mason et al, 1982 & 2010, Mason & Watson, 1998; Mason & Johnston-Wilder, 2006). The integrated framework also connected students' psyche, cognitive, affective and psychomotor development (Gattegno, 1977).

Two models were used to add clarity to the teaching situation namely, Focus of Mathematical Learning (Figure 1) and Cooperative Learning (Figure 2). The teaching and learning situation needed to contribute to the various concerns such as to enhance students' ability to take charge of their own learning, increase their understanding, communicate their mathematical learning, and to increase their awareness of their own mathematical thinking. The focus of learning identified elements that we thought were important and consistent with the University's philosophy of teaching. These were: Thinking, Knowledge Development, Soft Skills Development, in particular, communication, independent learning and teamwork and supporting Self-Regulated Learning.

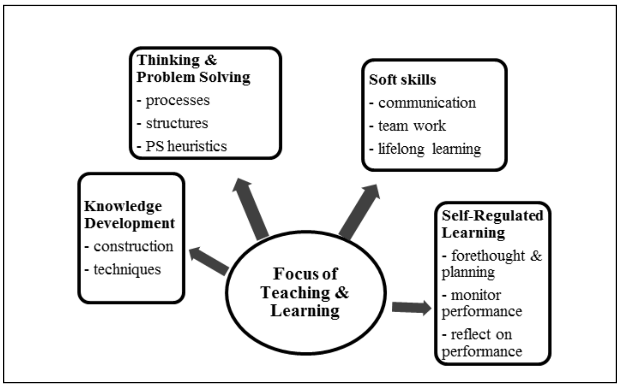

Figure 1: Focus of Mathematical Learning

The following strategies were used to support and encourage students to engage in communication:

(i) **Using classroom tasks** – the tasks require the use of various mathematical thinking powers and to initiate discussion which allows students to verbalize their mathematical ideas. Thus, structured questions with "prompts and questions" were used in addressing mathematical concepts and their problem solution in verbal and written modes. Thus, the need to communicate their knowledge was made explicit and help to provide context for the importance of communication.

We adopted cooperative learning (Meyers & Jones, 1993; Keyser, 2000; Felder & Brent 2008) to promote a learning culture in which students could think, talk and write. The sequence, "*read – write report – present – correct report & submit – test"* was implemented to ensure students undertake both oral and written communication.

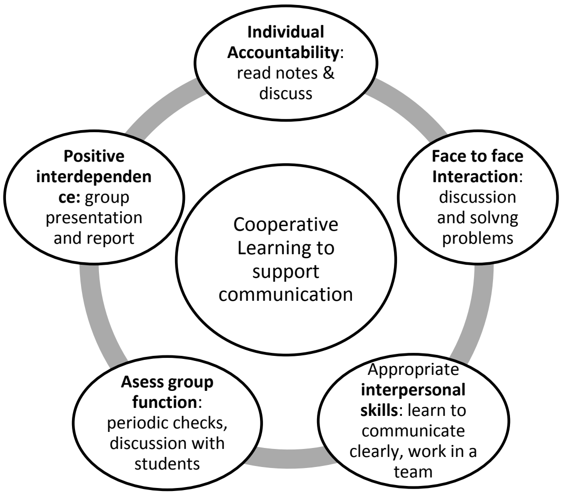

Figure 2: Model of Cooperative Learning

The Teaching and Learning Approach

Our model put forward an integrated approach that addresses knowledge and skills development, emphasising on mathematical communication in verbal and written mode. We found that encouraging students to talk, to read, to write and to reflect on their mathematical learning and problem solving, they are able to improve their understanding, gain insights into problem solving and became more able to communicate their ideas in a mathematical manner (Roselainy et. al, 2012). Students worked in small groups, in pairs and independently. They used the "*prompts and questions*" to learn how to talk about mathematics. In this way, they are responsible for their learning, gain insights into their own thinking and express their mathematical ideas and strategies in a precise and coherent manner using the correct symbols, notations and vocabulary. Conversely, we know about what they are thinking through their writing and oral communciation.

In our recent class for Engineering Mathematics III, we modified the delivery and assessment methods. For the delivery, an adapted flipped classroom was used whereby students have to read and discuss each new topic individually and within their group and to solve the given problems. They were given learning guides specifying the topic learning outcomes and the duration of time for each topic. The assessment methods provided a balance between individual and group work. For group work, the students are required to prepare a written report and present the report to the class. During presentation, their peers could participate by indicating they had understood the explanation, offer corrections or provide different explanations. The lecturer will intervene to address mathematical misconceptions or misuse of the mathematical language. Then, they are given time to improve their report. At the end of every major chapter or section, a short test was given a week after the presentation was made and this is the individual assessment, thus compelling them to engage as a team to ensure understanding of the materials and to prepare for the test.

Significance and Impact

A typical partial report guide to be presented orally and in written form is included here (Table 1).

REPORT 3
DOUBLE INTEGRALS
SMJM 2033 ENGINEERING MATHEMATICS 3

1. How do you evaluate double integrals?
2. How do you choose the preferable order of integration?
3. How are the limits of integration determined?
4. What do you do to evaluate double integrals by reversing the order of integration?

	Prompts/Questions
Question 1 (5 marks) Write the integral $\int_0^4 \int_0^{-(y-4)/2} f(x,y)\,dx\,dy$ with the order of integration reversed.	• Which part of the integral informs you about the region of integration? o Find and sketch the region • How do you determine the limits of integration for the reversed order?

Table 1: Questions for presentation and report

For the presentations, students were able to articulate the mathematical concepts and solutions as they were guided by the "prompts and questions". We found that their facility with the mathematical language became better although there were examples of misconceptions and mistakes in the use of terminologies. In terms of assessing their written responses, a simple criteria was used to categorise the responses, which is, "ability to display correct mathematics, clear explanations and the correct use of symbols and notations. A rubric in a range of 1 to 4 was used with 4 referring to '*Very Good*' and 1 referring to '*Poor*'. Most of the students' responses were in the range of 3 and 4, although there were responses in 1 and 2. At the beginning, students were uncomfortable with the activities as they were different from their usual learning experiences. However, after a few sessions, they adapted to the new environment showing particular enthusiasm working in groups, sharing of ideas and working out the mathematics for themselves. Thus, the environment had facilitated thinking and communication skills among the students, and made the class livelier (Roselainy et.al, 2014). The teaching acts implemented also shifted students' awareness from rote learning towards understanding the facts and procedures, recognizing their mathematical powers, and enhancing the students' generic skills particularly the mathematical communication.

This framework was a supportive structure that enables a learning environment that requires students to communicate and sharpen their inter-personal and intra-personal skills. As the underlying characteristics remain the same, the framework can be used in any other mathematics courses. The lessons, tasks, and activities designed must be fundamental in providing a conducive environment where students felt unthreatened to express their thinking, take responsibility for listening, summarising, questioning, and interpreting one another's ideas mathematically in small-group and in whole-class discussions.

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42. BLENDED STUDENT LEARNING EXPERIENCE: COMBINING VIRTUAL LEARNING ENVIRONMENT, 3D DESIGN AND ACTIVE COMMUNITY ENGAGEMENT WITHIN A FRAMEWORK OF KNOWLEDGE TRANSFER PROGRAM

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Extended Abstract

Many of the problems that academics face during the teaching and learning exercise include lack of motivation in learning by the students which could be derived from the lack of understanding for a particular topic or concept being taught in the class or (to be fair with the students) could also be due to monotonous teaching practices given by the academics. In this extended abstract, the author will briefly describe the implementation of '*Blended and Active*' student-centred learning tool as one of the teaching innovations or methods which could be used to minimize the problems described here. According to the "*Multiple Intelligences*" educational theories by Howard Gardner (1983), the '*visual-spatial*' intelligence, '*body-kinesthetic*' and '*interpersonal*'' intelligence could be used to develop *Blended and Active Student Learning* experience. In addition, the innovative teaching practice described in this paper is in similar idea with the *Partnership for the 21st Century Skills* - US Department of Education and MacArthur Foundation as well as individuals such as Henry Jenkins, Mimi Ito and John Seely Brown. The partnership group proposed a new learning theory that in this increasingly digital and connected age, skills necessary for students to master and experience success in school and life include digital literacy, traditional literacy, media literacy, content knowledge, and learning / innovation skills. The *Blended and Active* students learning experience proposed in this paper refers to the use of multimedia (such as 3D design and video animation) and interactivity using online 'open learning platform and assessment tools (VLE)' such as Moodle, as well as active hands-on participation of the students in an outdoor teaching and learning activity.

In practice, we have proposed that students taking the engineering and science courses that involve technical devices (such as biosensor, biomedical or biotechnological devices) could be expected to obtain a full or better understanding of the working principle and concept of the device if the teaching facilitators (teachers, lecturers or presenters) use a 3D design and animation tools to illustrate the concept and the system. In particular, this teaching tool helps increase students spatial understanding of the object or the device in accordance with the '*visual-spatial*' learning intelligence theory put forward by Howard Gardner (1983). One of the easiest, free and widely-used 3D design software is *Google Sketch Up*. It comes with full and comprehensive online video tutorials for the novice users to build any 3D ojects from scratch or from an existing 3D model library. Therefore, busy academic professionals like teachers and lecturers do not have to build the object from scratch. The free software comes with an online community-based collection or warehouse of 3D objects which the users can download and use freely (for modification, adjustments, etc.) for non-commercial or educational purposes. As an example, we have built a 3D design of an indoor orchid-growing kit utilizing aquaponics as the core technology. Following a classroom-based teaching and learning exercise, students were expected to familiarize the models and subsequently build or construct the device (aquaponics system) in a team work environment and develop their hands-on skills. This window of opportunity could also be used by academics for the assessment of the student's affective and psychomotor domains through direct observation and assessment using a suitable rubric system.

