

# CEE BOOK SERIES

3RD

# I-PHEX 2016

International Innovative Practices in Higher Education EXPO



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**IFEES**  
INTERNATIONAL FEDERATION OF ENGINEERING EDUCATION SOCIETIES



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## **Foreword**

From the Secretary General of IFEES and Executive Secretary of GEDC



Innovative Practices in Higher Education Expo 2016 (I-PHEX 2016) is a noble effort in recognizing the efforts made to enhance the quality of higher education with innovations. The International Federation of Engineering Education Societies (IFEES) and the Global Engineering Deans Council (GEDC) are committed to efforts in advancing engineering education, and higher education in general, which is a key driver to social and economic progress of a nation where institutions of higher education play a very important role particularly in the exploration, development and dissemination of knowledge working in partnership with key corporate colleagues.

Today, the world is changing rapidly, causing the need for change in education to develop the required qualities in graduates for facing challenges in the 21<sup>st</sup> century. Adapting to the current and future needs require innovations in higher education, very much like the innovations that I-PHEX seeks to bring out and reward. This expo is not only viewed as a platform to showcase innovative efforts that contribute to resolving the challenges of higher education, but also as a trigger to inspire others to be involved in the discussion, research and the implementation of innovations.

IFEES and GEDC are happy to collaborate with the Society of Engineering Education Malaysia (SEEM) for I-PHEX 2016. On behalf of IFEES and the GEDC, I would also like to congratulate Universiti Teknologi Malaysia as the host university.

A handwritten signature in black ink, appearing to read 'Hans J. Hoyer', written in a cursive style.

Prof. Dr. Hans J. Hoyer  
**Secretary General**  
**International Federation of Engineering Education Societies (IFEES)**  
and  
**Executive Secretary**  
**Global Engineering Deans Council (GEDC)**

## **Foreword**

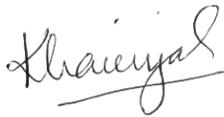
**From the Director of CEE and President of SEEM**



Welcome to the 3rd Innovative Practices in Higher Education Expo 2016 (I-PHEX 2016), a joint effort between the Society of Engineering Education Malaysia (SEEM) and the International Federation of Engineering Education Societies (IFEES)! Our utmost congratulations to all participants who are exhibiting their innovations!

We are very happy to bring you, for the third year in a row, I-PHEX 2016. The high standard of entries from various countries in the region that we get this year is indeed very encouraging. I am sure that everyone here will be able to gain and learn from all the exhibits and bring back great ideas for their home institutions.

Last but not least, I would also like to take this opportunity to thank and express my deepest appreciation to the organizing committee of the Centre for Engineering Education, Universiti Teknologi Malaysia and the Society for Engineering Education Malaysia for all their efforts in making this event a reality. Well done!

A handwritten signature in black ink, reading 'Khairiyah' in a cursive script.

Prof. Dr. Khairiyah Mohd. Yusof  
**Director,**  
**Centre for Engineering Education (CEE), UTM**  
and  
**President**  
**Society of Engineering Education Malaysia (SEEM)**

1.

## DEVELOPING TECHNICAL COMPETENCIES AND PROGRAMMING SKILLS THROUGH TEACHING OTHERS METHOD – THE CRYSTAL EXAMPLE

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Figure 1 Dale's Cone of experience

Source: Dale 1969

### Introduction

The need for a skilled workforce in developing countries is necessary to support the transition of all economic sectors towards knowledge-intensive activities, to drive labour productivity gains, and consequently to attract investment into Malaysia (Eleventh Malaysia Plan, 2016-2020). All of these require orderly educational transformation strategies in which the quality of education should be improved for better student outcomes and institutional excellence. CRYsTaL@UKM program was first initiated to address the issues on the decline in the enrollment of science students in the secondary schools, while at the same time exploring other teaching and learning methods to enhance technical competencies and programming skills among the undergraduates in the Faculty of Engineering and Built Environment, UKM. This study investigates the impact of this program on the undergraduates as well as the school students. CRYsTaL (Creative Youths through Innovative Learning) program has been running since 2009 and is focused on teaching others and learning outside the classroom strategies.

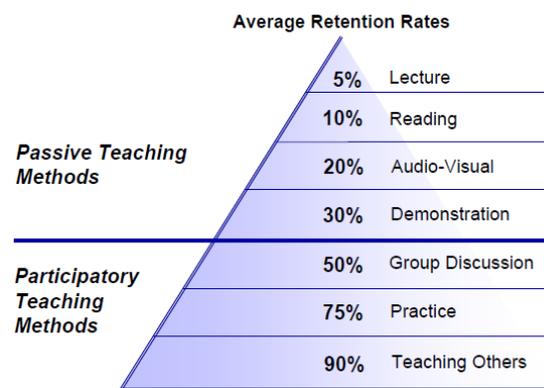


Figure 2 Learning Pyramid

Source: National Training Laboratories, Bethel, Maine

### Teaching Others and Learning Outside the Classroom

Effective teaching methods, especially in teaching hardware system design and programming skill for the electrical engineering students should also be a process that emphasize innovative learning methods (Bradbeer 1999, Felder & Brent 2001, Prince 2004). In Dale's Cone of Experience as shown in Figure 1 (Dale 1969), it should be noted that the higher level of learning outcomes, such as the ability to analyse, design, create and evaluate could be achieved if students are involved in real experience, doing the real thing or even participating in hands-on-workshops. Likewise, in learning pyramid as shown in Figure 2 (adapted from National Training Laboratories, Bethel, Maine), besides cooperative learning methods, the other active learning approach that can be seriously considered is mentoring or teaching others. Interestingly, this strategy has an average retention rate of 90% compared to group discussions (50%), practice (75%) and to the passive methods of lecture (5%) and reading (10%).

### Methodology

The structure of this 8-month program is based on the approach of teaching others or mentoring. In the first stage of the program, the school students are trained to practice using microcontroller-based development boards and electronic components to create simple, smart and autonomous systems by the experts in the field with the assistance of the undergraduates as mentors. Based on the theme chosen for a particular cohort, these students will then do a simple research on the problem to be solved, write and present their project proposals to be moderated by the experts. In the second stage, with the guidance from the mentors, the school students will undergo the process of developing the electronics and mechanical parts of their proposed devices. Additionally, they will be working in groups to write and debug the programs. This approach requires the students to devise solutions to real problems and fabricate the actual prototypes. Finally, at the third stage, the students will present, discuss the functions and the limitations of their products.

### Result and Discussion

The progress of the program has been monitored closely and studies were made to gauge the performance of the participants. Comparison was made of UKM students'

achievements on the Digital Design course (pre) and the Microprocessor and Microcontroller course (post). The t-test was performed for both the controlled and uncontrolled groups. The Pearson correlation of 0.68 indicates that there is a strong association of the students in the Group B (CRYsTaL participants) performing better than that in Group A (0.56). Although it could be noticed that the mean for both groups dropped due to the difficulty index of the courses, not surprisingly, Group A dropped by 16% compared to 13% for Group B.

Table 1 T-test Analysis

	Group A		Group B	
	Digital Design	Microp & Microc	Digital Design	Microp & Microc
Mean	52.98	44.43	59.06	51.25
Variance	242.24	377.73	186.72	178.6
Observations	55	55	16	16
Pearson Correlation	0.55		0.68	
t Stat	3.77		2.89	

## Conclusion

The school students with the guidance from the undergraduates have fabricated products of, which some have won several innovation competitions at national and international level. An analysis made to compare the performance of the students, those who were involved in the program have shown improvements in their Microprocessor and Microcomputer course grades. Consequently, they are more prepared and able to do well in the System Design course. Testimonials collected from the school students involved has shown that this approach has been well received and some of them have enrolled in engineering and technology programs. While those who have graduated have now joined big multinational companies or have enrolled in postgraduate programs, locally and abroad.

## Acknowledgement

The authors would like to acknowledge the grant from the UEM Group (HEJIM-FKAB-UEM-10-11-01-004) and UKM-PTS-2013-006.

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2.

## FRAMEWORK FOR AN EFFECTIVE PHYSICAL FIELD TRIP

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## Introduction

There are various techniques and countless innovations made to improve teaching and learning. One of the old and popular methods is experiential learning. Many researchers in the past believed that learning through experience can develop the so-called lifeong learning. However, in this new era where information can be obtained within seconds, many of the educators neglect to apply this 'hands-on' learning such as a field trip. The field trip is not just one-day off from school, but it is more than that. It is actually a visit to a specific location to stimulate students understanding of the subject matter and sometimes it is designed to expose the students with the information or knowledge that cannot be provided in the formal class.

In Universiti Teknologi PETRONAS (UTP), the first year students of the Petroleum Engineering program are required to take Introduction to Petroleum Geoscience subject. Through this subject, the students will be introduced to some fundamental theories of geosciences, which are closely related to Petroleum Engineering. The course covers concepts on the occurrence of petroleum accumulation, exploration methods, drilling, well logging, resource and reserves. To strengthen the knowledge and understanding among the students, there is an educational field trip planned to expose the students to the real field rock structures and natural formations. The field trip is often done after the first half of the semester and after all relevant chapters are taught to the students.

## Problem / Issues

For many years, field trips have been planned and organized in order to improve students' understanding on geology matters in UTP. It is reported by many researchers that this field trip can increase the students' motivation towards learning (Kern and Carpenter, 1984). Field trip involves all three domains of learning – cognitive, psychomotor and affective (DeWitt and Storksdieck, 2008). However, some observations are made and two major concerns regarding this field trip are concluded: 1) Students who went for the field trips commented that they did not obtain much information after the field trip; 2) The performance/result of the students did not improve even after the field trip. Hence, there is a need to relook at the field trips practices that have been conducted all these years. The question is, are we doing it right? Therefore, this paper addresses issues that are raised by the students who went to the field trip and what are the steps needed to be taken so that the field trip that is going to be conducted is not just another day off from school and waste of institution's money.

## Educational Theories

David Kolb (1984) once mentioned that learning is the process whereby knowledge is created through the transformation of experience. One of the ways that the students can obtain valuable and impactful experience is by going through educational field trips. He argued that an effective learning can be obtained when a student is going through four processes which are: 1) Experience; 2) Reflection; 3) Conceptualise; and 4) Test. This is the same cycle that the student goes through during the field trip. They will experience and observe by themselves the theories that has been taught in class and also during the field trip. Next, they will reflect on information that they receive and make better judgments on the reflection (conceptualise). The next cycle is that they are ready to use and test the information they receive on other examples and they are also ready to be tested on the knowledge that they received.

### Methodology

A few field trips have been conducted and observations are made. The field trips had been conducted two semesters in 2015. The duration of the field trips is usually 3 days and 2 nights. After the field trips, surveys are done and data from the students are gathered to analyse the feedback/reflections. Not only that, the lecturers' reflections is also recorded to have better conclusion. The information gathered is used to propose the framework to conduct an effective field trip.

### Results and Discussion

Below are the list of issues raised by the students after they went to the field trip:

#### *Big class, small instructors.*

This is true since from the two field trips that have been observed, the class size is more than 75 students. However, the instructors/ field guides available on the field are only 3. Hence, during the stops, one instructor can only entertain about 20 - 25 students at one time. This is considered a big student – instructor ratio. The result from this is some students cannot obtain the information properly and they are not really clear about what to do on the field.

#### *Limited time on the field.*

The field trips are planned with 4 – 5 stops per day. Sometimes, the students take more time to complete certain activities. This will interrupt the whole schedule. When this happens, the instructors need to cut the time provided in the schedule for other locations. Therefore, some activities at other locations cannot be fully completed by the students.

#### *No exposure to the field trip settings before the field trip.*

One conclusion that can be drawn from this statement is that there is no integration between the course content that has been taught in class with the field trips. The students might have learned about the topic in class, but the topic is most probably touched in general and not aligned with the location of the field trip.

#### *Not well-informed about the whole trips.*

From the observation, the students are basically not really informed about the whole process and stops for the trips. There are only briefed and received the schedule in the morning during the field trip day.

From the feedback and reflections from the students and instructors, below framework is proposed so that better field trip can be implemented in the future:

**Table 1. The framework before, during and after the field trip**

Before the field trip
<ul style="list-style-type: none"> <li>- The lecturers should familiarize themselves with the location and settings of the field trip.</li> <li>- The lecturers should plan integrate the teaching with the location of the field trip. For instance give examples that are related to the field, show pictures or videos of the location.</li> <li>- The activities planned should be done by the instructors first to ensure that the time given to the students to complete it is enough.</li> <li>- The necessary tools/materials are well prepared and enough to every student.</li> <li>- Consider the field stops that should be done in a day. The schedule should not be too compact.</li> <li>- Students should be given a mini task to search and obtain information regarding the field that they are going to visit.</li> <li>- Students should also be exposed and familiarized with methods and activities that will be conducted in the field.</li> </ul>
During the field trip
<ul style="list-style-type: none"> <li>- There should be activities/exercises planned for each stop, not only briefing/lecture.</li> <li>- Enough time should be given for the students to conduct activities.</li> <li>- The activities planned should be relevant and related to the field.</li> <li>- Consider the activities that stimulate the social aspect of the students such as communication.</li> <li>- Develop activities that involve pairwork and also group-work.</li> </ul>
After the field trip
<ul style="list-style-type: none"> <li>- Feedback/reflection from the students and also instructor should be collected.</li> <li>- Assessment should be done to test the understanding of the students.</li> </ul>

### Conclusion

Field trips are very useful to motivate and encourage students to learn the concept that is quite difficult to explain in the normal classroom. It is proven from many researchers that field trips can help in improving students' understanding. There are good feedbacks and reflections from the students after the field trip. However, there are also issues that are needed to be properly addressed and put into consideration when implementing a field trip.

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3.