The second component of *Blended Learning System* is the use of internet-based *Virtual Learning Environment* (VLE) and online assessment tool. The campus-wide implementation of VLE via Moodle-based application in Universiti Malaysia Pahang (UMP) for teaching, learning and assessment in addition to classroom-based teaching exercise allows academics in UMP (and other universities) to provide relevant teaching materials online for the student to learn and expand their knowledge anytime. It also allows academics to set the mode of quiz to be closed-book or open book. The open book quiz or tutorial could be conducted anywhere and anytime by the students within the time and duration specified by the academics. However, the closed book assessment using internet-based (Moodle) application, must be conducted in a computer room where the academic staff can invigilate the progress of the assessment. Overall, the use of internet-based VLE for teaching and learning purposes has increased students' academic performance and satisfaction in learning and could contribute to *Blended Learning* experience for the students. The method is also in line with the educational theories put forward by the *Partnership for the 21st Century Skills* (US Department of Education and MacArthur Foundation). The use of internet-based (virtual) learning environment (Moodle-based

application) shows student's digital literacy, media literacy, content knowledge, and learning / innovation skills.

The final ingredient of '*Blended and Active*' student learning experience is community engagement. We have implemented this aspect of innovative teaching practice within the framework of *Knowledge Transfer Program* for a (school) community funded by the Malaysia Ministry of Education (Grant Number: FK-IRC/3 (UMP-14) for the period 2014 - 2016). This method further increases students' cognitive understanding of the system while practicing / showing the construction of the system to other (school) students. This is in line with the '*interpersonnal*' intelligence put forward by Gardner in 1983 that also provides opportunity for the students to develop their soft skills such as language / communication skills.

Overall, the innovative teaching practice using a '*Blended and Active*' method described in this paper has given benefits and impacts for the students as well as for the local (school) community. In particular, this has increased student's spatial understanding, creative and innovative thinking as well as hands-on and communication skills. The role of academics (lecturers and teachers) should mainly be the facilitator of teaching and learning activities. Students of all ages can now access most if not all of the information they need in the palm of their hands via the use of internet technology.

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43. PBL APPROACH IN POWER ELECTRONICS SUBJECT

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Extended Abstract

Power electronics is an important subject for Electrical Power Engineering students. It links the core subjects to the elective subjects. Failure to grasp the concept in the subject will cause the students to face difficulty later. Upon study for six semesters (Semester 2 2010/2011 until Semester 2 2012/2013), the students' performance in the final exam were unsatisfactory. In average, 40% of the students got below 20% in their final exam. Moreover, students who selected Power Electronics as their final year project area had difficulties in relating what they had covered in the subject with their projects. This sparked an initiative among the lecturers to conduct a project-based learning (PBL) method to improve the students' learning process. This is also an evolutionary step to develop the students' ability to transfer theoretical knowledge into industrial practice.

Introduction

Project-based learning (PBL) has contributed to important developments in engineering education over the last few years. It was first introduced in the engineering field in Aalborg University, Aalborg, Denmark [1]. It has been used successfully in teaching electronic, electrical, and control engineering courses [2]–[4]. In PBL approach, students are organized in small groups and use a seven systematic approach [5]: clarifying concepts, defining the problem, analyzing the problem, formulating learning objectives, self-study, and reporting. Although much work has been done, not many PBL implementation in undergraduate level has been reported.

This paper presents the results and experiences gained from project-based learning (PBL) in a power electronics course at the Universiti Tenaga Nasional (Uniten), Malaysia. The objectives of PBL are the following: to allow students to analyze a complex engineering problem and to defend their solutions with coherent arguments. In the project, students are required to design a power circuitry to power up a number of appliances. Based upon the appliances output requirements, the students select suitable topology, determine the input/output voltage and design controllers in order to fulfill the requirements. In this paper, the underlying methodology and assessment of the project will be presented.

Course Design

Power Electronics is a third-year course in Bachelor's Degree in Electrical Power Engineering at the Universiti Tenaga Nasional, Malaysia. The 4-credit course is conducted in 14 weeks teaching period per semester. The course consists of a weekly 3-hour lecture which reviews fundamental concepts of power electronics circuits covering circuits such as rectifiers, dc-to-dc converters, inverters and electric drive. Students also perform three laboratory-work on selected devices covered in this subject. At the end of the course, the students are expected to know six course outcomes (CO). The desired outcomes that students are expected to acquire by applying PBL in the program were formulated to meet the requirements of the ABET [6] engineering criteria.

Previously, the course assessments were on lab-work (35%), test (20%), final exam (40%), quiz (5%), and formal report (10%). However, for the last four semesters the quiz and formal report assessments were changed to a PBL assignment. The lectures focus on the theoretical basis, and the application of the concepts was carried out by the PBL assignment.

PBL assignment

Normally by Week 10 of the semester, the lectures have covered all type of converters. Hence, the students are given the PBL assignment during this week. They have four weeks to define and solve the case study given (Figure 1). Each group must meet the lecturer once a week to report on their progress. This is to monitor the students' progress to ensure they meet the objectives and requirements of the PBL assignment.

The PBL case study was an open-ended problem, as usually encountered by engineers. The type of input supply was usually stated but no rating or specifications are given. Similarly, the output loads were open and had to be defined by the students. In order to design the converter topologies, a number of assumptions need to be made. By setting the current and voltage ripple, the output obtained can be maximized. Selection of the right switching frequency is also important to reduce the size of the capacitor and inductor without compromising the efficiency of the converters. In terms of control strategy selection, the most suitable one need to be chosen to ensure a low THD, thus increases the quality of the output. Simulation model of the system needs to be carried out in MATLAB/Simulink to verify the output waveforms of the system.

The assessment is based on the following,

- Written report (10%). The assessment of the written report, took into account the quality of the design, simulation results and discussions.
- Oral presentation (5%). In the oral assessment, each individual student in a group presents his/her contribution to the project. All students have to answer questions and/or clarify any concerns that were raised by the lecturer.

Results

Categories of students

The PBL is implemented to improve the students' understanding of the course and set as a group project to inculcate teamwork and cooperation in the students. These objectives cannot be achieved f the students do not engage themselves in the process. There were cases where students complained that their group members did not play their respective role in completing the tasks. Based on this situation, the groups are categorized into,

- Category 1: All students in the group did the task
- Category 2: All students in the group did not give full commitment to the task
- Category 3: Only part of the students did the task

For clarity, results of six groups (28 students) from Semester 2 2014/2015 were taken as samples for illustration in Figure 2. Referring to Figure 2,

- Group 1 and 2 were in Category 1. Clearly, when every students contribute actively in the PBL assessment, the good marks they obtained in the PBL assessment are an indication they understood the subject well. The hard work was also paid off, with good grades they achieved at the end of the semester.
- Group 3 and 4 were in Category 2 where all the students did not give their best to complete the task. They only met the minimal requirement of the PBL report. This was one of the reasons behind the low grades they obtained.
- Group 5 and 6 were in Category 3. In this category, not all the students cooperate to complete the task. The student/s who worked hard to do the task, got better grades compared to their group members who did not contribute in completing the task.

From this analysis, we can deduce that there is no linear relationship between the marks obtained in the PBL assessment and final grades of the students. It is very subjective to the students' behavior as well.

Improvement in grades

Even though it is not possible to do a one-to-one mapping between the marks obtained in the PBL assessment and final grades of the students, an overall conclusion can still be made. The final exam marks obtained by the students, who followed the PBL approach, for the last four semesters (Semester 1 2013/2014 to Semester 2 14/15) have greatly improved. Percentage of students who got below 20% in their final exam has dropped to 10% (or below) as shown in Figure 3. The improvement can also be seen on opposite side of the scale, where the number of students who obtained grade A (A-/A/A+) has increased as illustrated in Figure 4. These two results show that the PBL approach adopted does improve the students learning process.

Conclusion

This paper described the impact of the adopted PBL teaching approach on students learning and their performances. By working on a project, the students can gain a deep understanding of the fundamentals as well as the important experience of designing a real switch mode power supply system. The approach has been shown to be an attractive method that can improve students understanding in Power Electronics subject and also in their final grade. This learning approach could be applied to any other subjects by simply redefining the case study.

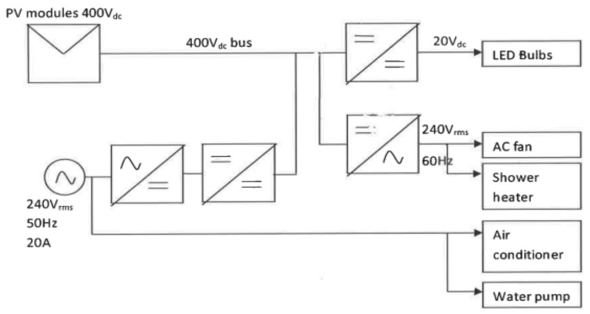

Figure 1: Example of an overall block diagram for a case study

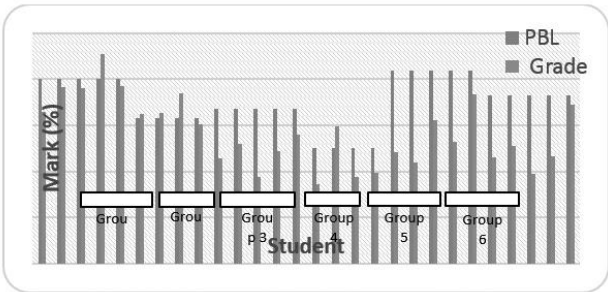

Figure 2: Sample of students' result according to their respective group

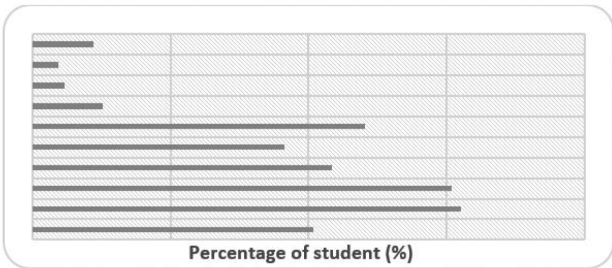

Figure 3: Percentage of students with final exam mark below 20% according to semester

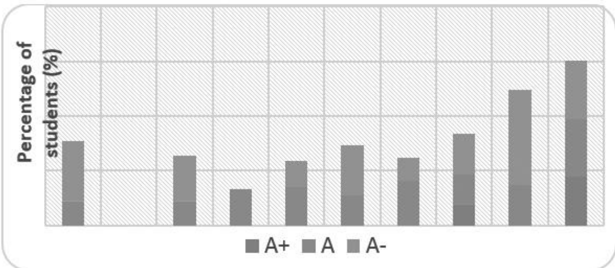

Figure 4: Percentage of students with grade 'A' according to semester

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44. COOPERATIVE PROBLEM-BASED LEARNING: FRAMEWORK FOR SUPPORTING STUDENTS IN DEVELOPING TEAM-BASED PROBLEM SOLVING SKILLS

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Introduction

The world requires engineers who can face novel problems. The Grand Challenges of the 21st Century include environmental issues, aging infrastructure, issues on poverty and health, security and many others [1, 2]. The Engineers 2020 [3] listed the significant characteristics associated with team-based problem solving that will support the success of engineering profession in 2020 and beyond. As such, it is not surprising that the Washington Accord (WA) included "complex problem solving" in six of the twelve program outcomes necessary for accreditation. Consequently, as a WA signatory, the Malaysian Engineering Accreditation Council requires all accredited engineering programs to include these outcomes [4].

The problem is, how to develop team based problem solving skill among students in a typical course, so that they have the ability to handle complex problems as engineers? It is not sufficient to just give students problems or projects without supporting them to develop the cognitive and affective skills required to be good team workers and problem solvers.

To overcome this problem, Problem-based Learning (PBL) was initially implemented in Process Control & Dynamics, a third year Chemical Engineering course in Universiti Teknologi Malaysia (UTM) in 2003. The PBL implementation was continuously improved and in 2009, Cooperative Learning (CL) principles were formally infused into the PBL model implemented to effectively develop students into learning teams. Thus, Cooperative Problem-Based Learning (CPBL) was introduced as a supporting framework that can be used in a typical course for supporting students in developing team-based problem solving.

Theories underpinning CPBL

CPBL is the infusion of CL principles into the PBL cycle that is designed as a scaffolding for the development of team-based learning skills to enable students to successfully undergo a PBL learning environment in a typical course setting. CPBL has also been used for projects. Figure 1 shows the CPBL framework to guide students step by step through the CPBL cycle as they go through the learning process together [6].

In addition to the constructivist underpinnings of PBL and the social interdependence underpinnings of CL, CPBL was inspired from How People Learn (HPL) framework, while the step by step process was designed using Constructive Alignment (CA). The HPL framework can be utilized for designing learning environments through four overlapping lenses, which are knowledge centred, learner centred, assessment centred and community centred [7]. CA requires the outcomes to be aligned with assessment tasks and teaching and learning activities, which should be based on the constructivist approach [8].

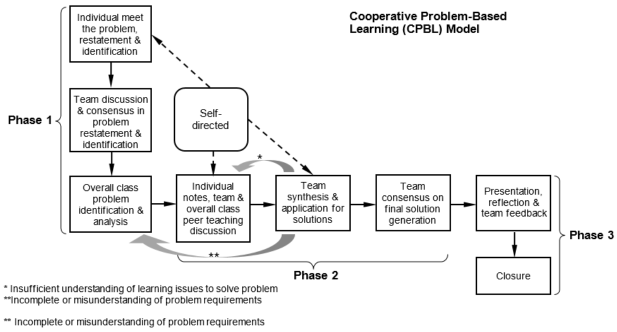

Figure 1: The Cooperative Problem-based Learning Cycle [6]

Implementation of CPBL

Currently, the CPBL framework has been used in several chemical engineering and mechanical engineering courses in UTM and other universities [9, 10]. CPBL is implemented by dividing students in a typical class into small groups. An instructor, who functions as a floating facilitator, can facilitate up to 60 students. To provide learning context, problems designed should be realistic, or even real, representing professional practices that resemble working environment possibly encountered in actual practice. The open-ended problems are mapped to the course content and structured such that the next one brings students up to a higher level of expectation [11]. In a semester, students go through three to four problems, which correspond to these stages of development: build, bridge, extend, and apply [12].

In the Process Control course, students were assigned the role as an intern in the first problem (building), where the technical knowledge concerns introductory knowledge aimed at helping students to learn terminologies and common control structures in a piping and instrumentation diagram. In the second problem (bridging), the expectation is higher where students were now in the role of newly graduated engineers, with the content on mathematical process modeling and analysis. In the third problem (extending), the expectation was increased where students now play the role of control engineers required to run dynamic simulations of the chosen process to perform model estimation, stability analysis and controller tuning. Finally, in the fourth problem (applying), students play the role of consultants assigned to design an automatic control system as part of a bidding effort for a section of a real chemical plant.

For each problem, students go through the CPBL cycle, as shown in Figure 1, consisting of:

- Phase 1 : Problem restatement and identification
- Phase 2 : Peer teaching, synthesis of information, and solution formulation
- Phase 3 : Presentation, closure and reflection

In Phase 1, students receive the problem through the course e-learning platform and individually restate and identify the problem in their own words, which they have to submit at the beginning of the next class.The individual preparation allows the team discussion to reach consensus on the restatement and identification of the problem to be efficiently carried out in class. This is followed by an overall class discussion, which allows instructors to assess students' ability to understand and define the problem and provide feedback. In Phase 2, students individually prepare peer teaching notes on the learning issues identified from Phase 1 and submit a copy. Next, they learn in their team, followed by an overall class discussion.Learning in a team that students are comfortable with encourages them to share what they learned, and feel safe to ask questions, which leads them to be more confident in sharing their understanding and asking questions in the overall class discussion while being facilitated by the instructor.All collated information and knowledge is shared and critically reviewed, before the relevant ones can be synthesized and applied to solve the problem. This step can be iterative, where students may need to re-evaluate the analysis of the problem, pursue further learning, reporting and peer teaching. In Phase 3, students submit solutions, in the form of deliverables that is aligned to the outcomes. The instructor probes students during discussions to determine acceptable solutions, and justify their choice of the best solution. During closure, feedback is given on the possible solutions, as well as identifies the best solution, serving as part of the formative assessment. To strengthen the community centred aspect in developing team working skills, a team-based post-mortem on the process and performance must be conducted in class.

Study of the impact

To determine the impact of CPBL, different studies were carried out for several semesters on courses that implemented CPBL (Process Control and Introduction to Engineering) using reflective journals, interviews and survey instruments. After undergoing the Process Control course using CPBL for the whole semester, quantitative analyses provided evidences that students significantly enhanced their team-based problem solving skills [13]. The qualitative analyses on observations and interviews showed how problem solving skills among engineering students was achieved through CPBL. Factors that contributed to the enhancement are categorized under four spotlights, which demonstrated how students improved problem solving elements, motivation and learning strategies, and team working, which develop students' problem solving assets, enhancing their team-based problem solving skills [14, 15]. These findings proved that CPBL can be effectively implemented to support the development of team based problem solving in a typical engineering course.

From the analysis of the reflective journals written by students in the "Introduction to Engineering" course, CPBL was found to be an effective and efficient means for learning of professional skills. CPBL not only offer the opportunity to learn knowledge contents, but it also creates leadership, inspires teamwork and promotes problem solving skills [16]. Despite initial negative reactions, the majority of the students stated that CPBL is an effective way to learn and appreciated the opportunity to work on a real problem. Thus, experiential learning of CPBL would provide the community with successful, well-equipped graduates who are competent in skills, knowledge, and wisdom.

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45. COMPUTER-MEDIATED COMMUNICATION THROUGH THE WINDOW OF ENGLISH AS A LINGUA FRANCA

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Introduction

While the Internet access remains unequally distributed across geographical areas around the world, the populations of its user continue to expand greatly. As such, the Internet use becomes pervasive alongside the fast pace of technological innovation world-wide. Similarly, everyday communication in professional, educational and interpersonal realms has also transformed globally, leading to ubiquitous communication via computer (CMC) (Georgakopoulou, 2011). Not only becoming proficient e-communicators is essential, online interaction in second (L2) or foreign language (FL) is also important. Warschauer and Healey (1998) state that a second language learner must have the ability to read, write and communicate in an electronic environment. Consequently, tertiary educators are constantly exploring how they can make the best use of these innovations in teaching and learning at higher institutions.