### **STUDENT'S REPORT CARD CONSIDERING INTEGRATED CUMULATIVE GRADE POINT AVERAGE (iCGPA)**

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#### **Introduction**

Integrated Cumulative Grade Point Average (iCGPA) is an indicator to evaluate the Program Outcomes (PO) of an educational institution. It is one of the initiatives under the first shift of the Malaysia Education Blueprint 2015-2025 (Higher Education) [6]. As we know, PO is the main agenda in learning and teaching nowadays not only in Malaysia but other countries as well. iCGPA was discussed and debated by many parties in Malaysia such as Ministry of Higher Education, Higher Institutions, Engineering Accreditation Council (EAC), Board of Engineers Malaysia (BEM), Malaysian Qualification Agency (MQA) and industries. The word integrated means that the assessment and evaluation process should consider the overall performance of students in both technical and generic skills. Thus the three important domain, i.e. cognitive, psychomotor and affective should be explicitly assessed and appear on the student's transcript. Up to now, there is no proper record provided by any institution to describe these elements explicitly. This becomes difficult to the employers or stakeholders to judge the performance of the graduates before employed.

This article briefly describes and illustrates the concept of iCGPA that was implemented at Faculty of Civil Engineering (FKA), Universiti Teknologi Malaysia, Johor. It was first conducted in semester 1, session 2014-2015 which known as the Summative Performance Assessment of POs or Student's Report Card. In fact the idea was started in 2007 when Outcome Based Education (OBE) was implemented in FKA. During its first exercise, the implementation was not very serious where the assessment was not done systematically.

#### **Problem Statements**

One of the key challenges of any higher education system is to produce graduates who not only excel in their fields of study, but are also equipped with the necessary generic skills such as knowledge, values (ethics, patriotism, and spirituality), leadership abilities, and the ability to think critically, etc.

We always hear comments wanting graduates who are holistic, have entrepreneurial characteristics and well balanced. The soft-skills requirement which had been listed was emphasized in the Malaysian Qualifications Framework (MQF) but it was not recorded in the student assessment system [6]. Thus, the record can be made through iCGPA.

#### **Objectives of iCGPA**

- i. To display the performance of generic skills for each student.
- ii. To align formal academic learning experiences in the curriculum with the non academic campus activities.
- iii. To solve the graduate-employer expectation mismatch and enable our graduates to find meaningful employment.

#### **Educational theories or references**

Predicting potential student success is of great interest to educators and academic administrators alike. Grade Point Average (GPA) is a key predictor of academic success in any institution. Curiously, while GPA has established predictive validity, little is known about its reliability. Cumulative grade point average (CGPA) has traditionally been used to screen the candidates, but CGPA itself has shown to have no statistically significant predictive value and may in fact screen out individuals who possess social intelligence attributes that are essential for success in our practice.

To our knowledge, few universities in Malaysia have begun to evaluate and demonstrate the performance of students based on the iCGPA. Malaysia is the first country in the world that uses a special CGPA for their education institutes of higher learning (IHL). It is anticipated that it will be transmitted to the colleges and schools after the implementation of IHL to settle. Up to now there is no article published in any journal or proceedings relating iCGPA. However a number of studies related to Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA) have been made by some researchers, but the number of articles related to this topic are very limited.

Jan and Mary [1] have investigated whether the students whose emotional intelligence characteristics meet or exceed those of successful staff nurses are more likely to be successful in a baccalaureate nursing program. They found that emotional intelligence presents a compelling adjunct to current selection criteria for nursing students. However, the lack of research prevents widespread adoption of this criterion. This study suggests that students with higher levels of emotional intelligence, particularly intrapersonal capacity and stress tolerance, are more likely to be successful in a baccalaureate nursing program than students with lower levels.

Syarif et al. [2] have conducted a study to determine the relationship between time spent on Facebook and the Cumulative Grade Point Average (CGPA) of third year Biomedical Science students in the Faculty Health Sciences, Universiti Kebangsaan Malaysia. A cross sectional study was carried out and the tools to collect information were close ended questionnaire. The study found that there was no significant correlation between time spent on Facebook and students CGPA;  $r = 0.152$ ,  $p = 0.185$ . There is no significant difference CGPA between gender  $p > 0.05$  and there is a significant difference between race  $p < 0.05$ . It can be concluded that the FSK students' CGPA achievement was not significantly associated with the time spent on Facebook.

Ashby et al. [3] tried to clarify why the amount of study by college students is a poor predictor of academic performance. A model was proposed where performance in college, both cumulatively and for a current semester, was jointly determined by previous knowledge and skills as well as factors indicating quality (e.g., study environment) and quantity of study. The findings support the proposed model and indicate that the amount of study only emerged as a significant predictor of cumulative GPA when the quality of study and previously attained performance were taken into consideration.

Carla et al. [4] studied on the impact of field of study, college and year on calculation of CGPA. They found that the difference between fields of study was small, accounting for only 1.5% of the variance. However, differences among 16 universities were larger, and accounted for 9.3% of the variance. The results of this study suggest that all weighting schemas are virtually equivalent, making any formulation reasonable. Differences by field of study are small, but do not show any bias against non-science students. Differences by institution are larger, amounting to a range in average score from 78.7 to 84.6; however, it is not clear whether this reflects the candidate's ability or institutional policy, so attempts to correct for institution may be difficult.

Conrad and Matthew [5] has investigated the relationship between completion of an orientation by new community students, higher retention, and grade point average (GPA). Retention was measured in terms of total credit hours the student completed, and GPA was the cumulative GPA after 1 year of continuous enrollment or at the time the student withdrew. Subjects consisted of 86 matched pairs from four community colleges. One of the pair was in an orientation course and the other was in the control group. Data indicate that completing an orientation course during the first term of enrollment promotes retention and improves GPA.

The iCGPA was in line with the Malaysia Education Blueprint 2015-2025 (Higher Education) first shift in producing holistic, entrepreneurial and balanced graduates. Under the new system, students will graduate with a complete "report card", detailing not just their subjects and performance, but the skills that they have picked up along the way [7]. iCGPA will see a new method of assessing students. iCGPA will not only assess knowledge and thinking skills (as is the current practice), but also competencies based on the other primary attributes that comprise Malaysia's student aspirations, namely: ethics and spirituality, leadership skills, national

identity and language proficiency; and the creating of opportunities for students to acquire entrepreneurial skills. The assessment is not only done through activities in the classroom, but also other activities on campus [6]. The iCGPA will be used to track, develop and fill the gaps that may exist within students. The iCGPA assessment will be reported in the students score cards using a 'Spider Web' methodology which enumerates all the achieved, expected or desired performance of the student. This is not a standard template, but nothing wrong to have own standard [8].

### **Description of the innovation and how it solves the problems in teaching & learning**

The innovation is in the form of a template (or Student's Report Card) as shown in Table 1. It was prepared using Excel spreadsheets. Since the template cannot be fitted into A4 paper (to avoid difficult to read), for the purpose of explanation, it was divided into several parts. Part 1 of the template displayed all courses, credit, its weightage and marks (Table 2). For Bachelor of Engineering (Civil), there are 57 courses need to be completed by students at the end of their, study which consist of 41 courses from Civil Engineering Faculty and 16 courses are general university courses. There are 10 program outcomes (PO) set by the faculty to fulfill the requirement imposed by EAC. Each of these courses should address the relevant program outcomes. PO1 to PO3 are knowledge, skills whereas PO4 to PO10 are generic skills. Based on the guidelines given by EAC, the weightage for knowledge and generic skills is about 70% and 30%, respectively (refer to Figure 1). The weightage was then distributed and mapped with POs as shown in Table 2. Credit and percentage contributed to each PO for each semester were calculated and these values will also indirectly indicate the learning time required to grab the respective PO. The distribution of POs at FKA at the end of the program is shown in Figure 2. The next columns show the marks obtained by a student where the total mark was set to 100 for each PO.

The first region in the next part of the template (Table 3) was the points for each PO and courses based on the scale used in the normal practice at UTM (0 to 4). The second region was the weighted points where the values were obtained by multiplying the points with the credit and weightage. The GPA and CGPA for each PO were then computed for each semester. The values were presented in the form of spider web as shown in the third template (Figure 3).

### **Research or evidence of the impact of the innovation towards teaching & learning**

The development of the student's report card based on iCGPA allows the employer to have an idea of the true potential of graduates. It is aligned with EAC requirement which emphasize on student achievement of PO. It also tallies with Shift 1 of Malaysia Education Blueprint, which is to produce holistic, entrepreneurial and balanced graduates. The presentation of the report card was very systematic, transparent and easy to understand.

### **Acknowledgement**

The writers are grateful for the financial support received from the Universiti Teknologi Malaysia, Research University Grant: Flagship (Q.J130000.2422.02G84) and R.J130000.7722.4J127 in performing this research. Thanks to all my friends, especially those who directly involved in this project and great support from FKA and give permission to publish the work in this exhibition.

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Table 1. Student's Report Card

(see the attached file)

Table 2. Weightage and marks

(see the attached file)

## Curricula Models

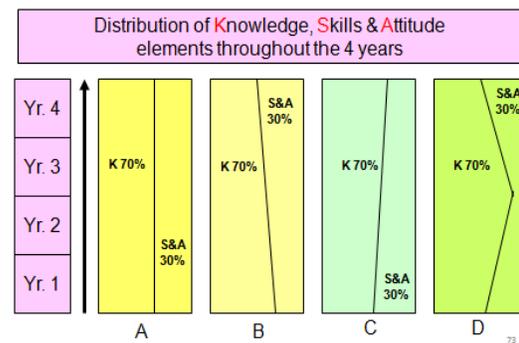


Figure 1. Distribution of knowledge and generic skills

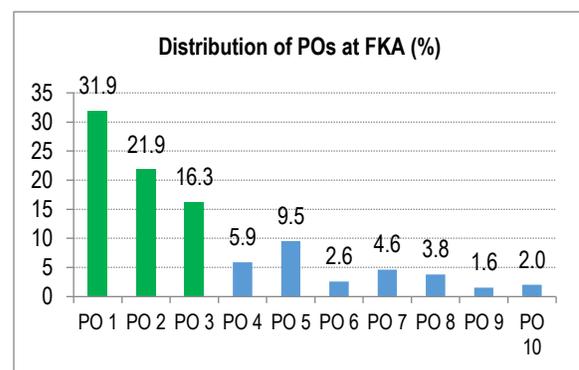


Figure 2. The distribution of POs at FKA at the end of the program

Table 3. Points and weighted points

(see the attached file)

Figure 3. iGPA and iCGPA (spider web)

(see the attached file)





Program Outcomes									
Acquire Knowledge	Analysis and Tool	Design	Investigation and Research	Communication	Financial and Project Management	Team Work	Life Long Learning	Entrepreneurial and Leadership	Sustainability and Ethical
PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
4.00	4.00								
4.00	4.00	4.00		4.00		4.00		4.00	
4.00						4.00			
4.00				4.00					
4.00									
4.00						4.00	4.00		

Program Outcomes									
Acquire Knowledge	Analysis and Tool	Design	Investigation and Research	Communication	Financial and Project Management	Team Work	Life Long Learning	Entrepreneurial and Leadership	Sustainability and Ethical
PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
5.60	2.40								
2.00	0.40	0.40		0.40		0.40		0.40	
10.80						1.20			
10.80				1.20					
10.80				8.00					
12.00									
0.00						4.00	4.00		

GPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0  
 CGPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0

Points									
4.0	4.0	4.0					4.0		
4.0	4.0								4.0
4.0			4.0						
4.0									
4.0						4.0	4.0		

Weighted Points									
7.20	2.40	1.20						1.20	
3.20	4.00								0.80
10.80			1.20						
12.00									
12.00						4.00	4.00		

GPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0  
 CGPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0

Points									
4.0				4.0					
4.0	4.0				4.0				
	4.0	4.0							
	4.0						4.0		
4.0		4.0					4.0		
4.0				4.0					

Weighted Points									
7.20				0.80					
3.20	4.00				0.80				
10.80			1.20						
7.20							0.80		
4.00		3.20					0.80		
12.00				8.00					

GPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0  
 CGPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0

Points									
4.0		4.0					4.0		
4.0				4.0		4.0			
					4.0		4.0		
4.0							4.0		
4.0	4.0		4.0						
4.0	4.0		4.0						

Weighted Points									
3.20		4.00					0.80		
12.00							1.60		
				6.40		1.60			
7.20					4.00		4.00		
4.80	6.00		1.20						
4.00	3.20		0.80						
7.20			0.80						

GPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0  
 CGPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0

Points									
		4.0	4.0			4.0			4.0
4.0	4.0								4.0
		4.0							4.0
4.0	4.0	4.0				4.0			
4.0	4.0		4.0						
			4.0						

Weighted Points									
		2.80	0.40			0.40			0.40
4.00	2.40								1.60
		10.80		1.20					0.80
		7.20							
4.80	4.80	1.20						1.20	
3.20	4.00		0.80						
			8.00						
			4.00			4.00			

GPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0  
 CGPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0

Points									
4.0		4.0							
		4.0	4.0			4.0			4.0
		4.0	4.0	4.0		4.0			4.0
		4.0				4.0			
		4.0	4.0						
	4.0		4.0						

Weighted Points									
4.00		4.00							
		2.80	0.40			0.40			0.40
		5.00	5.00			5.00			5.00
		10.80				1.20			
		10.80	1.20						
	7.20		0.80						
4.80	6.00							1.20	
			8.00						

GPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0  
 CGPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0

Points									
								4.0	
4.0				4.0					4.0
4.0	4.0			4.0		4.0		4.0	
		4.0	4.0	4.0		4.0			
	4.0			4.0					
	4.0								4.0

Weighted Points									
								8.00	
2.40				0.80					0.80
3.20	3.20			0.80		0.80		0.80	
		5.60	0.80	0.80		0.80			
	6.00			6.00					
	10.80								1.20
		7.20	4.80						

GPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0  
 CGPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0

Points									
	4.0		4.0	4.0	4.0				
		4.0				4.0			
4.0	4.0	4.0					4.0		
		4.0	4.0						
		4.0	4.0						

Weighted Points									
	11.20		1.60	1.60	1.60				
		10.80					1.20		
1.60	4.00	1.60						0.80	
		7.20	4.80						
		7.20	4.80						

GPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0  
 CGPA 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0



4.