In light of this phenomenon, the students at tertiary education in Malaysia should also be well equipped with the skill of interaction mediated by computer. Therefore, one initiative has been implemented at one of the technical universities in Malaysia to promote and enhance students' learning experience. In one of the English language courses at the university, students are given the opportunity to use Skype as a platform for communicating online. For tertiary students in an either L2 or FL environment, ample opportunities for interaction in their L2/FL are limited. The interaction occurs mostly between peers or with teachers, who in the case of the current practice are L2/FL speakers of English in Asia. Therefore, it is a worthwhile effort to incorporate the online interaction activity as part of the practice session in one of the English courses at the tertiary level. Likewise, in the preparation for future workplace, the students at tertiary levels need to be exposed to innovative educational technology to complement their professional knowledge and skill. As such, having the opportunity to engage in online interaction with students from other countries who do not share the same first language may motivate them to communicate in their L2/FL, the situation which they may face in their future workplace.

The theory applied in implementing the practice/ innovation to overcome the problems

For language learners in a foreign language environment, opportunities for interaction in their second or foreign language (L2/ FL) are limited. Additionally, in most instances, communication that occurs online is between the non-natives (NNSs) themselves, either they share the same native language or not (Nik, 2015). Therefore, it would be beneficial for them to practice their target language through computer-mediated communication (CMC) because the technology holds great potential for increasing opportunities for language learning as it greatly expands the virtual space available for communication and collaboration (Sauro, 2012). Previous studies in second language acquisition have highlighted that CMC may assist in amplifying opportunities for students to focus on form (Sauro & Smith, 2010), offer a less stressful environment for practicing second language (Adams & Nik, 2014), and promote cultural language exchange between the non-native speakers (Freiermuth & Huang, 2015). CMC may occur either in the mode of synchronous (SCMC) or asynchronous (ACMC) communication. The mode used in the current practice is synchronous computer-mediated communication or SCMC.

SCMC refers to real-time interaction between people over either a local or a wide area network. Messages are typed, sent, and received instantaneously, and participants are required to communicate in the same session. SCMC has been found to exhibit characteristics that resemble spoken and written communication, and still others that are unique to CMC discourse (Chen & Eslami, 2013). It has been firmly established that SCMC promotes non-native speakers-to-non-native speakers (NNSs-NNSs) interaction in their L2/ FL that promotes linguistic benefits. Successive studies have suggested that there is a scope for linking L2 learning and practices to SCMC and participatory spaces in online interaction of web 2.0, e.g. skype and wikispaces (Adams, et. al. 2014). The linkage may afford learners opportunities for experimentation of the language and it may lead to important consequences for online L2 interaction.

In his proposal of Interaction Hypothesis, Long (1996) argues that in addition to exposure to linguistic information (as input) and opportunities for language production (as output) when non-native speakers interact with each other, there may be conditions which require them to modify their utterances to facilitate comprehension, which in turn may promote acquisition. During interaction involving NNSs, negotiations of meaning are found to be frequent. Gass and Torres (2005) claims that through negotiation, the attentional resources of the NNSs may be oriented to the gap between their L2 knowledge and the L2 in its own right or an L2 area in which they have little or no knowledge about. Interaction may serve as an attention-drawing device to an unknown part of language (Gass, 1997). Hence, language acquisition and development may take place during the interaction. Nevertheless, interaction that occurs via electronic platform, particularly online text chat, requires some skills that warrant effective communication to take place. This is because of the challenging nature of communication in this context, which lacks paralinguistic features that aid communication as found in the face-to-face setting. Therefore, the ability to choose appropriate and effective communication behaviour to suit a given situation in this context is required. According to Spitzberg and Cupach (1984), such ability is regarded as communication competence.

As indicated in the earlier discussion on computer-mediated communication, interaction may occur via e-communication between individuals who are geographically divided. Evidence shows that almost half of the world region who uses the Internet was monopolized by the Asian. Thus, having communication competence alone maybe insufficient as the interaction occurs between people of different culture. To relate to this situation, Deardoff (2009) proposes the importance of having intercultural competence, which is the ability to interact effectively and appropriately in intercultural situations, based on specific attitudes, intercultural knowledge, skills and reflection. Consequently, the importance of understanding the world from others' perspectives is deemed necessary to ensure the success during SL/ FL interaction particularly between the NNSs. This circumstance serves as a starting point for the L2/ FL instructors to consider using computer-mediated communication as a platform for language learning practice.

In relation to the use of interaction via computer by people who own different cultural values requiring the need of being interculturally competence, the influence of lingua franca is prominent. Firth (1996) states that lingua franca is a contact language between persons who share neither a common native tongue nor a common (national) culture. Lingua franca may play an important role as the people around the globe are easily connected via the Internet 24/7. Based on world Englishes model represented by three concentric circle proposed by Kachru (1992), Lewis (2005) identifies the world Englishes speaker-listener intelligibility matrix which is illustrated in Figure 1.

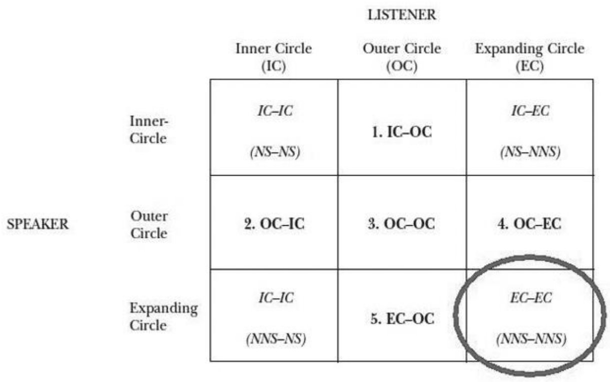

Figure 1: World Englishes speaker-listener intelligibility matrix (Lewis, 2005)

As evident in Figure 1, the listeners and speakers of English do consist of the non-native speakers among themselves (NNS-NNS) which occurs in the Expanding Circle (EC) column. This means, such interaction is inevitable in today's communication which is largely connected through the Internet. Therefore, the influence of lingua franca during the interaction between them may be seen to a certain extent, particularly when their language proficiency is diversified.

Individuals who do not speak the same mother tongue are required to use a language comprehended by both parties in order to ensure successful communication. The question that remains is how interculturally competent are the students at tertiary institutions and what can they do to increase their own development in this area? Since intercultural competence is not a naturally occurring phenomenon, the educators must be intentional about addressing this at our institutions, either through the course syllabus or/ and co-curricular efforts.

Therefore, it would be beneficial to encourage students at higher institutions to engage in online interaction in an attempt to practice the target language.

Impact of the practice/ innovation in improving the higher education system

Using Skype as the platform for online communication for students in one of the English language courses to practice their L2 interaction at the university has been implemented for approximately four years. The effectiveness of employing this activity in the language classroom is measured through several factors which include the examination of the interaction between the students. Some evidences of the use of intercultural communication and English as a lingua franca in computer-mediated settings by the students from the two countries emerged from the text chat transcripts. These include 1) negotiation of meaning to increase mutual comprehensibility, 2) accommodation of language, cultural similarities and differences, 3) linguistic awareness exhibited, for example spelling and grammar corrections by the students, 4) social appreciation for example continuing the friendship beyond the formal activities, and 5) the use of text chat conventions for example abbreviations, short forms and pragmatic particles.

Most students also provided written feedback with regards to their learning experiences with their counterparts. Some comments include their contentment in having the chance to chat and communicate with someone from a different country, and this opens up the opportunity to practice their L2/FL as required. With the emphasis on integrating online interaction between students with different nationalities, the students who are trained to communicate electronically in their L2/FL should have increased confidence if they need to communicate online with people or clients from other parts of the world in the future. Due to the positive feedback received from the students, the practice of online interaction as part of the L2/FL learning and teaching language at the university is now moving to another level, i.e. between the students from other countries beyond Asia.

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46. DEVELOPMENT AND IMPLEMENTATION OF FORMATIVE EVALUATION SYSTEM IN THE UNIVERSITY OF MALAYA MEDICAL SCHOOL

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Extended Abstract

Evaluation on teaching and learning activities is a systematic investigation on the processes or products of these activities. There are two kinds of evaluation: summative and formative. The purpose of conducting summative evaluation is to examine effectiveness of the teaching and learning activities, whereas formative evaluation is aimed to improve the effectiveness of the activities.

Students, as users of a curriculum, are often invited to evaluate delivery and effectiveness of the curriculum. In the University of Malaya, evaluation is conducted on each course that students have attended for the current semester. However, the Bachelor of Medicine and Bachelor of Surgery (MBBS) programme follows neither the course nor semester system which contributes to credit hours. The MBBS programme is divided into four stages with each stage comprising of approximately from 1 to 1.5 years in duration (Stage 1 ≈ Year 1). Each stage can involve more than 50 lecturers and their commitment to teaching is discipline-specified depending on the different expertise in pre-clinical sciences (e.g. Anatomy, Physiology, Molecular Medicine), para-clinical sciences (e.g. Medical Microbiology, Pharmacology, Parasitology) and clinical sciences (e.g. Surgery, Paediatrics, Obstetrics & Gynaecology) and teaching hours of a particular lecturer are inconsistent each week.

In the previous evaluation system, a questionnaire was administered to all students at the end of a stage. The faculty management and members were informed of the students' perceptions of effectiveness of the programme after they had been following the programme for one year. This system, however, has limitations. Firstly, the questionnaire was designed to be administered right after students sat for the final examination. Therefore, students' emotions and feelings following an examination should be taken into considering possible bias (e.g., students are confident or unconfident in passing the examination). Secondly, sense of "feeling good" can cause complacencies when lecturers are unaware of upcoming threats. There were no checks and balances because the evaluation results present an overview and summary based on numerous teaching and learning activities, whilst lecturers are not informed of the effectiveness of their delivery of content (i.e., teaching and learning activities which they were in charged). Therefore, an evaluation system needs to be put in place in order to aid lecturers in reflecting on their teaching approaches.

In alignment with the implementation of a revamped medical curriculum, the medical school introduced a formative evaluation system since academic year 2013/2014. Four major types of teaching and learning activities in Stage 1 (Year 1) were evaluated by medical students on a daily basis. The four activities were conventional lectures, multidisciplinary and interactive seminars, laboratory and clinical teaching sessions. For a 1-hour lecture, an example of Likert-scale questions asked in the questionnaire included "Was the content delivered in this lecture aligned with the learning objectives". Other Likert-scale questions were related to delivery of the content (i.e. clearness, level of interesting), intellectual level (i.e. appropriateness at this point in the curriculum), amount of content (i.e. appropriateness considering the time allocated) and an overall rating. Students were also prompted with two open-ended questions "What did you like about this

session and why" and "What are areas for improvement and how". Open-ended questions enabled students to write about their learning experiences and they could recommend suggestions in which Likert-scale questions could have missed.

In the academic year 2013/2014, one hundred and sixty nine (n=179) Stage 1 students were divided into 12 groups. Each group evaluated all teaching and learning activities for a period of two weeks, and the process was repeated throughout the academic year. Students submitted their feedback online via the university's Learning Management System (SPECTRUM at www.spectrum.um.edu.my). Subsequently, the Medical Education and Research Development Unit (MERDU) generated students' feedback into reports and these reports were sent to the respective lecturer/s via emails after the two weeks. Through the same emails, lecturers could inform medical education coordinators and the managements of their counter feedback. Lecturers' counter feedback might show their level of acceptance "Thank you for the feedback. It is useful for me to know the areas of strength and limitations so that I can further improve on my teaching" or indicating areas of concern "I was also very concerned when I discovered that during the lecture itself the students did not learnt much of the systems in depth in order to associate basic biochemical investigations to previously learned topics". In addition, MERDU met students regularly to present a summary of their feedback and actions which the faculty had taken.

It is argued that students' feedback could motivate lecturers to maintain effective teaching approaches. Examples elucidated by students included charisma of the instructors "Dr Y was lively and full with enthusiasm. She was also able to form a good rapport with the students" and some students pinpointed the approaches "Explaining things with diagrams… Helps to aid in the learning process" and "Good student-lecturer interaction… I like the way they guided us to think and relate until we have got the answer". There was also appreciation by students when comments such as "Happy to be of service to the students and nice to feel appreciated". Meanwhile, lecturers realised the need to improve. Dr Z received a comment from students "I hope the lecturer can speak slower". He accepted the recommendation and students appreciated his effort "The lecturer spoke slower and continued repeating the facts that he wanted to tell us... he had improved his approach in giving lectures".

Impact

Implementation of this formative evaluation system encountered challenges. Firstly, several lecturers were concerned on the reliability of the evaluation which involved small number of students "How reliable were these evaluations…were able to make correct interpretation of each lectures and lecturer". However, it is unpractical to invite whole class to evaluate every teaching and learning activity as they could be fatigued and turn into perfunctory behaviour. In an attempt to resolve the lecturers' concern, MERDU invited all students to evaluate three randomly selected lectures. With a response rate of approximately 85%, Mann–Whitney tests revealed that for all nine Likert-scale questions, there was no significant difference between responses of a randomly selected group (n=15) and other peers (n=130). Secondly, several students' comments contained negative emotions and inappropriate wording. Therefore, meetings with students were arranged regularly as to enhance their practices on providing constructive feedback. One of the interventions was by showing students examples of non-constructive feedback "I could not understand what this lecture was trying to deliver" and its comparison to constructive feedback "The lecturer can put small description of how the organ/tissue characteristics are in the slides along with the diagrams, so that we learn to identify the important signs and symptoms". The meetings were also aimed to develop students' personal and professional development. Communication skills are essential for these future medical doctors. Thirdly, a small number of lecturers would need to be more enlightened in receiving criticisms from students. Fourth, formative evaluation system administrators had been transferring statistics manually from the university's Learning Management System into Microsoft Power Point application in the processes of generating students' feedback reports. Human errors are unavoidable. Therefore, an automatic transfer was developed and commenced since the academic year 2014/2015.

Conclusion

In conclusion, the formative evaluation system at this medical school provides timely feedback to lecturers in order to implement continuous improvements on their subsequent teaching and learning activities within the academic year. The success of this system would rely on efficiency of the system administrators, as well as buying in from both lecturers and students.

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47. MAKING ACADEMIC CHANGE HAPPEN: A WORKSHOP TO DEVELOP CHANGE AGENTS IN HIGHER EDUCATION

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Introduction

Our increasingly interconnected and technology-dependent world needs individuals with training in science, technology, engineering and mathematics (STEM) more than ever. Not only do we need more STEM experts, we need STEM experts with new kinds of skills. We need scientists/engineers who are prepared to handle the rapid pace of technological development, and who are also prepared to solve complicated problems that integrate technical and societal/cultural factors. As a result, there have been many calls for change in STEM higher education across the globe, including changes in how and what students learn on a daily basis in a class, changes in curricula and co-curricular experiences, and changes in how institutions of higher education operate [1-5]. Unfortunately, previous calls for change (e.g., [1]) have not resulted in deep or widespread change in STEM education. Faculty and administrators acting as change agents have instead largely focused on individual courses and curricula, exploring teaching and learning methods and examining their efficacy [6].

The global forces that shape our need for STEM experts with new kinds of skills are also modifying the context of change in higher education. Today's connections between higher education and larger social and economic goals mean that faculty and administrators need to be more transparent and accountable for change efforts [7], and to more clearly demonstrate the value of such change efforts to a variety of audiences. As Kezar wrote, "This is a time when skills in change agency are critical to the health and success of the higher education enterprise." [7, pgs. 3-

4] Change agency skills and strategies for broad change are documented in the literature of some disciplines, such as organizational psychology and behavior (e.g., [8, 9]), but have not been brought to STEM education in an accessible way.

If we are to implement broad changes in STEM education, we must help faculty and administrators become effective change agents within the contexts of their higher education institutions and climates. Our 'Making Academic Change Happen' (MACH) workshop was created to bring research-based change strategies and skills to higher education faculty/administrators. The workshop encourages these leaders to select and adopt change strategies that are aligned with their institutional cultures, and helps them to develop change agent skills. It is designed to transfer skills to STEM higher education practitioners, and to connect them with a community of practice and with mentors.

Teaching Strategies

2a) Why is Change Agent Skill Training Important for STEM Education?

Traditionally, STEM faculty are trained primarily as STEM researchers and practitioners, and secondarily as educators. Successful STEM faculty are therefore often independent investigators, accustomed to logic and autonomy in decision-making. This mindset can lead to mistakes such as neglecting to focus on the process of change (expecting others to adopt an idea when presented with logical evidence that it is effective; expecting tacit acceptance of mandated change), ignoring external and organizational contexts for proposed changes, adopting a single linear approach to change adoption, and not grounding change strategies in research. [7, 10] Successful change agents in STEM education need to move away from operating as independent experts, and adopt a different mindset to encourage others to participate in shaping change efforts [11], including experience in relationship/partnership-building skills, communication skills that build shared cognition and goals, working with and across diverse perspectives, and ethically influencing and motivating people. [7] Instead of developing these skills solely through trial and error, our MACH workshop provides opportunities for participants to practice them with immediate feedback from facilitators and peers (developing a community of practice) as well as periodic post-workshop feedback from MACH facilitators acting as change mentors.

2b) What Are the Underlying Principles of the MACH Workshops?

Although Rose-Hulman's reputation for being a leader in STEM education innovation [6] is well-established, we recognize that each campus environment and circumstances are unique. Rather than offer a workshop that merely taught "the Rose-Hulman way," we started with a deep consideration of the fundamental dimensions of change as we saw embodied in our own projects (both successes and failures) and the literature on change. The MACH workshop is organized around three themes: "Knowing Yourself," "Cultivating an Allied Community of Colleagues," and "Making Change Happen on Campus." The "Knowing Yourself" segment helps participants focus on skills and change aspects that an individual faculty member can control, including interactions with students and colleagues. The "Community of Colleagues" segment focuses on building teams, garnering support, and maintaining effective relationships with others. The "Making Change Happen on Campus" segment targets developing measurable objectives and assessment for the project, building and implementing partnerships, identifying sources of support and resistance, and creating action plans for moving the project forward. Every session includes time for learning, practice, and feedback from facilitators and participants. References that have strongly influenced the strategies and skills emphasized in the MACH workshop include Kezar's "Understanding and Facilitating Organizational Change in the 21st Century," Eckel and Hartley's "Developing Academic Strategic Alliances: Reconciling Multiple Institutional Cultures, Policies, and Practices," and Eckel et al.'s "On Change III. Taking Charge of Change: A Primer for Colleges and Universities." [12-14] From these works and others, we identified four underlying principles that guide our MACH workshop activities.