## ASSESSING STUDENTS LEARNING OUTCOMES AND APPROACHES TO LEARNING THROUGH SOLO AND BLOOMS TAXONOMY

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### Introduction

The objective of this invention is to develop a tool to assess the students approach to learning (SAL) and the achievement of learning outcomes based on Blooms and SOLO taxonomy. Identification of SAL and its characteristics that contribute to learning success are important in order to achieve learning outcomes. Previous study (Shahri, Abdul Rahman, & Hussain, 2014) has shown that most students use surface learning approach instead of a deep learning approach in their studies. This finding was the result of data collected in an earlier study using the Revised Study Process Questionnaire Two Factor (R-SPQ-2F) and face to face interview with students.

Students will be assessed based on a combination of Bloom and SOLO taxonomy. Structure of Observed Learning Outcome (SOLO) taxonomy is a framework to classify students learning outcomes comprising four levels of complexity which are uni-structural, multi-structural, relational and extended abstract (Biggs & Tang, 2011).

While, Bloom's taxonomy is a framework for classifying statements of the intended students learning that consists of six levels of thinking in the cognitive domain which are knowledge, comprehension, application, analysis, evaluation and create (Anderson et al., 2001). An adaption of verbs for Bloom's level of taxonomy in SOLO taxonomy for each level can enable a lecturer to assess students' work in terms of its quality (Potter & Kustra, 2012). Each level of SOLO taxonomy then has been added a week section based on academic calendar in particular institutions as the students able to record their learning progress over time according to the verbs from Bloom's taxonomy.

The invented tool was tested among students in Industrial Mechatronics Engineering Technology Program diploma level for some technical core courses such as Electronic Devices, Electrical Machine, Programmable Logic Controller, Instrumentation and Control System, and Production System in Kolej Kemahiran Tinggi MARA (KKTm) Penang, Malaysia. The instruments used comprising R-SPQ-2F questionnaire and SOLO map. The data obtained is useful to uncover the response in adapting SOLO-Bloom's map based on the course taught.

Instead of measuring the students learning outcomes, the structure of SOLO taxonomy will reflect students complexity of learning whether the students are using a surface learning approach (level 1 and 2) or deep learning approach (level 3

and 4). Furthermore, the use of the R-SPQ-2F questionnaire in this tool will provide a measurement of student approaches to learning with regard to surface and deep learning approach, with cognitive (strategic) and an affective (motivational) component as well (Biggs, Kember, & Leung, 2001).

### Background/issues Related on Innovation

Assessment of student learning is an important agenda at the national higher education level as well as being a regional and worldwide issue. Experts generally agree that no single assessment tool or approach can adequately represent collegiate level student learning thus the need for Multiple Measures or methods to Assess Learning (Flores, Veiga Simão, Barros, & Pereira, 2015).

Other important considerations are the requirements from external bodies such as the accrediting and governmental entities (Malaysian Quality Agency, Civil Service Department etc) that require better evidence of student accomplishment.

Therefore, integrating assessment with the core teaching and learning functions is vital and thus Institutions need examples of how assessment of authentic student learning can be built into the everyday work of the faculty and student affairs staff as well as into program reviews and governance.

### Significance of the Innovation

This tool is useful for students' self-reflection in their learning process as the summary of adapted SOLO-Bloom's map could be as a qualitative course learning outcome indicator as shown in Figure 1. From a student's perspective, learning progression can be self-monitored weekly or monthly according to a stipulated timeframe.

Code	WeekNo	Verb	Description
L1	1		
L2	2	Describe	Describe the concept of production system
L2	3	Classify	Classify the type of production operation management
L3	4	Apply	Apply the concept of production operation management concept to proposed virtual prod

Figure 1. Students able to monitor their learning through self-reflection according to time range

The chart of SOLO's map indicator also can be displayed in a specific group of students as shown in Figure 2.

In addition, this tool can measure students' approaches to learning with regard to surface or deep approaches to learning as shown in figure 3.



**Figure 2. SOLO's chart also can be displayed for a specific group of students**



**Figure 3. Measurement of students' approaches to learning with regard to surface or deep approaches to learning**

Furthermore, this tool can be used as a guide for lecturer to develop questions for students' learning according to specific course learning outcomes since the selection of verbs according to the cognitive level that match with the level of SOLO Taxonomy.

Therefore, this tool is beneficial not only for students, but for faculty members to achieve program educational objectives as well.

### **Educational Principles/Theories Underpinning of Innovation**

Based on Constructivism learning theory; learning is an active, contextualized process of constructing knowledge rather than acquiring it passively. Knowledge is constructed based on personal experiences and hypotheses of the environment. Learner continuously tests these hypotheses through social negotiation. New information is linked to prior knowledge, thus mental representations are subjective (Boylan-Ashraf, Freeman, & Shelley, 2014; Kozulin, 2003; Wang, 2014). Therefore, learning progression or learners' knowledge will develop over time through a self-reflection on SOLO & Blooms Map taxonomy.

### **Principle of Operations**

Students need to key in their matrix identification card number, semester, session, year, program and course.

Then, in SOLO and Bloom map section, they can chose code representing the level of thinking in SOLO taxonomy (Level 1 for uni-structural, level 2 for multi structural, level 3 for relational and level 4 for extended abstract).

For each level, students can choose which effective week that they start to know or learn new knowledge.

Next, they need to choose the Bloom's verbs that describe their learning. For example; Level 1 (L1), Week 1, Describe the Ohm's Law principle in an electrical circuit.

Students can key in and write down whatever they have learned and save the log from the beginning of the lesson until the end of the course for the effective session or semester.

At the end of the course, they can see how much knowledge they have learned and in which level they are currently at. The summary of SOLO map can be displayed in bar graph that indicated the levels of thinking in their learning. For example; David found that the level of thinking in SOLO was in level 3 (relational). This indicates that David in the area deep learning approach.

As an additional tool, students also need to answer 20 questions in the R-SPQ-2F questionnaire. Each of the questions has 5 Likert scale to choose from 1 (never) to 5 (always).

Result from the R-SPQ-2F will indicate whether the students are using surface or deep learning approaches. Besides, students' motivation and strategy for each learning approaches will be displayed as well.

### **Result Impact, Benefits and Potential for Expansion**

Based on results from two semesters (January – June and July – December 2015 session), a positive impact has been shown by students through their SOLO's map study log thus students know their learning outcomes of the specific course were achieved or not.

Current design software is only for local database in one institution. It is possible to expand to network database covering multiple institutions with various educational discipline programs.

From the lecturer's perspective, students' SOLO map can be used to measure learning outcomes qualitatively to augment their academic achievement in examinations. In addition, the used of Bloom's verb in SOLO taxonomy is useful to craft a question that is suitable with the complexity and difficulty level.

Therefore, this software could be a support tool for teaching and learning enhancement not only for faculty members, but also useful for students to monitor their learning progression and processes.

### **Acknowledgement**

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## 5.

### OPEN-ENDED MALIK & NAVEED INTERVENTIONS (OMNI) TECHNIQUES FOR ENGINEERING FRESHMEN

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## Abstract

The present technology infested environment has made the knowledge access an exceedingly simple affair. The emerging scenario encourages students to make sense of this open knowledge through self-learning. The issue becomes more challenging for the developing countries where English is not the mother tongue, yet it is established as the educational language. In this context a need was felt to develop ready-to-use self-intervention techniques to facilitate active learning and to overcome the specific issues related to the non-English speaking societies. These techniques guide learners' thinking in a multiple structured manner making use of different perspectives, e.g., linguistics, visual clues, anchoring, grafting. The overall

objective is twofold: 1) convert students into active learners; and, 2) make them unconsciously competent.

The core concept of OMNI techniques so far developed and implemented is briefly explained below:

- The C-Through Concept (CTC) technique disintegrates complex concepts into constituent elements for easy assimilation in a visual format. C-thru (see-through) technique helps in exploiting processing capabilities of the learner by exposing him/her to exploded visual clues of a concept. The concept is synonymous to performing X-ray of an object to facilitate the learner to see through its sub-surface constituents.

- The Basic Linguistics Templates (BLT) technique reduces subjects into nouns-verbs-adjectives and uses their generic templates for understanding the subjects in depth. The templates are designed to scaffold the thinking of learner to investigate any topic in a guided manner. Ability to understand an apparently unfamiliar topic independently with known templates also contributes to generating curiosity and improving self-confidence.

- The Universal Knowledge Constructs (UKC) technique systematically introduces fifteen elementary knowledge constructs which are invariably used in all scientific domains. These core constructs are: energy & force, flow & resistance, time & space, entity & parameter, function, change, variable, process, measurement, relation, representation, control, model, organization, and system. As per design these constructs are visually introduced to the students in a social context using their prior knowledge. Once the concept is understood, the role of these fifteen constructs, as applicable in engineering domains, is explained using scientific terminologies.

- The Knowledge Grafting (KG) technique uses horticultural concept of grafting to make use of prior knowledge roots for new learning through guided framework. The approach is largely inspired by the concept of constructivism and be considered as one of the tools to connect to prior knowledge. This concept implies that learners construct knowledge for themselves---each learner individually (and socially) constructs meaning---as he or she learns. The technique inherently accounts for two major facts: 1) learner thinking about learning is to be focused; and, 2) as no knowledge is independent of the meaning attributed to experience therefore individual differences in understanding are to be essentially addressed.

- Thematic Anchoring (TA) technique reduces complex academic subjects into rather crude and simple ideas to a rudimentary level. With this tool, learners through thematic anchoring can climb to knowledge heights of any altitude. Thematic anchor is to be grounded deep into semantic depth! The tool presented to the learner is in the form of an idea (mental anchor) that helps them in converting all of their energy to a single focal point which the individual can clearly watch, focus and understand how it is to be reached while knowing the existent constraints. Thematic anchoring implies reducing any academic subjects into rather crude yet loveable and digestible ideas, e.g.,

management reduced to more-with-less, arithmetic reduced to how-many, algebra reduced to how-much, calculus to how-will, statistics to how-was. Primarily it is only meant to orientate the learners towards the theme in broadest of sense and gradually they are to be piloted towards more detailed scenario without losing any of content details.

- Neural Network Interfacing (NNW) technique extends individual neural network with new bi-lingual hybrid terms that ensure interfacing of semantic and phonetic aspects of the English language with the learner's mother tongue (a language other than English). This technique is considered beneficial for cultures where English is used for education as a second language. Multiple hybrid terms have been coined that come into existence with the merger of two words from different social languages like English and Urdu. It is synonymous to plug-and-play concept for devices. This technique is designed to encourage the learner to venture into academically rich languages for higher studies by linking English with native language.

- Knowledge Formatting (KF) technique converts socially acquired knowledge into scientific format, thus activating tacit knowledge and making use of experiential learning to transform student into active learners. Considering the fact that scientific knowledge is parametric, relational and objective in nature therefore method of eliminating the subjectivity in thinking has been used to develop this tool. Additionally, this approach invites the learner to decompose the knowledge up to the desired semantic depth. The technique is simple, practical and connects the learner with their bigger knowledge reservoir, i.e., tacit knowledge.

- The Common Sense Integration (CSI) by the learner in formal education has been observed to be a major weakness in the developing countries. Low self-esteem, alien medium of instructions and lack of general understanding are the inhibiting factors that prevent the otherwise street smart learner to integrate common sense in formal education. As common sense is mostly used in social context, therefore by replaying such known examples in slow motion attention of the learner is drawn to sequence of activities that human mind processes unconsciously. Awareness of such sequential activities in the explicit manner has been found useful for the learner. The developed template tempts the learner to have a social view of formal education, thus real life-academic integration becomes possible.

- The Sourcing Themes (ST) technique to understand the understanding-making sense, and how it is different from learning-the process. The idea is for the student to be able to understand things and shed away the old habits of rote learning.

The development and maturation of OMNI techniques is a work-in-progress. It is linked to a longitudinal study project to improve the standard of engineering education in the country. In essence OMNI techniques are a set of tools for: 1) developing a scientific and inquisitive mindset; 2) developing culturally relevant mind-operating-system; 3) restoring self-image, self-confidence, and self-esteem of the learner who has been through the primary/secondary

education system infested with innumerable setbacks; 4) making use of the vast bank of prior tacit knowledge acquired through social interaction; and, 5) seamlessly integrating student's IQ with EQ. It is believed that a one-time thorough session of OMNI techniques shall enable the student to transform into an active learner forever. These mutually exclusive techniques were primarily designed for engineering freshmen yet are considered equally applicable to any domain. OMNI techniques complement each other when applied in unison. The techniques have been found to be impacting the learner in a Major Engineering University (MEU) in Pakistan. The OMNI techniques were piloted in fall 2013 in a newly designed Engineering Foundation Course (EGR 100) and have been subsequently implemented successfully in the UG curriculum for freshmen in MEU for the last two years (fall 2014 to date).

Key words: Academic interventions, Active learning, Prior knowledge, Structured thinking, Rote learning

6.

### **USE OF 3D SIMULATION OF PICK-AND-PLACE ROBOTIC ARM FOR TEACHING CONTROLLER DESIGN**

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#### **Introduction**

Controller design, which is core to a third-year module, Control & Automation, in Electrical Engineering Diploma course at Ngee Ann Polytechnic, requires analysis and design of proportional, integral and derivative (PID) controllers. Students are expected to understand the characteristics of first- and second-order control systems in the time domain and to design controllers as per the system requirements. Due to its mathematical nature, many students, who lack strong mathematical foundation, are not enthused and grapple with understanding of the design process.

This study explores the use of 3D simulation courseware of a pick-and-place robotic arm in a printed circuit board (PCB) assembly line to aid students in the visualization and translation of control parameters to physical system outcomes and thus develop their higher-order thinking skills.