1. Change strategies should be selected to align with an institution's or educational system's culture and mission. We work with participants to adopt an anthropological approach [14, 15] to identifying key aspects of their institutional/system culture. Participants can then frame their proposed change project within the context of their organization's values, mission and beliefs [16]. Because change agents are more likely to be successful when their strategies are aligned with institutional culture and values [7], MACH workshop facilitators provide participants with targeted questions, explorations, and challenges regarding institutional culture and their own relationships to that culture. We view this as a critical factor in the ability of participants to successfully effect change on their campuses.
2. Change agents should view their project and organization through multiple frames, to anticipate potential resistance and to cultivate partnerships. Because a good deal of research has indicated that multiframe thinking is associated with management and leadership effectiveness (reviewed in [17]) MACH workshop facilitators encourage participants to deliberately view their project through multiple frames (e.g., the four-frame model presented in [17]). Each frame presents different potential barriers to change, and suggests different strategies for effecting change. For example, viewing a change project from a structural frame would cause participants to consider whether their project could make others fear a loss of direction and clarity. Strategies for avoiding those barriers might include communicating and renegotiating formal policies or authority structures. Viewing the same project through a political frame would cause participants to consider whether their project could make some colleagues feel disempowered or fear losing scarce resources. Strategies for avoiding those barriers might include forming new coalitions and sharing resources. As a result of the MACH workshop activities, participants create an action plan that includes multiple change strategies [7] and items designed to facilitate change from diverse perspectives.
3. Change agents should practice communicating to multiple constituencies, in multiple ways. STEM education experts are typically well-versed in scholarly writing, and in creating lectures for students. These communication skills are different from 'selling' an idea to an upper-level administrator in a few minutes of discussion. At the MACH workshop, participants practice communicating about their project in a persuasive manner [18] to gain support, and in a respectful, deflective manner [19] to minimize opposition. Participants also spend time working on 'elevator pitches' for their change projects. These are short verbal presentations, as if the participant were riding in an elevator and explaining their project to a fellow passenger. The structure of an 'elevator pitch' requires participants to concisely identify what problem they are trying to solve, how the problem is adversely effecting various stakeholder groups, a core action that is needed, what desired outcomes would be produced for the stakeholder groups, and a defining milestone of success.
4. As with most things, practice is key to learning. MACH is a very active, participant-focused workshop. Each MACH facilitator has implemented change projects at the level of an academic department at a minimum, and many facilitators have implemented changes across multiple departments and/or institutionally. Rather than simply recount these experiences, facilitators briefly introduce theories or principles from the research on change, and then help participants actively apply the principles to their specific project through individual/small-group work and whole-group discussion. For example,

facilitators help participants through role-playing scenarios from selected readings such as Kotter and Whitehead's Buy-In, Stone, Patton, and Heen's Difficult Conversations, and Harvard Business Review's On Teams [19-21]. The active nature of the workshop allows participants to practice skills with immediate feedback from facilitators and peers – again, developing a community of practice – and to learn and benefit from the diverse experiences and ideas of other workshop participants.

Results

We have now conducted the MACH workshop three times – twice on our home campus (2012, 2013) and once off-site (2014; the 2015 off-site offering will occur in mid-June). We have additionally conducted "mini-MACHs" (selected sessions from the MACH curriculum, highly reduced) at the 2013 American Society of Engineering Education national meeting in Georgia, USA; at the 2013 IEEE International Professional Communication Conference at the University of British Columbia in Vancouver, Canada; and at the Universiti Teknologi Malaysia in December 2013. We used both formative and summative assessments for continuous quality improvement. We partnered with the Engineering Communication Center at Virginia Polytechnic Institute and State University (Virginia Tech), asking them to conduct assessment and evaluation of the 2012-2014 workshops while the Rose-Hulman team focused on developing, revising, and refining the content.

Evaluation of the MACH workshop has focused on two issues: strategies and approaches used at the workshop to support and engage participants; and immediate and intermediate (6 months post-workshop) impacts. Two data sources were used to gain insight on participants' perceptions of confidence, and their abilities regarding planned or hopeful academic change. The first source of data was a post-workshop online survey, and the second data source was a follow-up online survey. The surveys were administered online using the Qualtrics software program licensed through Virginia Tech.

Because MACH seeks to empower individuals and teams to create academic change, the learning environment is intentionally designed to support such empowerment. To effectively support this learning environment, an evaluator from Virginia Tech attended each MACH workshop and took extensive field notes during sessions regarding the ways in which the facilitation practices, course materials, and activities engage participants. Two key frameworks guided these observations: cognitive apprenticeship [22] and expectancy-value theory [23]. In addition, given the workshop focus, the observers also explored the ways in which the workshop functions as a community of practice [24]. These observations provided the basis for immediate formative assessment as the evaluator met daily with the MACH team, as well as summative evaluations that both helped explain the impact findings and informed continuing quality enhancements to the workshop for the following year. Virginia Tech researchers tested and refined this observation protocol iteratively during the 2012, 2013, and 2014 workshops.

The impact of the workshop has been evaluated via surveys that include both Likert-scale and open-ended questions. Like the observation protocol, the survey has been tested and revised at each workshop. The first survey is administered immediately after the end of the workshop, and solicits information regarding changes in salient expectancy-value constructs [23], feedback on the workshop, and plans for action when participants return to their home campuses. The second survey is administered approximately 6 months later, after the conclusion of the fall semester; it again solicits information regarding salient expectancy-value constructs, then asks participants about actions they have taken with respect to the plans developed at the workshop. In the spring, the Virginia Tech evaluation team synthesizes the findings from all of the evaluation tools and provides a report to the MACH facilitator team to help inform the continuous quality improvement and planning of the next workshop.

Based on the data collected thus far, participants report agreement with statements regarding the workshop enhancing their confidence in their ability to identify potential barriers to change, capability of identifying potential barriers to change, confidence in their ability to develop and implement plans to overcome barriers, and capability of developing and implementing plans to overcome those barriers. Six months after the workshop, participants report high levels of agreement with statements associated with their active participation related to expanding their network of supporters, feeling more confident with barriers to change, and successfully identifying barriers to change. Responding participants also begin putting into action the plans they developed during the MACH workshop. Finally, participants report that they have adequate time to work on their project and apply workshop content to their project.

We recently conducted an additional qualitative investigation consisting of a series of targeted interviews with MACH alumni at different points in their academic careers. In this work [25], we learned that these change agents wrestled with time limitations, but were still able to apply workshop content to their work. These individuals were open to alternate interpretations/diverse viewpoints on issues, and to exploring situations to reveal areas for future work. The change agents looked for opportunities to create connections in various ways – through curriculum, programming, management strategies, non-academic departments on campus, professional societies, etc. In short, the MACH alumni were constantly seeking connections through which to build partnerships and shared engagement in change efforts. The change agents initiated their projects with a clear vision of their roles within their institutions, and then worked within those roles to meet the needs of various constituencies. Change agents – especially those hired to accomplish a specific goal – tend to be forward-thinking and fast-moving. That personality can cause internal or external conflict with stakeholders. We are taking this challenge into consideration as we review and refresh material for the next offering of the MACH workshop. However, uniformly, the change agents described the value of their change projects from a very personal position and with a strong sense of identity. Regardless of their career stage, these individuals demonstrated the underlying principles of MACH and have clearly adopted the change agent mindset recommended in the literature [7, 11]. They understood their institution's culture and their roles within that culture; they worked with and valued diverse perspectives on their projects; they used communication skills to build relationships and develop shared cognition and goals.

Conclusion

MACH and 'mini-MACH' workshops have reached an estimated 60 participants, and inspired the submission of three peer-reviewed papers (two of which are published [25, 26]) as well as grant submissions. We are working on building capacity within our workshop team by training new facilitators, and increasing the team roster, so that experienced facilitators can step away from intensive MACH duties from time to time to take on larger change roles at our institution. We were informed recently that the U.S. National Science Foundation has awarded us an Early Concept Grant for Exploratory Research; the purpose of the grant is to provide a customized MACH curriculum to recipients of "Revolutionizing Engineering Departments" (RED) National Science Foundation grants. As a result of our work with RED recipients, we will be supporting disruptive change in engineering education at the level of departments and institutions across the United States. This is exactly aligned with the mission of the MACH workshop: to disseminate change agent skills and mindsets informed by the literature on change, and to share practices that can be adopted at a variety of institutions. Through MACH, we are working to enable innovative leadership in STEM education – ultimately, to help produce new STEM experts who are well-equipped to solve the complex problems of our world.

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48. IMPLEMENTATION OF INTEGRATED STUDENT CAPABILITY SYSTEM (IMS ACADEMIC) FOR ALL ACADEMIC PROGRAMS AT UNIVERSITI MALAYSIA PAHANG TOWARDS INTEGRATED CGPA

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Introduction

Studies conducted by Engineering Accreditation Council (EAC) in 2002 with respect to graduate generic attributes concluded that most Universities in Malaysia prior to the studies has provided a mismatch graduates attribute as compared to what were required by modern industries. Graduates were lacking in some skills such as critical and creative thinking, leadership, communication skills, team working, and other interpersonal skills even though holding a distinctive academic qualification from the university.

Furthermore, the assessment on Cumulative Grade Point Average (CGPA) alone cannot sufficiently demonstrate and explicitly relates to the graduate's capabilities with respect to their interpersonal skills as sought by the industries. As education system was geared towards CGPA, there was no requirement for educators to enhance student's interpersonal skill. On the other hands, since no structured assessments were conducted to measure the student's aptitude, students obviously were unaware of what they were lacking and what needed to be improved. Consequently, most of the graduates needed to be retrained by the industries or worst, unemployed.

In contrast, the process of implementing an Integrated Student Capability System (ISCS) for all academic programs at Universiti Malaysia Pahang (UMP) are an ongoing efforts towards further developing the potential of individuals in a holistic and integrated environment to create balanced and harmonious quality graduates with respect to their intellectual, spiritual, emotional and physical development. The move has been included as one of the strategic initiatives and has been laid out in UMP's 2011-2015 Strategic Plans.

In delivering the strategic initiative, it has been decided by the University to standardize all academic deliveries at all faculties in UMP i.e. teaching & learning activities as well as assessments must be driven by pre-determined outcomes which integrates all three elements i.e. cognitive, psychomotor and affective domains. By integrating those aspects in an integrated system through proper academic deliveries, and the outcome of the assessment can also be assessed by all educators as well as the student himself, both educators and students would be able to recognize student's strength and weakness holistically. In this case, both parties can realign their objective and make proper actions for any incompetency addressed by the system in order to improve student's capabilities; not only focusing on knowledge and technical capabilities, but also student's interpersonal skills.

Higher Education Curriculum Design

New provisional signatory of Malaysia into Washington Accord in 2004 (now full members since 2010) has significantly changed the demography of higher education in Malaysia which caused the curriculum, teaching methods and assessment to adopt The Outcome-based Education (OBE) approach. Universiti Malaysia Pahang (UMP) has embraced the OBE approach in teaching and learning activities for all its academic programs, both for engineering and non-engineering programs since its inception. OBE has enabled UMP to plan its academic program and train student to meet the attribute needed by the industry. An implementation approach of OBE, described by John Biggs as Constructive Alignment (CA) is becoming one of the most influential ideas in higher education throughout the globe. Thus, both OBE and CA concepts have led to an important innovation of developing an ISCS for all academic programs at UMP.

Moreover, OBE has underlined important attributes of what students are expected to know and able to perform or possess upon their graduation. These attributes basically relate to the skills, knowledge, and behaviour that students should acquire throughout the program. OBE encourages assessor to not limit their assessment only on the technical aspects, but also covers on how students are behaving in completing their task. As a result, an academic course which normally focuses on marks for theoretical knowledge has to change towards assessing theoretical knowledge as well as affective or psychomotor skills.

On the other hand, Constructivism is a learning theory that discusses on how learner learns through interaction between his/her experiences and reflecting on those experiences. In the classroom, constructivism is often being linked with pedagogic methods that encourage active learning for learners to ideally become "expert learners". In this case, constructivism modifies teacher's role, from being the main reference to a person that facilitate learners to construct understanding, articulate and test their concepts and draw conclusions. Equally, constructivism transforms the learner's role from a passive recipient of knowledge and facts to an active participant in the learning process. Therefore, constructivism undeniably plays an important role in realizing the OBE approach.

The Traditional Educational (TE) approach is lecturer-centred and focuses on coverage of syllabus for a particular course, whereas the elementary idea of CA is opposite of that. In CA, which is basically based on the constructivism learning theory, students are the main focus and involve in constructing what they are learning. CA stresses that the curriculum is designed and delivered as such that the learning activities and assessment tasks are aligned with the intended learning outcomes and teaching decisions are made based on how best to facilitate a student to learn in a course. Moreover, through CA, the concept of teaching of what was taught to the student has become less significant since the quality of teaching is judged by the quality of learning that takes place. The students are actively involved in the learning process whereas the lecturers facilitate students to acquire desired outcomes. In addition, not only the cognitive and psychomotor skills need to be developed as seen in most traditional evaluation systems, so are the generic skills of the students. To achieve this, the curriculum and teaching approach must advocate students to be cognitively, physically and emotionally involved in learning. This principle of OBE and CA which emphasize impact on student can be observed as an alignment to other educational models such as VAK / VARK Model (Fleming, 2006), KOLB's Model (Kolb, 2005), and Cone of Learning (Edgar Dale 1969) etc.

TE approach was driven by non-behavioural objective and lack of emphasis on soft skills competencies needed for student's prospective jobs such as communication skill, leadership skill, team working etc. Furthermore, as the world becomes borderless and rapid expansion of knowledge and information occurs, there were urgent needs to equip graduates with the appropriate skills to function effectively. As Malaysia progresses to achieve a developed nation status, there is a need to groom graduates in soft skills acquisition to allow them to function in a team-based environment which include leadership skills, interpersonal skills, critical thinking and problem solving skills, self-discipline and self-confidence.

The vision of developing global Malaysian engineers is the basis for joining the Washington Accord. Malaysia, through The Board of Engineers Malaysia (BEM) and EAC, must ensure the quality of engineering education attains the minimum standard comparable to global practices. New accreditation manual (first published in 2005) which outlines details for accreditation of an engineering program in Malaysia which includes elements of hard skills and soft skills outcomes that must be presented in the design of curriculum in the engineering curriculum was formulated. Adopting American Board of Engineering and Technology (ABET), EAC has instructed that all curriculum design must start with Institutional mission and Constituents' needs, translated into Program Educational Objectives-(PEO)(Desired skills of alumni), Program outcomes-(PO) (Desired knowledge & skills of graduating seniors), Course outcome-(CO) and Lesson outcome-(LO). With all the outcomes properly tabulated, all teaching activities must be geared towards achieving the outcome. To measure the effectiveness of teaching and learning, the assessment tasks must be fully aligned to evaluate the achievement of the outcome. Based on this movement, Malaysian Qualification Agency (MQA) has brought up the ideas and then laid requirements of adopting OBE concept for all academic programs in Malaysia.

Looking back to the history of the OBE implementation at Universiti Malaysia Pahang (UMP), the alignment of teaching and learning with assessment and objectives started in 2005. The foundation of OBE was laid in curriculum design, learning activities as well as assessment. An OBE culture was also initiated. This has resulted in full 5 years accreditation for one of the academic programs that was evaluated in 2007. Based on the Integrated Management System (IMS) at UMP, there were efforts conducted by Academic Management Department (BPA) for making Online OBE's Approach Mark Entry in 2009, named as IMS Academic. In 2011, the concept was taken up by two engineering faculties i.e. Faculty of Electrical & Electronics Engineering (FKEE), and Faculty of Civil Engineering & Earth Resources (FKASA) as well as one non-engineering Faculty i.e. Faculty of Computer Systems & Software Engineering (FSKKP). Believing the IMS Academic could deliver, both engineering Faculties even presented the idea to accreditation panels in 2012 but it was backfired for incomplete data presentation to translate the attainment of outcome when the same accreditation panels visited in 2014.

EAC Manual in 2012 highlighted that "Program Outcomes are statements that describe what students are expected to know and be able to perform or attain by the time of graduation. These relate to the skills, knowledge, and behaviour that students acquire through the program". Furthermore, UMP in the Strategic Planning 2011-2015 has outlined specific target for producing Proficient Graduate. Centre of Academic Innovation & Competitiveness (CAIC) has been entrusted to enhance the system further. Therefore, in contrast to practice by most of other universities in Malaysia that evaluation of program outcome attainment are done at cohort level, it is the intention of UMP to evaluate the performance of individual student with respect to outcome attainment. The main idea is that, each individual student who fails to grasp one or more of the intended outcome must be identified and made to undergo an **intervention process** to improve their performance for each outcome. The intervention plan is run on a yearly basis in order to simplify management processes.

Development of Integrated System

In describing the process of implementing an Integrated Student Capability System (ISCS) for all academic programs at Universiti Malaysia Pahang, the processes are divided into three sub-processes i.e. system development, program setup & assessment, and reporting & Continuous Quality Improvement (CQI) processes. A sample of engineering course is used in describing the specific sub-activities of the implementation of the concept of Outcome-based Education (OBE) approach as well as CA; focusing on processes of setting up course vs. program outcome matrix, assessment types and methods, reporting and actions for CQI. Good practices at the Faculty level, as well as suggestion for system improvement are also highlighted.

In terms of system development, the scope of work mainly covers monitoring, improvement and intervention of teaching and learning that takes place at various levels in UMP's interest such as Course Level, Student level, Program Level, Faculty Level and University Level. At Course Level, both Lecturer and Course Coordinator would benefit for course delivery improvement as the performance of students' outcome attainment can be compared for each different sections as well as the ability to compare with previous semesters' course performances. With data being presented in simple graph on top of raw data, an academic staff can easily evaluate their own performance in delivering the content with respect to their fellow colleagues of the same course and further improve as part of CQI at the course level. Furthermore, the main idea of comparison to previous semesters' course performances is to help academic staff to evaluate if the previously planned for CQI at the course level really resulted in improving delivery of content and improving the quality of graduates to be produced.

On the other hand, at Student Level, UMP has gone beyond the result based on the bathes performance as mostly implemented by other universities, but rather to look at individual performances. For each individual student, both individual student and their Academic Advisor can monitor two results for every semester, one the famously used grading CGPA system, and the second is result based on **Outcome Attainment**. The outcome attainment for each individual student is merited in the format of "**competence**" or "**incompetence**" to reflect their achievement in a particular course, measured through various assessments carried out in one course. The decision of competence and incompetence is made based on the accumulated score. In this case, the main idea is that, every time a student is unable to reach minimum standard of competencies of intended outcomes for the particular semester, the student needs to undergo an **intervention process** so that they could improve themselves before graduating. In this case, if compared to product supplied by a manufacturing process, it is unacceptable for one manufacturing process to produce sub-standard products, and deliver it to the customers. Therefore, it is our intention to treat each individual student as an important product produced by UMP and this has become our main agenda or promise to deliver quality graduates to the industries.