#### **Challenges Faced by Students**

Controller design comprises of understanding the design requirements, making valid assumptions and calculating control parameters using the appropriate mathematical techniques. Many students find it challenging due to its emphasis on mathematical steps. During a focus group discussion with students who have completed the module, it had come to light that some of the students who scored well for this module did not have a good grasp of the knowledge.

This sharing by the students led to some concerns about the transfer of learning, as “Being able to reproduce knowledge in a de-contextualized examination does not guarantee that knowledge can be used in a real-life setting” (Bloxham, S., & Boyd, P., 2007). In other words, the students were just exam-smart and the results were not a good indication of their real understanding of this module. This is an example of the “negative backwash” (Biggs, J., & Tang, C. (2007). Even the academically better students resort to strategies that will guarantee higher grades in the examinations rather than understanding the module content, resulting in “surface learning” (Biggs, J., & Tang, C. (2007). Consequently, when the question is varied (albeit slightly), they get easily confused and are not able to answer it. They get frustrated and feel that they are being tested on something that has not been taught.

Referring to Bloom’s Taxonomy (Bloom, et al., 1956), as shown in Figure 1, low level of learning such as remembering the design steps will not be enough for graduating students. Without understanding the underlying principle behind the mathematical calculations, the design process boils down mere execution of a series of steps without thinking.

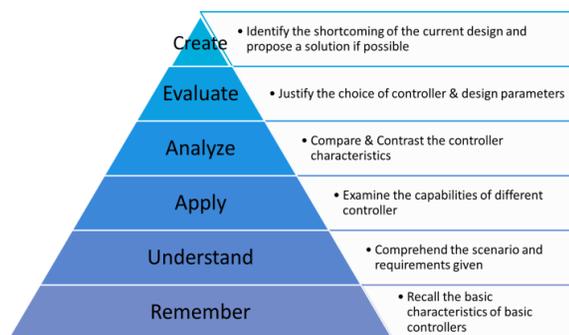


Figure 1. Bloom’s Taxonomy pyramid

They have to move to the next level of Bloom’s Taxonomy, where they will form relationships between the design steps and actual execution of the control system, so that they will better appreciate the relationship among the control parameters, output waveforms and physical outcomes of the system. Appreciation is the foundation upon which higher-order cognitive skills such as analysis and design are built.

### Methodology

The courseware is used in laboratory sessions to involve and engage students in the design-visualize-evaluate-improve cycle. Students need to design a controller based on the requirements given to them in the context of a pick-and-place robotic arm, as shown in Figure 2.

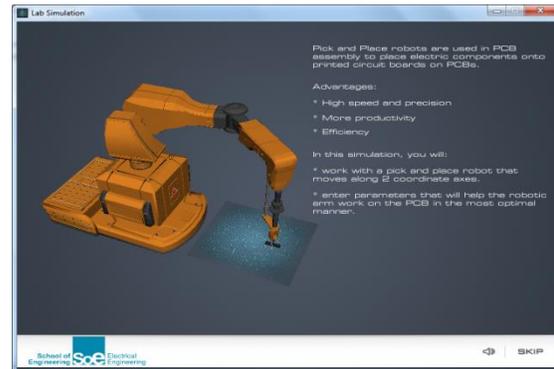


Figure 2. The PCB assembly scenario

Before the laboratory session, lecturers set design requirements and system transfer functions in the administration webpage to customize the design task for their own class. During the laboratory session, students are to login to the courseware with their student identification number and class group to get the task details. The simulation rules and assessment criterion are also available in the courseware, as shown in Figure 3.

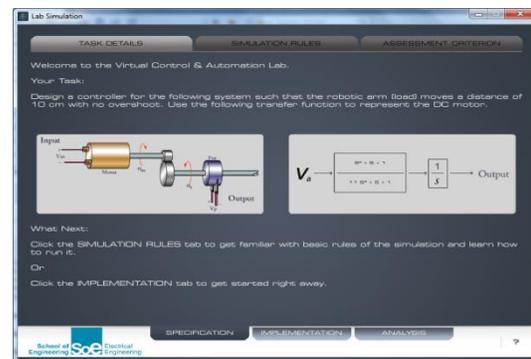


Figure 3. The design specification in the courseware

In the process of simulation, the 3D robotic arm moves according to the control parameters which students choose. The output of the waveform is generated in sync with the real-time movement of the robotic arm so as to allow students to make the association between the control parameters and system physical performance. The courseware also compels the students to compare the system performance with design requirements and decide how to tweak their design to better it.

After students finished the simulation, lecturers can download the class report in Excel format from the administration webpage. The report contains all students’ simulation parameters and results, from which lecturers can assess and comment on students’ performance.

### Use of the Courseware

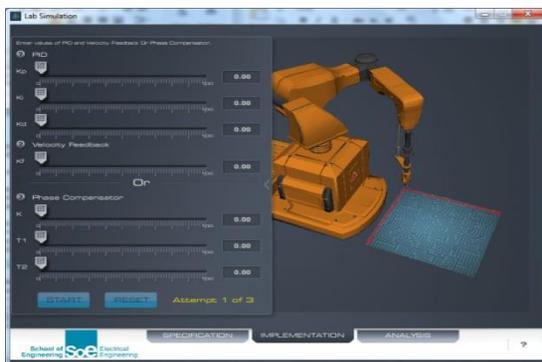
The courseware is designed with deeper learning in mind as depicted by the Bloom’s taxonomy pyramid. It provides students with authentic learning experiences.

### A Real-life Scenario

One of the ways to help students relate the knowledge they learnt in class to practice is to show them how this knowledge can be applied in real-life scenarios. This courseware adopts an industrial scenario in the PCB assembly line to engage students actively in the design process, as the students have an actual role play rather than just have another assignment to hand in to the lecturer.

*Open-ended nature of the question*

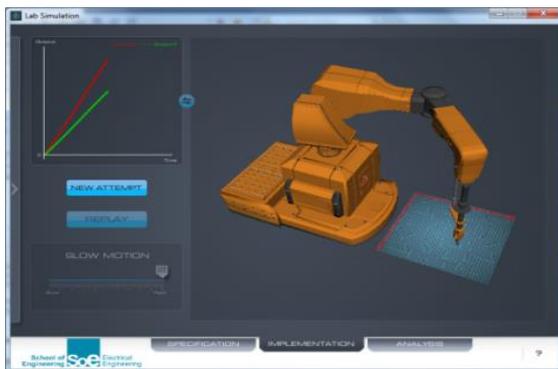
The courseware requires students to design a controller based on the given requirements specified in the courseware. It does not suggest any controller and only provides general tools such as Bode plot and step response to aid students in the design. The open-ended nature of the question forces students to explore characteristics of the various controllers, such as proportional, proportional-integral, proportional-derivative, proportional-integral-derivative and velocity feedback, as shown in Figure 4, and be open to the possibility of more than one type of controller as the solution to the given problem.



**Figure 4. The selection of controllers**

*Visualization of Implication of Design*

Waveforms and motions of the robotic arm are generated side by side to show their correlation, as shown in Figure 5, which allows students to view the implication of their design choice.



**Figure 5. Waveform and motion of the robotic arm**

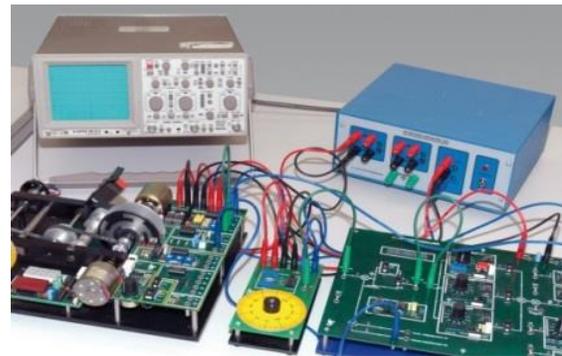
Students are allowed to revise their design with justification for up to 3 times. This provides students with an opportunity to take on the role of assessors and to make decisions based on their own understanding of what would be the best design. “Students themselves need to develop the capacity to make judgements about both their own work and that of

others in order to become effective continuing learners and practitioners.” (Sambell, K., McDowey, L., & Montgomery, C., 2013)

*Extrapolation from Simulation to Real Hardware*

To complement the simulation, students would then implement their design on a hardware set-up of a servo control motor set, as shown in Figure 6.

They have anticipated certain system performance based on the simulation. However, when the system behaves in a manner that is different, they are compelled to draw reasoned from the concepts learnt about non-linear hardware effects such as hysteresis and lag.



**Figure 6. Hardware set-up of a servo control motor set**

This structured form of pedagogical guidance ensures that students are not overwhelmed and at the same time reinforces the concepts in a systematic manner.

**Result of the 3D Simulation Courseware Pilot**

A pilot of this 3D simulation courseware was conducted with a group of 41 students studying the Control & Automation module in one of their 8 laboratory sessions. Students generally commented that the movement of robotic arm improved their intuitive understanding of control parameters and control terms such as stability, overshoot and speed. A survey on the pilot was conducted and Table 1 summarizes the students’ responses on the 4 questions which are relevant to the learning value of the courseware.

**Table 1. Survey result of the courseware pilot**

Survey Questions	Agree or Strongly Agree
The activity helped me understand the topic.	83%
The activity stretched my thinking.	88%
The activity motivated my interest in the module.	85%
The visuals helped my learning.	85%

Members of the teaching team also commented that the courseware would be a value-added addition to our teaching material. The future plan is to conduct a control group study

to understand how the use of this courseware translates to students' performance in their tests and exams.

## Conclusion

By having this 3D simulation software, students are not bound by the time, space and location of the hardware sets to enjoy a learning experience via exploration. Simultaneously, a simulation would isolate key design components for learning so that students will not be overwhelmed and confused by factors like delay affecting the performance of a hardware set. Students will also have a feel of personalized learning where they are able to customize the learning process according to their current levels of understanding and set personalized targeting to motivate or challenge themselves.

The positive feedback from the pilot has given the teaching team confidence that the students' learning experience in this challenging area of controller design would be enhanced using this 3D simulation courseware.

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7.

## COGNITIVE LOAD THEORY-BASED LECTURE MODEL: AN EVIDENCE-BASED STRATEGY FOR EFFECTIVE LECTURING

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**Problems faced in teaching & learning in higher education that called for the innovation**

Lecturing has been criticized for not being able to promote learning (Gibbs, 1982), yet prevails as the most feasible method of delivering information to a large group of learners in higher institutions (Bacro, Gebregziabher, & Ariail, 2013; Goffe & Kauper, 2014; Roth & Friesen, 2014). Despite the claims that lecturing fails to stimulate appreciation of values towards the subject, lecture is still favored by many students, as it provides a conceptual overview of a topic (Abdul-Kadhumi-Al-Modhefer & SeanRoe, 2009; Cashin, 1985; Covill, 2011; Struyven, Dochy, & Janssens, 2008). Likewise, the role of lecture in current settings is not limited to, delivering information; rather, lectures are regarded as capable of instilling prior knowledge, challenging beliefs and guiding the learners on how to learn a topic (Brown & Manogue, 2001; Charlton, 2006). Unfortunately, little is known about how to convert the classical knowledge-transfer process of lecturing to actual learning. Hence, we developed a lecture guideline, termed as cognitive load theory-based lecture model (CLT-bLM) by using various types of empirically proven strategies of Cognitive Load Theory (CLT) for managing students' mental load during lectures.

## Theoretical Foundation of CLT-bLM

CLT-bLM was developed based on the CLT, an instructional theory that describes the occurrence of optimal learning when the instructional material is aligned with the human brain function (Paas, Renkl, & Sweller, 2003). Human cognition consists of two important components; a working memory with limited capacity that processes new information into small schemas; and a long-term memory with unlimited capacity that stores the schemas (Baddeley, 2003). Actual learning occurs only if the schemas are successfully constructed and stored in the long-term memory (Rumelhart, 1978). Hence, an effective instruction should be able to facilitate the process of schema construction and storage.

The CLT-bLM framework is grounded on a strong foundation of CLT which are, managing the intrinsic load (IL) and reducing the extraneous load (EL) of a learner during a lecture. To prevent cognitive overload that can hamper learning, total cognitive load must not exceed the limited capacity of working memory (Kalyuga, 2011).

The IL is imposed by complexity level of an instruction, which is influenced by learners' prior knowledge and amount of interactions between chunks of information (Sweller, 2010). While the EL is imposed by the way that a teacher delivers the instruction (Sweller & Chandler, 1994). By reducing the EL, some working memory resources could be freed, and thus could be used to process the IL (CR<sub>L</sub>) instead of EL.

## Description of the innovation and how it solves the problems in teaching & learning

The CLT-bLM is a four-phased guideline that outlines 27 principles in managing the cognitive loads of learners (Figure 1). The principles apply at least one cognitive load strategy as summarized in Table 1.