Additionally, the Head of Program could monitor the performance of their respective students at cohort level for the improvement of delivery at Program level. Likewise, Faculty at the level of Dean and Deputy Dean could monitor the performance of students' outcome attainment for each individual Academic Program offered by the Faculty. In addition, the Faculty also can monitor cohort performance for counter check of any improvement and intervention plan that has been executed by the Head of Program and academic staff. Ultimately, Senate could monitor the effectiveness of teaching and learning that takes place in each Faculty by being able to see the data at Faculty Level as well as at Academic Program Level. In this case, Senate are always in the loop to ensure the best learning experience is delivered by the university. All these reports of student's performance based on outcome attainment are available for every semester and must be presented to respective academic governance body within the UMP. It should be noted that each academic governance body are accountable for decisions made in order to improve academic standard at UMP.

Moreover, to ensure the full implementation of OBE at UMP is done comprehensively, the following actions were taken by the CAIC. Firstly, standardization of PO being assessed for Support Courses i.e. Languages, Soft Skills, Math, Chemical, Physics etc. for All UMP's Academic Programs regardless of their program scope (Engineering / Engineering Technology / Non- Engineering) has been done. Secondly, a standardised rubric for evaluating psychomotor and affective domain skills has been introduced for all UMP's academic program and mapped accordingly to Ministry's LOKI. The standardised rubric is a key element for UMP to identify appropriate intervention for each incompetence cases. Previously, every lecturer just used rubrics that may differ from one lecturer to another. The rubric used may not address the outcome that students should accomplish. In mapping to LOKI's, it is important to note that, the main intention is to map assessment correctly and for each incompetence cases, the right intervention plan can be executed.

To encourage full participation by all academic staff at UMP, each academic staff is given autonomy to vary the approach assessing the outcome. Furthermore, as for good practice, starting from 1415II, all courses can monitor the performance of student mid semester through Mid-term Report; where the lecturers have entered 20 % marks by week 7 of academic calendar. In this case, the main idea is that, by reviewing the performance of the student half way through the semester, the lecturer and the student can immediately take remedial action to improve the performance of the student, before they are flagged as incompetent at the end of the semester. This intention is to inculcate culture of always looking for ways to improve as part of preventive plan rather than a corrective plan which is executed through intervention. The main idea is to have an integral system to prevent (which is most desired) and to correct; if unavoidably students still fail to reach the minimum level of outcome competencies.

With the system now fully developed, all monitoring and improvement can now be implemented for the realisation of the OBE in higher education. Finally, with the interest for better promoting of UMP Graduate, UMP has developed a new system, christened as "**Student Profile System**" which integrates all achievements of a student involving academic and personal development during their tenure years at UMP. Their performance in academic program as well as their level of involvement and competencies in extra-curricular activities will be measured towards the implementation of an **Integrated CGPA (i-CGPA).**

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49. INTEGRATED COURSE DESIGN FOR SUPPORTING CONTEXTUAL LEARNING AMONG FIRST YEAR ENGINEERING STUDENTS

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Introduction

The contributions of engineers have dramatically affected the nature of our society. Future engineers must be prepared to face novel challenges of the 21st Century, such as those on sustainability, borderless global economy and etc. However, developing future engineers that are fit for these challenges require students who are motivated and willing to undergo the rigors of education and training required. Unfortunately, most students enroll in engineering programs without understanding 'what is engineering', and its importance. A larger global issue is the unwillingness of young people to pursue careers in engineering in the first place (Becker, 2010). Many are ill-prepared to undergo the challenging content and the rigors of skills and attitude development required to become an engineer. Without the proper understanding of engineering, the context of its applications and future roles, students do not have the motivation to put in the required effort. Thus, it is not surprising that some students drop out of engineering programs (Becker, 2010), even in their first year (Baillie, 1998).

As part of the effort to overcome this problem, many engineering programs added an introductory course to Engineering, which normally provide an overview of engineering to first year students. There are a variety of aims and approaches to the course throughout the world, depending on the program owners and the student intake, ranging from giving students a taste of everything in the program, doing first year projects, developing soft skills required for engineering, professional talks and plant visits, engineering ethics, to providing supporting skills for studying. Many concerns have been raised regarding this matter including whether one should teach the fundamentals first or help to inspire first year students so that they become motivated (Baillie, 1998). Given the possibilities, the question is what should the curriculum for a first year introductory course be?

In Universiti Teknologi Malaysia, the "Introduction to Engineering" (ITE) course was added in the chemical engineering program in 2005. The purpose of the course is to support students to bridge the gap between learning in a school environment and learning to be an engineer in the university. The course also aims to help students understand what is actually engineering, in everyday and professional context, and the need for good engineers, especially in facing up to the challenges of the 21st Century. For this reason, it was decided that the course should have a semester long problem based on the issue of sustainability. The course design takes into account that students in the school system in Malaysia are used to a highly teacher-centered, examination-oriented environment, where the ability, and thus the available opportunities for students, are determined by the results of standardized examinations. To help students during this transition, the course is designed to have a supportive student-centered learning environment that allowed students to develop important skills to learn, as well as understand and develop abilities required to be a good engineer when they graduate. To prevent over-stuffing the course, professional input in the form of presentations and plant visits are coordinated with the first year 1-credit hour seminar course. The topics given by engineers and experts during the seminar are arranged to coincide with the content or skill required in the ITE course.

Educational Principles

The ITE course is designed based on the How People Learn Framework (HPL) (Bransford, et al, 2004) and Constructive Alignment (CA) (Biggs and Tang, 2007). Based on constructivist principles, CA asserts that both the teaching and learning activities (TLAs) and the assessment tasks (ATs) should support the development of the learning outcomes (LO) among students. The HPL framework consists of four criteria that define an effective learning environment that is conducive for learning: knowledge, learner, assessment and community centered. To incorporate both educational principles, Problem-Based Learning (PBL) and Cooperative Learning (CL) are implemented as the teaching and learning approach to learn and solve a sustainable development based problem. PBL embeds small groups of students and presents them with a messy, unstructured, realistic (if not real) problem, to solve. The problem is crafted to engage and immerse students in going through engineering processes and sustainable development issues. CL is based on five principles to develop and promote learning teams: positive interdependence, individual accountability, face to face interaction, appropriate interpersonal skills and regular team role assessment (Johnson, Johnson and Smith, 2006).

Course Description

The Introduction to Engineering (ITE) course is a three-credit hour course. The contents of this course include a short project on overview of engineering, the profession and its requirements in the Malaysian scenario, basic calculations of common process variables and unit conversions using active learning, introduction to engineering ethics using case studies and a problem on sustainable development using cooperative problem based learning. The problem is set as a competition to find engineering solutions for issues related to SD that is practical and cost effective for the society, related industries and agencies are solicited and included in the problem to make it realistic. The problem is designed in three stages to gradually challenge students with increasing difficulty, while systematically providing the necessary support to scaffold students' learning.

In the seminar, practicing engineers from industry are invited to share their real experience in the work place. The topics and visits during the seminar is coordinated with the topics in ITE as a form of support and motivation for students. Generally, the topics in the seminar include: The University Semester System, Outcome-Based Education, Engineering Overview, Code of Ethics, Effective Public Speaking, Sustainable Development, and short workshops on the Application of Search Engines in the Internet for Research Purposes, Introduction to Microsoft Excel for Basic Engineering Calculations, Introduction to Microsoft PowerPoint and Basic Presentation Skills and Problem Solving using TRIZ. Students also visit industries related to their ITE problem under the seminar. By integrating ITE and the seminar, information obtained from the seminar provide context from the experts' and industries' perspective for the ITE course.

Impact of the course

To study the impact of the course, students' were asked to define engineering the beginning and the end of the semester. The analysis of the survey response showed that students have a better understanding of engineering and its importance at the end of the semester. Their reflective journals written throughout the semester and submitted at the end of every part of the project were analyzed. Using thematic analysis, four professional skills emerged from the reflective journals, namely team working, communication, problem solving and time management skills. Their awareness and behavior on sustainable development (SD) can also be noted from the data. The main thrust of the skills developed through the course are the four professional skills, and thus shows that the students were indeed developing the skills which were purposefully intended through the design of the course.

The course learning environment has positively filled in the gap between 'knowledge' and 'action'. The skills developed are also consistent with other studies on students who had undergone PBL (for developing problem solving skills) and CL (for developing team working skills) (Woods, 1994; Savery, 2006). The findings of this research shows that the first year students who went through the ITE course gained both professional skills development as well as self and social development enhancement in sustainability. Therefore, the ITE course has met its aim to support the first year students in developing the attributes of engineers needed to face the 21st Century.

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Innovative Practices in Higher Education Expo 2015 (I-PHEX 2015) is a platform to showcase innovative practices that can be shared and emulated among academics in higher education worldwide. The purpose of the exhibition is to recognise and award efforts to improve higher education. I-PHEX 2015 is jointly organised by the UTM Centre for Engineering Education (CEE), Malaysian Higher Education Teaching and Learning Council (MAGNETIC), Higher Education Leadership Academy (AKEPT) under the Ministry of Education Malaysia, International Federation of Engineering Education Societies (IFEES), the Society for Engineering Education Malaysia (SEEM) and the Institute of Engineers Malaysia (IEM).

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