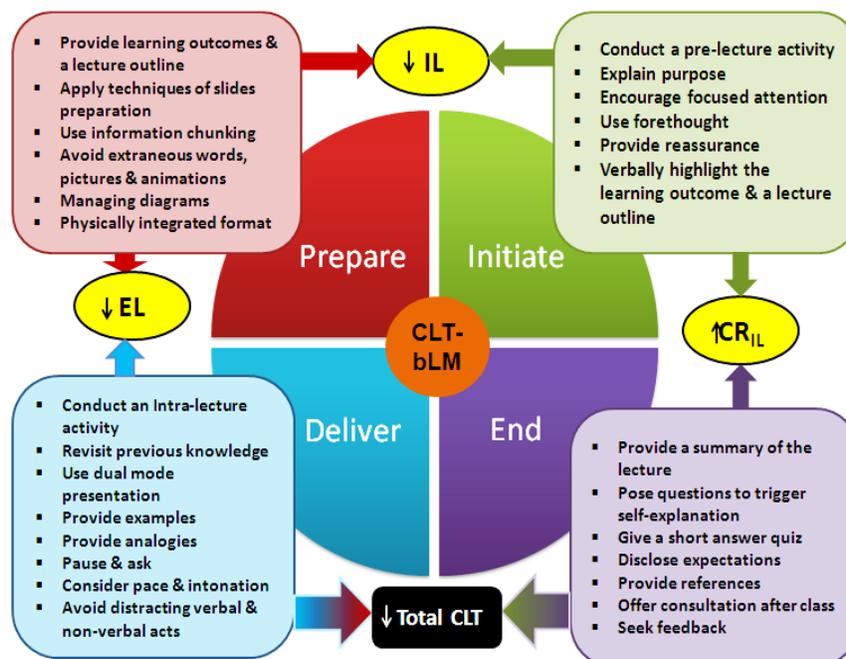


Figure 1. The CLT-bLM

Table 1. The cognitive-load strategies of CLT-bLM

Aims	CLT strategy/effect
Reduce IL	Element interactivity Stimulation of prior knowledge Isolated/Interacting elements
Decrease EL	Worked/completion example Split attention Modality Redundancy Expertise reversal Guidance fading Imagination
Reduce CR <sub>L</sub>	Stimulation of interest and motivation

This guideline has been applied for preparation and delivery of three anatomy lectures at three different institutions, which were Universiti Sains Malaysia (USM), Universiti Sultan Zainal Abidin (UniSZA) and Universiti Malaysia Sarawak (UNIMAS). Hence, the lectures were delivered to three different cohorts of first-year medical students of 2015/2016 academic sessions. Two weeks prior to each lecture, each lecturer was given a self-explanatory CLT-bLM guidebook that provides a step-by-step approach to the application of each principle. In addition, all lecturers attended a workshop on CLT-bLM and were given hands-on exposure to the application of the model with guidance from the developer.

The application of the model begins with the preparation of the lecture materials, of which the instruction was prepared according to the allocated learning outcomes, using certain slides preparation techniques. The principles of this phase reduce IL through information chunking (Gobet et al., 2001; van Merriënboer, Kirschner, & Kester, 2003); and reduce EL through elimination of distracting extraneous elements; management of pictorial materials; and integration of information.

The second phase of CLT-bLM is a phase where the lecturer initiates the lecture by adopting strategies that could reduce IL but increase the CRIL of the learners. A short pre-lecture activity such as watching a short video related to the lecture topic would be able to stimulate prior knowledge of the learners, and thus reduces the IL. Furthermore, the CRIL could be increased through stimulation of students' interest and internal motivation (Pintrich, 1999), in which the lecturer explains the purpose of learning the topic, encourages students to pay attention, provides reassurance on future guidance and instills forethought on what students would encounter as a result of learning the topic. The last principle of this phase helps the students to create a mental mapping on the organization of the lectures; hence, they would be mentally prepared to learn the topic.

The third phase of CLT-bLM comprises eight principles that reduce the main source of extraneous load, which commonly arise from a poorly delivered lecture. For instance, when a diagram is explained using verbal explanation (dual-mode presentation); two learning modalities of the students are being stimulated, which are visual and auditory centers, and thus optimized the working memory capacity of the learners (Crooks, Cheon, Inan, Ari, & Flores, 2012; Hadie, Hassan, Rahim, Ismail, & Ismail, 2014). Likewise, by revisiting previously learned information, and providing examples as well as analogies during lecture, the schema automation process of the students working memory is enhanced. This condition would stimulate students' minds to create a good mental imagery on the subject matter (Leahy & Sweller, 2004). To address the short attention span of students, several pauses and ask session would be beneficial as the students would be able to refresh their working memory that might have been overloaded with information (Ruhl, Hughes, & Gajar, 1990). This session could also be used to conduct a simple beneficial intra-

lecture activity such as posing questions, short video session or light discussion session. Apart from that, the verbal and non-verbal elements of teaching behaviours are also addressed in this phase.

The 'end' phase outlines seven steps on how a lecturer could end the lecture in such that can stimulate increment of CRIL. As mentioned previously, CRIL could be increased when the students' interest and internal motivation towards learning the topic are stimulated (Kalyuga, 2011). Hence, by summarizing the lecture in an intelligible manner, students would feel motivated to revise the topic after class. Besides that, posing tricky questions that could stimulate self-explanation and providing a short quiz session at the end of the lecture could trigger the students to initiate self-learning and group discussion (Mayer et al., 2009). To ensure that students know what to revise from the topics, the expectation of the topic should be explicitly mentioned by re-emphasizing the learning outcomes of the topic. In addition, a list of references and additional suggested readings should be provided and the lecturer's preferred method of after class consultation should be made explicit. This effort could cultivate good perception of students on the lecturer's support to their learning, which indirectly boost their internal motivation to learn. Moreover, obtaining feedback from the students is an essential element addressed in this phase, not only for future improvement, but to instill a sense of being appreciated by students, as they are able to contribute their thoughts and opinions in the teaching and learning process.

The elaboration of techniques on conducting each principle of CLT-bLM can be obtained in a 52-page CLT-bLM guidebook prepared by the developer (Hadie, in press)

### The impact of the innovation towards teaching & learning

Although the model is still at its infancy stage, its evidence of validity and effectiveness has been proven in several well-designed controlled studies. We conducted two studies to measure its item response-process validity and internal consistency through experts' judgement ratings. Following that, the established valid model underwent for effective measure evaluation through a multicenter randomized controlled trial that required implementation of the model at three different institutions to three different cohorts of students. The findings of these studies showed that: (1) CLT-bLM has good response process validity and acceptable internal consistency (Hadie, unpublished); (2) CLT-bLM-based lecture enhances knowledge acquisition and retention of the learners (Hadie, Hassan, Talip, Mohd Ismail, et al., 2016); (3) CLT-bLM based lecture reduced the cognitive loads of the learners (Hadie, Hassan, Talip, & Mohd Ismail, 2016) (4) CLT-bLM-based lecture increases the invested mental effort of the learners during lectures; and (5) CLT-bLM has good concurrent validity and efficiency measures evident by good correlation between students task performance and invested mental effort (Hadie, unpublished). The effects of CLT-bLM-based lecture on the cognitive load level, task performance, and invested mental

effort are highly evident through the calculated Cohen effect size as summarized in Table 2.

**Table 2. Difference in the learning quotient score between groups**

Outcome measure	Variables	Cohen effect size	Interpretation
Students' cognitive load level	Intrinsic load	0.429	Small to large effects
	Extraneous load	0.697	
Students' task performance (Knowledge acquisition and retention)	One-hour post lecture test scores	0.404	Small to very large effects
	Three to five week post-lecture test scores	0.408	
	Seven to ten week post-lecture test scores	1.696	
	Structure test recall scores	0.691	
Students' invested mental effort	Engagement level	0.853	Very small to large effects
	Internal motivation	0.119	
	Students' self-perceived learning	0.578	

Cohen effect size was calculated using the Effect Size Calculator for T-Test, (Statistics, 2015). Cohen effect size thresholds: Very small < 0.20; Small= 0.20; medium= 0.50 and large= 0.8, very large=1.13 (Cohen, 1988)

These findings indicate significant impact on pedagogical practice as such that: (1) it create a stimulating and engaging learning environment in a lecture-based setting by manipulating the mental loads of students during lecture; (2) it stimulates self-directed learning after a lecture session through stimulation of interest and internal motivation towards learning the topic; and (3) it provides guidance for lecturers especially novices on lecture preparation and delivery through it step-by-step approach. Notwithstanding of our positive findings, the use of the model requires prior training from the developer; hence, the model serves as a potential valuable module for professional development. In fact, this model has been incorporated into a module of teaching and learning course in School of Medical Sciences, USM starting from April 2016, which is an annual compulsory course for new lecturers. Nevertheless, we call for a concerted effort in providing evidence of efficiency for this model in various disciplines as the results would contribute in optimizing instructional design decision, particularly in a lecture-based setting.

### Acknowledgement

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## 8.

### INTERACTIVE APPROACH IN TEACHING ENGINEERING ETHICS TO A CLASS SIZE OF MORE THAN THIRTY

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*Abstract* -Teaching engineering ethics to a class size of more than thirty students is very challenging. Prior to the introduction of this interactive method, several

transformative learning strategies have been employed in my ECETHIC course, a course taken up by graduating electronics engineering student at De La Salle University. These include brainstorming activities, survey, lecture, film showing, case studies, and ethics bowl. Due to the big class size, students are grouped with at most five members. In the aforementioned activities, it has been observed that some of the students in the group were not participating. The activities did not help them express better rationalization during the ethics bowl and more so during the individual written case evaluation. Upon introduction of the interactive approach, the number of students that became more engaged in the debates increased and their rationalization in their case studies greatly improved as evidenced in the scores that they obtained in these two activities. The assessment of the improvement is done by comparing the final grade and the scores in ethics bowl and case studies. With the interactive approach, although most of the students have a two point five (2.5) final grade, a median grade in the grade range, the score in the ethics bowl and case studies remarkably logged scores greater than eighty (80). In fact, most of them got ninety with a few obtaining eighty and one hundred versus the non-interactive strategy where some scored seventy and the curve almost follows the distribution of the final grade.

## I. Introduction

Transformative learning is a teaching tool that allows learning to be student centered. Several strategies have been used in teaching engineering ethics. These include conducting a survey regarding the opinion of the student on an ethical issue [1], group discussions [2], brainstorming activities [3], ethics bowl [4], lecture, and film showing. All of these are used in my class ECETHIC. However, this class is not purely an ethics course, it also covers discussion on the existing laws that affect the electronics profession, and different types of contracts and manner of contracting, leaving the ethics part to be discussed in only eight class meetings with one and a half hour per meeting. The limited time allocated for the discussion of ethics plus the number of students per class requires thorough planning on how the above strategies will be carried out. Prior to the introduction of the interactive method, the following sequence is implemented, (1) Survey, (2) brainstorming activity, (3) lecture, and (4) ethics bowl which is the culminating event. Film showing is done outside class hours while case study is given as an exam. From the presented sequence of events, only the first is an individual activity while the rest is done by group or by the whole class. Specifically, for the brainstorming activity, a series of cases is shown to the class and they are free to give their discourse. However, it was observed that some students tend to monopolize the discussion while the others simply listened and did not participate. The apparent shallow rationalization of some of the students is evident in the data shown in Section III.

In order to increase participation and enhance their rationalization, an interactive approach based on the 'activating event' teaching strategy of McGonigal [5] for the brainstorming activity is adopted in this year's ECETHIC. The following section discusses this strategy.

## II. The Interactive Teaching Method

In this approach, students are asked to stand up. Simple cases that they themselves may have encountered are flashed on the screen. For each case, they are instructed to take a stand by moving to either side of the room (Fig.1). After the students have chosen their position, two students are randomly asked why they chose that option. Their responses are carefully critiqued so as not to lead them to an answer that they may construe as the best answer so that they can independently assess their answers as well as those in the opposing group. The discussion ball is freely thrown so that the other group can answer the challenge of the opponent and vice-versa. Since students are standing, it is a lot easier to pick a respondent. Some are adamant to give them ethical evaluation, they are gotten to get engaged in the discussion by rephrasing the question or by supplying additional information to them. Table 1 enumerates the different cases shown to the students. Once students have given their evaluation of the case, a possible position is presented to them in order to introduce the different ethical problem solving approaches.

TABLE I: Prelude Cases

No.	Case	What to do	Ethical Approach /Issue
1	Pilfering of organization's materials [1]	Go to Right if this is right, Left if wrong	Virtue Ethics
2	Misha gave to a beggar a piece of bread infested with flies	Go to LEFT if you said right, GO to RIGHT if wrong	Respect for person approach
3	You are entrusted the attendance sheet of an activity that is credited to a course; a friend of yours was not able to attend and requested you to allow him to sign in the attendance sheet	Go to the LEFT if will allow, Right if you will not allow	Ethical dilemma, Loyalty versus Honesty
4	What would you do if a lady in front of you dropped her purse	Go to LEFT if you will RETURN it, to RIGHT if not	Ought-to-do is introduced
5	Variation of the previous case where the lady is changed with a man who may have been hostile to you	Go to LEFT if you will RETURN, to RIGHT if not	Use of emotion clouds the decision making
6	Variation of the previous case where this time no one saw the person who dropped the purse	Go to RIGHT if they will keep the purse, LEFT if they have other options	Different perspectives and Good Citizen's duty
7	Mae's been absent for three days because her son is sick. Since the company policy is "no work no pay", she just can't afford another day without a salary. Being employed in a small company, she learned from her colleague that their Boss is out of town that day. So she asked her colleague to punch her time card and the colleague agreed.	Go to RIGHT if Mae's action is right, and LEFT if her action is wrong.	Principle of Complicity and Consequential Ethics
8	The general trolley/train problem, original track has ten children tied to the track, the other track has only one child	Go to RIGHT if Pull the switch to change track and to LEFT if will do nothing	Split second-decisions, Utilitarian vs Kant and Double Effect Theory

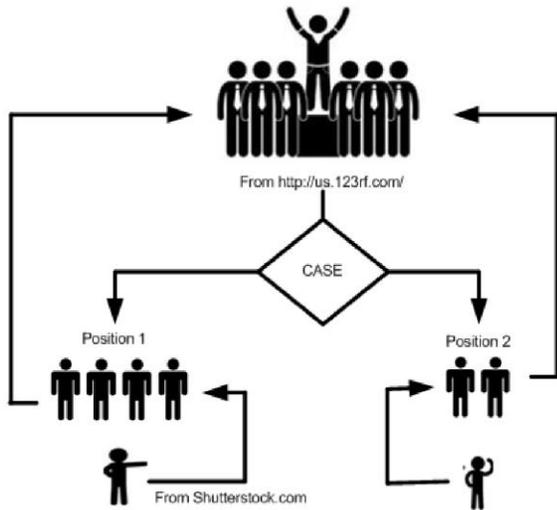


Figure 1. Interactive Activity Flow Graph

After the activity, the students are prompted to give a brief answer to the following questions in preparation for the next meeting activity

- In your understanding, what is Ethics?
- Why do you need to study ethics?
- What are engineering ethics?

### III. Data Comparison Before and After Introduction of Interactive Activity

To correctly assess the effect of the interactive activity on the students' rationalization, the scores of the students on their ethics bowl and their case study evaluation are averaged and plotted in a histogram. The scores are plotted and juxtaposed with the plot of the final grades that the students obtained in the course. The plotting is done per section per year. As already mentioned, the course contains other topics aside from ethics, and the assessment for the other topics follows the usual examination format like multiple choice, identification, or enumeration. The purpose of the juxtaposition of the final grade and the ethics-related

activity scores is to determine how the interactive activity enhanced learning in ethics. Only classes with more than thirty were evaluated and Fig.2 to Fig.10 show the data for the years where the interactive activity was not yet employed while Fig.11 shows the data where the interactive activity was carried out.

For Year 1 (Figs.2-4), the distribution of the ethics scores follow the same distribution as that of the final grades. We can surmise that the higher score in ethics is due to the fact that the class comprise of mostly intelligent students. However, the graph also shows that there are a few who got a score of 70 or below.

For Year 2, except for Section A, section B and C (Figs.6 and 7) also show a high correlation between the final grade and the ethics scores. The high score could have been dominated by those with high grades. In section A (Fig5), while many are having low final grades, the scores that they have in ethics are remarkably higher. This invalidates the hypothesis that only students who are intelligent rationalize well. Nevertheless, this study does not intend to prove that only intelligent students can reason well. Instead, this study would like to emphasize how the interactive study can improve their rationalization skills. The graph here shows some students having a grade of 70 or less.

Year 3 with two sections (Figs.8 and 9) and Year 4 with only a single section (Fig.10) show the same pattern, the ethics scores have high correlation with the final grades. And it is notable that some have a score of seventy (70).

Year 5 is the year where the interactive activity is introduced. Fig.11 shows the final grades and the ethics scores. The Final grade shows that most of them are average students having a grade of 2.0. What is notable here is that none of them got 70 and mostly in fact got 90. The criteria used in grading the ethics bowl and the case study did not change for these five years. And all of these classes were under my mentorship.

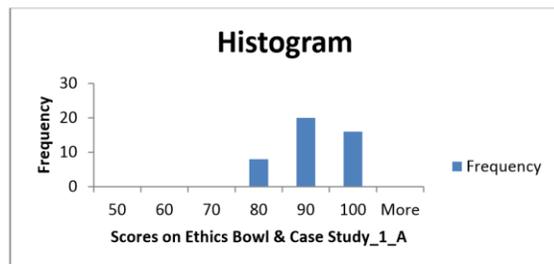
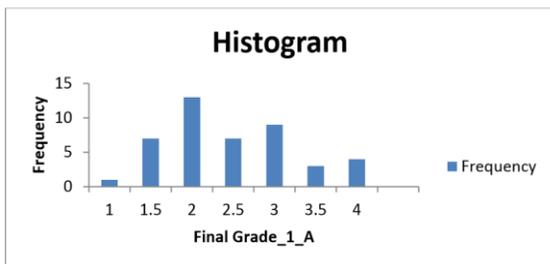


Figure 2. Final Grade and Ethics-related Activity Scores for Year 1 Section A

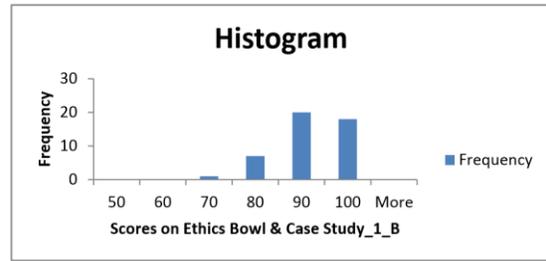
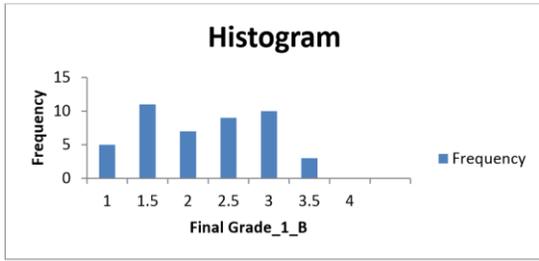


Figure 3. Final Grade and Ethics-related Activity Scores for Year 1 Section B

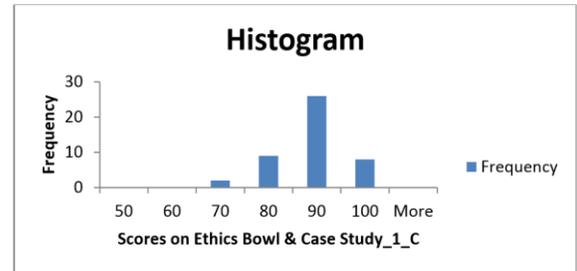
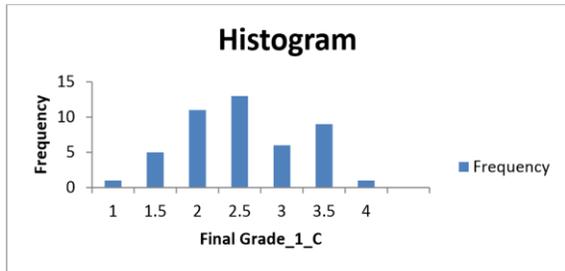


Figure 4. Final Grade and Ethics-related Activity Scores for Year 1 Section C

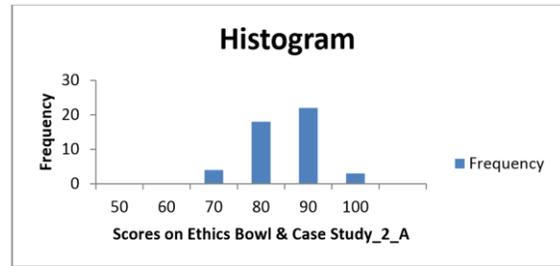
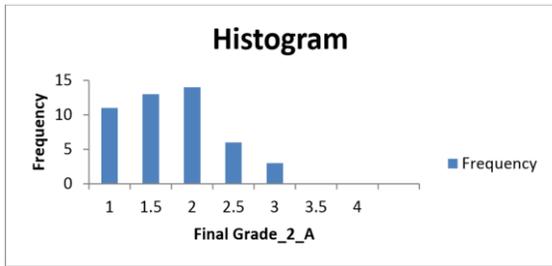


Figure 5. Final Grade and Ethics-related Activity Scores for Year 2 Section A

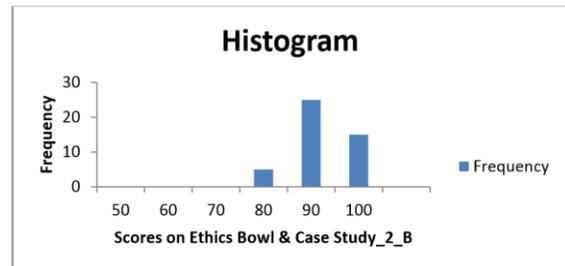
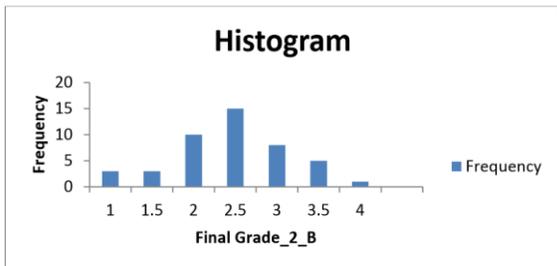


Figure 6. Final Grade and Ethics-related Activity Scores for Year 2 Section B

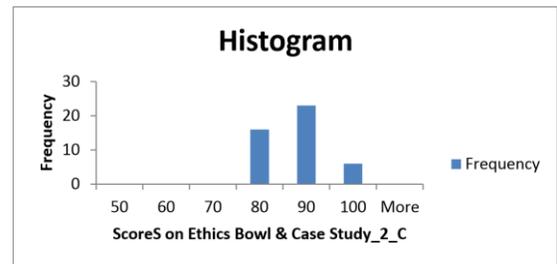
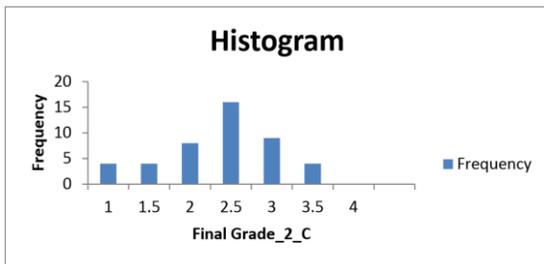


Figure 7. Final Grade and Ethics-related Activity Scores for Year 2 Section C

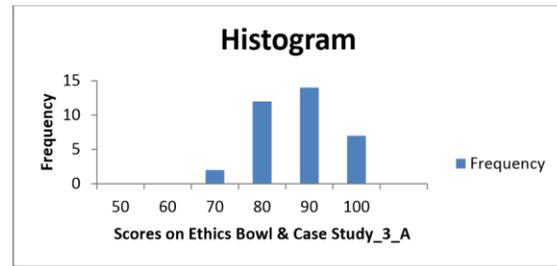
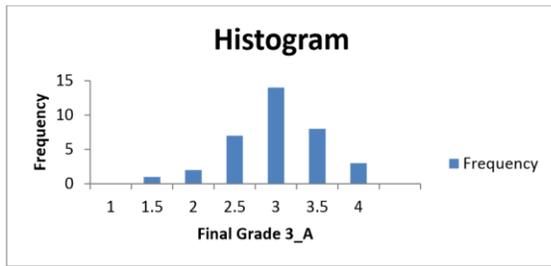


Figure 8. Final Grade and Ethics-related Activity Scores for Year 3 Section A

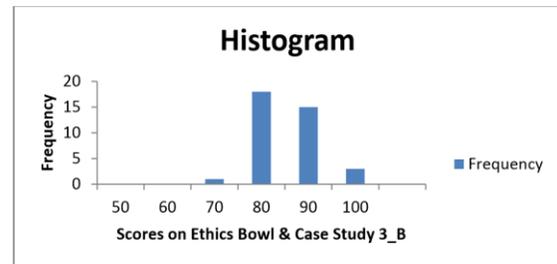
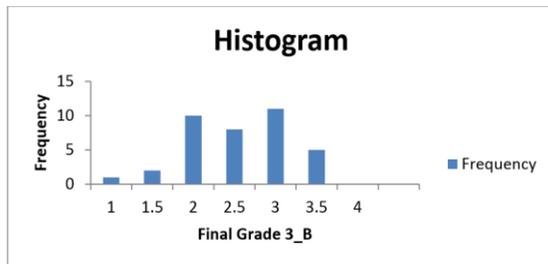


Figure 9. Final Grade and Ethics-related Activity Scores for Year 3 Section B

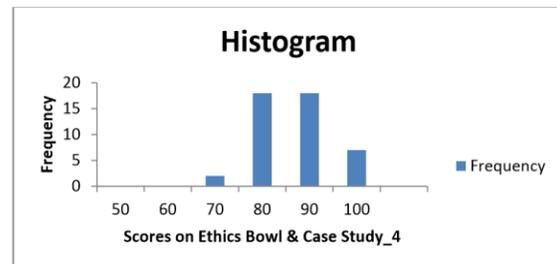
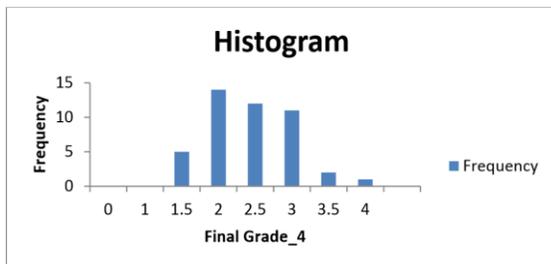


Figure 10. Final Grade and Ethics-related Activity Scores for Year 4

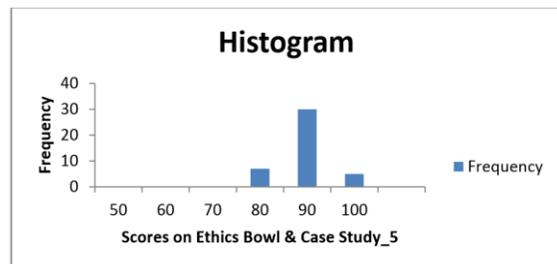
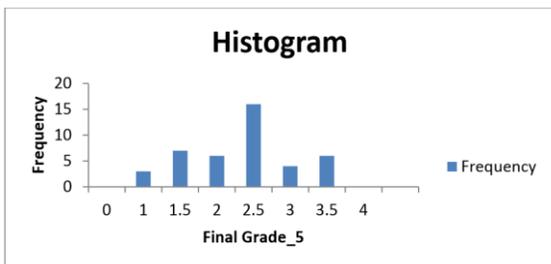


Figure 11. Final Grade and Ethics-related Activity Scores for Year 5

#### IV. Conclusion

Transformative learning (TL) approach in teaching engineering ethics to a class size of more than thirty has greatly improved students rationalization. This is evident in the data presented above where students obtain scores higher than eighty. However, it is observed that there are still those whose scores are seventy or below. Due to the big class size, some students opted to be passive listeners while some tend to monopolize the discussion. With the interactive activity, everyone has a role to play since all of them are enjoined to participate in the activities by requiring them to make movements in the room upon showing several cases to them. As provided in the last figure above, the histogram is skewed to the right with most of the students having an average score of ninety in their ethics bowl and case study

with a few having a score of eighty but none with a score of seventy. This is despite the fact that the final grades show a non-uniform distribution of grades. While it can be debated that intelligent students cannot claim better rationalization than the other students, the several data presented here show a great correlation between the two. Hence, it can be concluded, that the interactive approach has indeed enhanced the rationalization of students taking up the ethics course regardless of their intellectual ability. It should not be forgotten that the other transformative learning activities in the class prior to the interactive approach were not removed when the interactive approach was carried out. These approaches include survey, brainstorming activities, film showing, lecture, and ethics bowl. Specifically, the interactive approach was applied to the brainstorming activity.

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9.

### EVALUATING KNOWLEDGE TRANSFER SUCCESS IN PERSONAL LEARNING ENVIRONMENTS AMONG STUDENTS IN HIGHER LEARNING INSTITUTION

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## Introduction

Knowledge transfer has been the common practice that happens daily through individuals' learning process. Be it a formal learning process or informal learning process, knowledge is assured to be transferred among the learners when both of those processes occurred. Significantly, this study looks into the success of knowledge transfer that happens in informal learning through Personal Learning Environments (PLE) among students in Higher Learning Institution.

## Extended Abstract

Personal Learning Environment (PLE) is defined as the informal learning processes of the learners via the Web; or a single learner's e-learning platform that allows the learner to communicate and collaborate with other learners as well as instructors in a large circle of connections across a wide range of systems ((Dabbagh & Kitsantas, 2012) (Harmelen, 2006)). In Higher Learning Institution, the process of transferring knowledge was seen as the commonly happening practice, as it is where the learning processes take place. An evaluation framework to evaluate the success of knowledge transfer in PLEs is proposed in the early

(planning) stage of this study. In the process of coming out with the proposed evaluation framework, a deep literature studies into previous works has been conducted. The proposed evaluation framework is developed based on the combination of few previous model/ frameworks from the literature study and then were brought into the knowledge management perspective especially knowledge transfer. It includes a chain of fit relationships between human, organizational and technology factors.

The proposed evaluation framework is then assessed by conducting a qualitative action research experiments in a chosen higher learning institution that conduct knowledge transfer process through PLEs. The activities of the action research experiment are conducted according to the one ideal cycle of action research in education which consist of 4 stages which are 1) planning 2) acting 3) observing and 4) reflecting (Foster, 2014). The action research experiments were conducted in a few cycles and took place in a well technology- equipped lecture and tutorial room and participants were provided with sufficient materials related to the syllabus in the course chosen. The action research experiments were conducted concurrently during lecture and tutorial sessions, weekly. The PLEs session has been conducted consistently and continuously for 2 semesters. The first experiment has taken place since September 2015, and up until now, the PLEs sessions are still undergoing.

The experiments include the researchers (lecturers/ tutors) together with the participants to undergo the PLEs sessions. In every PLEs session, a topic is given and participants are required to gain as much knowledge through their own ways. Materials related to the given topic such as interactive videos are provided through the chosen streaming platform, YouTube. The communication between peers, tutors/ instructors or even through Social Network Sites (SNS) are encouraged. Participants are encouraged to perform their own learning process at their own pace to gain as much understanding as they could. At the end of the PLEs session, participants' understanding is being assessed through pop quizzes, assessment presentations and exercises which are prepared for them, according to the topic related. The participants are obliged to take the assessment without (Dabbagh & Kitsantas, 2012) referring to any notes or lectures contents. Those assessments' score is significant findings in determining the ability of knowledge being transferred through the PLEs process.



Figure 1. One ideal research cycle (Foster, 2014)

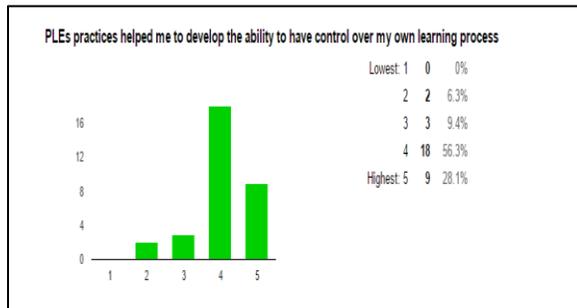


Figure 2. Participants' opinion on the PLEs session conducted during experiments

The findings of this action research experiments are categorized into two significant aspects which are the performance on objective scores and performance on the subjective views. Both aspects look into the participants' performance while undergoing the PLEs sessions and the traditional learning sessions. Objective scores measure participants' performance in exams, quizzes and other assessments. On the other hand, various patterns were observed on how the participants' performance was affected by the PLEs. Based on the finding patterns, participants seem to be adapting to the different environment learning process that they experienced in the experiment conducted. Based on these performance scores and views, the success of knowledge transfer is evaluated.

A reflection interview was later conducted in order to gain more findings regarding the participants' perspective on the implementation of PLEs in their learning process. Insights on the proposed success factors embedded in the evaluation framework were also collected through the interview process.

The research findings contribute to practitioners, specifically academicians, in providing guidance to essentially evaluate knowledge transfer that happens in classrooms among students. Next, the practitioners could also use the evaluation framework in evaluating issues and reasons why their knowledge transfer process fails. This study also provides a new perspective on PLEs where it promotes the learners to organize and take control of their own learning process and therefore reflects on their ability to capture knowledge by learning on their own.

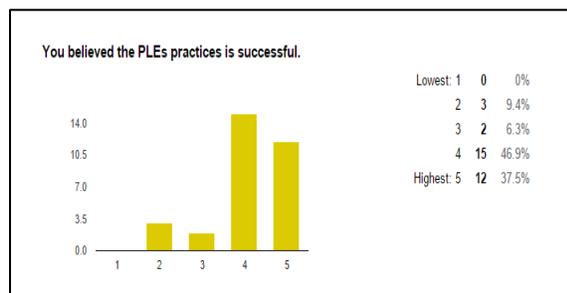


Figure 1. Participants' opinion on the PLEs session conducted during experiments.

### The Proposed Evaluation Framework

The framework includes a chain of fit relationships between human, organization and technology factors. The double arrows linking between technologies to human, technology to organization, human to organization indicate the interdependencies within the three fit- factors. The components of three fit- factors affect the net benefits that will be evaluated through the performance score. Besides, the proposed evaluation framework also revolves around the theory of DeLone and McLean IS success model and Morton's IT- Organization fit model in order to emphasize the evaluation of the knowledge transfer process during the PLEs session. The underpinning theory in this study were proved to be related to each other are relevant to be adapted into the proposed evaluation framework.

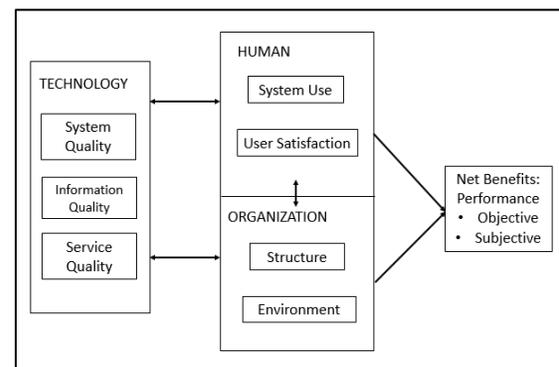


Figure 2. The proposed evaluation framework ((DeLone & McLean, 2003); (Morton, 1991); (Yusof, Kuljis, Papazafeiropoulou, & Stergioulas, 2008))

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10.

### IMPLEMENTATION OF 'B-LEARNING' METHODOLOGIES FOR STUDENT ENGAGEMENT IN COMPUTER SCIENCE EDUCATION: A MALAYSIA CASE STUDY

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#### Introduction

According to the literature by De Leng et al. (2010), blended learning (b-learning) is considered as an online learning combined with face-to-face with the use of educational technologies when delivering the teaching, learning and assessment activities in the classroom based practices. In Malaysia, the blended learning concept has been widely accepted amongst the higher institutions. Many of them adopted Learning Management Systems (LMSs) or Course Management Systems (CMSs) such as Blackboard, WebCT and Moodle to be part of everyday experience in campus-based teaching and learning.

The Moodle system developed at Universiti Teknikal Malaysia Melaka (UTeM) provides the flexibility for students and lecturers to better access their teaching and learning, thus in effect better learning environment. Indeed, students in Computer Science (CS) courses seem to value the option of having Moodle in their learning. In the literature review of CS science education research area, there is a dearth of pedagogical guidelines for practitioners. The research done by Holley and Oliver (2010) acknowledges that it is important to have students' experience learning in the classroom with LMSs in order to renew pedagogy approaches of 'b-learning'.

#### Theories of the practice

The problems and issues in teaching, learning and assessments (TLAs) with the emerging educational technologies are often discussed. Sadly, not many researchers in this area shared their experiences on how the instructional delivery should take place in managing the changes of teaching form. The purpose of our work is to

renew some principles of pedagogy through constructive alignment theory into a Computing Science course.

In this abstract, we would like to discuss and shared our teaching experience of how the instructional delivery are conducted during the implementation of 'B-Learning' method using Moodle based on the underpinning theories of learning such as Constructive Alignment (CA) by Biggs (1999) and a Table of Learning by Shulman (2000). This integration is traced from intended learning outcomes, active student engagement in a range of learning activities and assessment tasks, to assessment of the student learning outcomes using criteria-referenced standards.

The study aimed at exploring the significance of the CA approach using Moodle at higher education level. It also examined its effect on student engagement. Successful learning is an on-going process that involves the identification of learning outcomes, the participation of students and teaching forms (Biggs, 2003).

In order to support the construction of knowledge and engagement, students need to be prepared at an early stage of the learning process (Shulman, 2004). We adopted Shulman's taxonomy (2004) in this study. The idea is that we want to assess the student engagement in each stage of learning process in the classroom. By adopting the Table of Learning introduced by Shulman (2004), the indicator of student engagement can be done from the early aspects of learning until the end of the process. We model the student's learning in the classroom as shown in Table 1.

The model illustrates the learning process, learning activities is aligned with e-Assessment tasks and student's activity that match with intended learning outcomes as defined in constructive alignment definition. Figure 1 illustrates the practice of constructive alignment for all stages of learning process in the subject taught through Moodle (Figure 1).

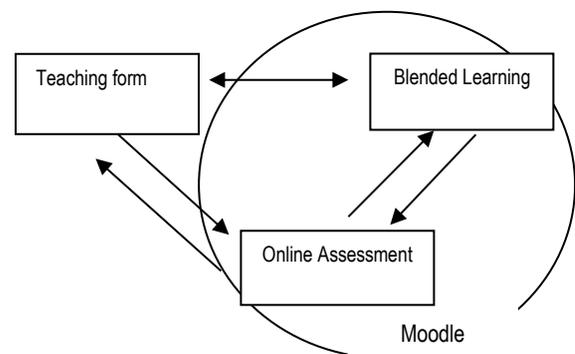


Figure1: An aligned of the course using CA through Moodle

Table 1: Aligning stages of learning process using Moodle

Stage of learning process	Learning activities	Task in Moodle	Student's activity
Engagement & Motivation	<ul style="list-style-type: none"> <li>• Stated the intended learning outcomes (ILOs) explicitly</li> <li>• Getting feedback from students about their assessment experience.</li> <li>• Introduce online announcement about assessment tasks, assessment result and marking criteria</li> <li>• Getting feedback from students on their preferred topics of the course</li> </ul>	<ul style="list-style-type: none"> <li>• Online survey type – 'Approach to Studying'</li> </ul>	<ul style="list-style-type: none"> <li>• Respond to the discussions of intended learning outcomes</li> <li>• Submit their respond through online to the approach of studying questionnaire</li> <li>• Submit their respond through online to the topics preference</li> </ul>
Knowledge & Understanding	<ul style="list-style-type: none"> <li>• Stated the ILOs explicitly</li> <li>• Aligned in-class learning activities based on negotiation style</li> <li>• Encourage social skills such as interactions and participation in the course.</li> <li>• Giving out feedback to monitor students' understanding</li> </ul>	<ul style="list-style-type: none"> <li>• Weekly online quiz</li> <li>• Online peer review quiz</li> <li>• Immediate online quiz</li> </ul>	<ul style="list-style-type: none"> <li>• Submit answers to the weekly online quiz</li> <li>• Students interact and operate their participation through the immediate online quiz</li> <li>• Student use feedback given as guidance in learning</li> </ul>
Performance & action	<ul style="list-style-type: none"> <li>• Stated the ILOs explicitly</li> <li>• Aligned in-class learning activities based on negotiation style</li> <li>• Introduce online short essay test to develop student's higher order thinking skills.</li> <li>• Allocate tasks on real-life industrial/commercial issues for students to encourage students to use back the knowledge gained in the course.</li> <li>• Giving out feedback to monitor students' understanding</li> </ul>	<ul style="list-style-type: none"> <li>• Online short essay tasks</li> <li>• Online tasks on real-life problems</li> </ul>	<ul style="list-style-type: none"> <li>• Submit answers to online short essay tasks</li> <li>• Submit answers to online tasks on real-life problems</li> <li>• Students interact and operate their participation through the online tasks</li> </ul>
Reflection & Critique	<ul style="list-style-type: none"> <li>• Stated the ILOs explicitly</li> <li>• Reiterated learning activities based on students' feedback</li> <li>• Introduce online and presentation reviews of e-Assessment submissions to encourage reflection practice.</li> <li>• Giving out feedback to monitor students' understanding</li> </ul>	<ul style="list-style-type: none"> <li>• Presentation</li> <li>• Online presentation reviews</li> </ul>	<ul style="list-style-type: none"> <li>• Students interact and operate their participation during the presentation</li> <li>• Students respond to the online presentation reviews</li> </ul>

## Research Methodology

### Participants

The research respondents are drawn from a Software Engineering course in FTMK for two consecutive semesters. There are three subjects chosen; 1) DITP 2213 – Data Structure & Algorithm, 2) BITP 2223 – Software Requirement and Design (BITD) 3) BITP 3253 – Software Verification and Validation. However, only subject code BITP 2223 results and analysis will be discussed in this paper. The first phase of our research methodology, we set up our target learning outcomes using the SOLO taxonomy in the teaching plans. At this stage, teaching plans shall be the guidelines for the lecturer's instructional delivery.

Lecturers shall implement some principles as shown in Table 2.

Table 2: Some principles of good pedagogy used in the practice with Moodle

Principles	Description	Application
Individualization	Learning tailored to the needs of the individual	Sending online survey for learning preferences of the subject taught.
Motivation	Students are motivated when presented with meaningful and rewarding activities	Students are rewarded with marks not more than 5 per cent for participating in online discussion.

Social	Learning is a social and participating process	Apply online peer learning assessments.
Self-Assessment	Individuals have the opportunity to assess their own learning and/or compare it to that of others	Giving sample of best answer done by other students as a reference.
Active Learning	Learning should engage the learner inactive discovery and construction of new knowledge	Encourage student to find their own case study related to the knowledge of the subject taught.

### Teaching and learning tasks

Later, we distributed online questionnaires through Moodle from week one of the semester. The reason why the questionnaires were sent out at the beginning of the semester is to seek the student learning preferences in learning the subject. The results of the questionnaire analysis will guide lecturers in designing the instructional delivery that is related to the profile of students enrolled in the course (Figure 2 – Survey results of subject BITP 2223 – Software Requirement & Design).

From the output of the survey conducted, we analysed the preference student learning approach and aligned the delivery instruction to fit the context. With this information, we found out that students might have their own favouring one approach based on the situations in learning as stated by Scouller, K (1998).

Thus, in the second week of a semester, based on the results obtained we used a negotiation style to align teaching and learning tasks in the classroom. Students were given an opportunity to discuss the dateline to submit their work and were told that all assignments will be given and explained clearly based on the materials taught in the classroom. The results were received in time and the number of students attempted to submit was the same as those attended the classroom.

In designing and developing the new approach, we select and filter information for students to provide discussions and questions. This approach is to create a better interaction between students and instructor, and aligned between our teaching form and students' learning. In this case study, we gave students to vote for their preferred topics of the subject taught to learn the course. The assessment of topic preferences was given in the multiple choice question formats in Moodle. The results then were presented to students, allowing them to have a clearer picture of the next steps in learning processes occurred in the course. These were done to determine the lecturer engagement by sharing their perceptions with the students.

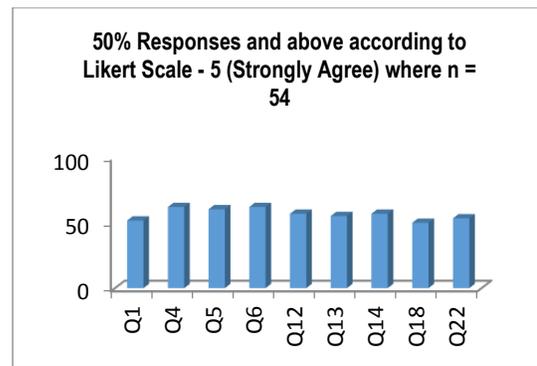


Figure 2: Summary of students' responses above 50% to questionnaires

### Findings from student learning preferences survey

The online survey yielded 54 responses from 56 participants in the computer science course subject which is BITP 2223 – Software Requirement and Design. Based on the Figure 2, we analyse from the Likert Scale -5 : Strongly Agree where **Q4, Q5 and Q6** provide more than 60% response that students will be engaged in their learning if the lecturer uses learning support tools, taught the subject topics that related with real-life problems and could guide them in details in doing the assignments. This showed that students' are more keen have real-life issues to be discussed during the lecture.

Regarding Moodle and LMSs, 57% (**Q12 & Q14**) students responded that they are engaged in learning because 1) they can easily access the learning platform at anywhere and anytime with the internet connection; 2) the language used in teaching materials should be simple and easy to understand. 55% (**Q13**) students responded that the lecturer should know how to relate the topics to the subject taught with current issues problems in the software industry. Followed by **Q22**, 53% voted that they would engage when the lecturer give detailed feedback on how to answer correctly for the assignments given. The way lecturer organized their LMSs also could engage students in the subject taught. This is from the responses given by 52% (**Q1**) of the students' learning the subject. 53% (**Q18**) students responded that they engaged in learning because LMSs allow them to receive detailed feedback from their lecturer on how to answer the assignments correctly.

### Results

#### Evidence of student engagement

It is widely acknowledged that any proposed approach in teaching and learning methodology becomes acceptable only if it is validated. In this work, we validated the proposed blended pedagogy by doing the interview. The interview session with the respondents were conducted at the end of the semester for each of the subjects taught. Since this research is still ongoing, we shared the result of research process that are fulfilled and concluded.

The response obtained from the interview conducted for student engagement in blended practice was coded using

NVIVO and categorized. The engagement factors were generated from various answer of the interview session. In summary, all the students' comments offered the blended practice with CA promoting the engagement factors including the following:

- 1) Promoting interest in learning
- 2) Personal thought
- 3) Organizing study better
- 4) Promoting answering skills
- 5) Promoting communications
- 6) Promoting better understanding
- 7) System flexibility
- 8) Promoting higher order thinking skills
- 9) Prompt feedback

The summary of the factors on students' engagement is referring to Figure 3 as below:

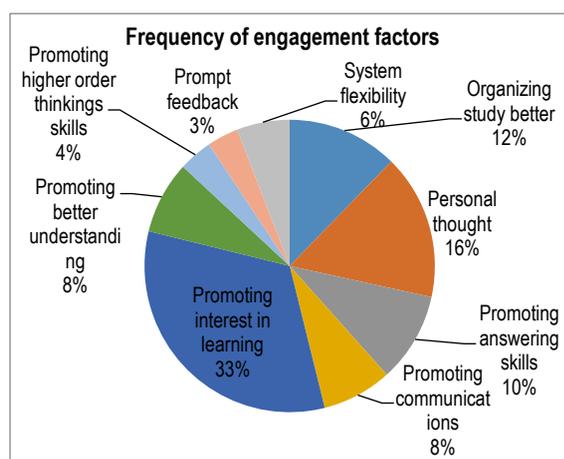


Figure 3: Factors on students' engagement using Moodle

## Discussions

From the results showed that there are positive impacts of the practice using Moodle on the student engagement in the classroom. The main reason for this could be that both Moodle with 'b-learning' and the innovative practice using CA in the instructional delivery have created an acceptable new approach amongst students' to engage in their learning. With the use the Table of Learning as unit of measurement, allow lecturers to monitor the student engagement progress progressively in learning. Furthermore, having Moodle as a medium of learning allows students to be engaged with his/her learning at anytime and anywhere.

## Acknowledgement

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11.

## VIDEO BASED ON COGNITIVE CONFLICT STRATEGIES TO ENHANCE STUDENTS' CONCEPTUAL CHANGE

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## Introduction

Technology forms a new identity in the academic world, so the teaching becomes a more flexible, innovative, creative and exciting prospect to add to a student's potential. So the use of technology in teaching and learning has shown a large impact on the education sector in Malaysia by introducing video-based learning, which can help ease the burden and constraints that exist in traditional learning.

## Misconception in Learning

For the past 40 years, many researchers have studied students' misconceptions in various topics of education. Conceptually, a misconception is a situation where students have understood certain concepts in the wrong way. In other words, students' conceptions of scientific issues are often not in line with the accepted scientific thinking, Worse than this, students' preconceptions are hard to change because their biases are not mistakes or false beliefs, but are retained as their own cognitive thought, and they defend against the truth (Driver et al.,1994).

There are two implications of misconceptions in the teaching and learning process (Ulthayakumari, 2005). First, if misconceptions are not detected and corrected immediately it can lead to an incorrect understanding of the concepts which will affect student achievement. Second, students learn the knowledge in abstract concepts. In this situation, students may only memorize it due to lack of understanding of these concepts. Memorizing concepts simply cannot afford to give students a real understanding and learning will become useless and meaningless.

## Video Based on Cognitive Conflict Strategies

Cognitive Conflict Strategies help students to sweep over their misconceptions by using information based on research about how students learn (Arons, 1990; Minstrell, 1989). For that reason, the key to success is ensuring that students are constructing or reconstructing a correct framework for their new knowledge. Lee & Kwon (2001) stated that the cognitive conflict process occurs when a student experience three activities; (i) recognizes an anomalous situation, (ii) expresses interest or anxiety about breaking up the cognitive difference, and (iii) engages in cognitive reappraisal of the situation.

A combination of Cognitive Conflict Strategies along with the worthwhile benefits of video may lead to a more meaningful student learning process. Video is one of the marvelous creations that have paved the way for progress in multimedia based learning. Currently, it is stepping up to a higher level by offering new options for users to access videos in high definition (HD) with high sound quality. Many researchers have shown that using video as instructional material results in a positive impact on the student; either in their cognitive performance (Goldman, 2004; Lu-Fang Lin, 2010), practical skills (Donkor, 2010) or motivation in learning (Hee & Johnson, 2005). These positive effects are of significant help in the case of teaching generation Y who have grown up with digital lifestyles.

The Cognitive Conflict Strategies elements can be implemented in the video to trigger the students and make them aware the differences of their current concept and new knowledge while watching the videos. These help students easy to capture the new knowledge and promote them to restructuring their conceptual framework on the topic delivered in the videos.

**Table 1. The descriptions of Elements of Cognitive Conflicts Strategies which can be embedded in a video**

No	Element of Cognitive Conflict Strategies (CCS)	Descriptions
1	Meaningful Information	The video should have high efficacy for giving clear concept.
		Capable of introducing contradictory information to induce cognitive conflict.
2	Challenges student's existing concept	Identify student's current state of knowledge.
		Focus on condition that promote a situation where the existing concept can be explicit.
3	Able to gain attention	Provide situational interest by identifying student's characteristics.
4	Motivation	Students need to feel curious to be motivated for learning activity.

5	Comfortable while using it	Provide the idea that able to make cognitive conflict lighter.
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## Learning Process on Video Embedded with Cognitive Conflict Strategies

Using video to present scientific concepts in clear and well-illustrated way makes the student feel they are in a learning process. The video will starts with providing a discrepant event to give high efficacy information for help student aware of differences between their own idea and the topic learn. Then, by asking a question can cause students to start seeking further information either to confirm their prior knowledge or to develop new concepts. It is purposely to identify the student's current state of knowledge about the topic. It is also to support conditions in which the existing idea can be made explicit.

In Cognitive Conflict Strategies, it is important to gain learners' attention by providing an example based on the student's characteristics. For that, the situation in the video and music background embedded is suitable for the user. Deeper explanation on the topic was given in an appropriate way such as the animation and shown in a step by step process. This helps to increase students' attention so that cognitive conflict easily recognized and it can influence student's conceptual understanding. Student attention is important, while they experience a conceptual change process in dealing with cognitive conflict.

An additional question should be provided to make sure students become active and feel curious about the topic. These will increase the student's motivation which promoting them to restructure their idea of the concept. Motivation is an important element for students to further explore the topic through the video as well as other references. Finally, the video will provide an answer for some of the questions that were asked beforehand in the simplest way so that students feel comfortable to digest the information given with their prior knowledge. It is to help student to bring cognitive conflict to light and conceptual change process would feel more relaxed.

## The Impact of Using Video Based on Cognitive Conflict Strategies

The video can be used as a teaching aid. The educator can choose either blended learning or flipped classroom approach in order to use the video effectively. An educational video entitled 'File Transfer Protocol' is an example of a video based on Cognitive Conflict Strategies. This video was tested with a group a student who took Information Technology Applications & Communications subject.

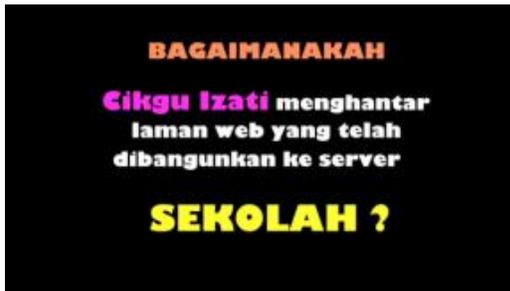


Figure 1. Screenshot of video based on Cognitive Conflict Strategies that challenges student existing concepts



Figure 2 Screenshot of the video about motivation

Result in Figure 3 showed this video help student to overcome students' misconception and it effective in enhance students' conceptual change based on pre-test and post-test.

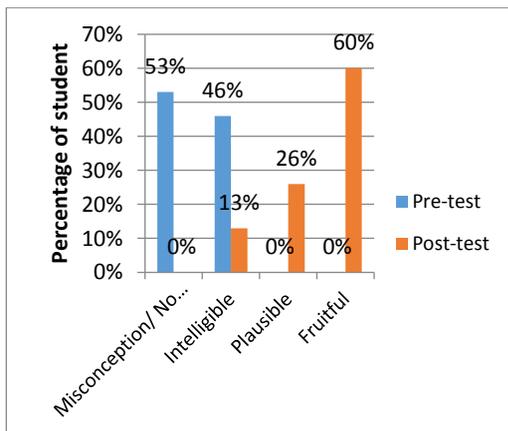


Figure 3. The level of students' conceptual change for pre-test and post-test

The video for learning embedded with elements of Cognitive Conflict Strategies can give a lot of benefits to the education field especially in the Computer Science area. One implication of the findings for teaching this subject through well-adapted the video based learning embedded with Cognitive Conflict Strategies to assist student in rearranging their concept for conceptual change process. As a result, it helped to increase the student achievement and also help in reducing students' misconceptions. Other than that, the video help educator in their teaching since the video presentation interesting and help them to deliver the concept better. With that in mind, the video embedded with Cognitive Conflict Strategies, acts as a beneficial learning tool for enhancing material delivery and enforcing meaning.

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## 12.

### IMPLEMENTATION OF EDUCATIONAL TECHNOLOGY COURSE THROUGH MOOCS BASED ON AUTHENTIC LEARNING STRATEGY

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## Background of the study

Recently, the number of people who are seeking skill enhancements or lifelong learning has increased tremendously. This is due to the high unemployment rate of young graduates because they lack in skills needed by employers and the industry. This has forced universities to find new ways to provide education in order to close the gap between the demands of employers and the preparation for work provided by universities. Recent developments in

digital technology and Internet have enabled that by delivering web-based courses via open course Massive Open Online Courses (MOOCs). MOOC is a free Web-based distance-learning program that is designed for the participation of a large number of geographically dispersed students. MOOC was launched in 2008 and the term MOOC was originated out of the open educational resources (OER) movement. MOOCs provide a new methodology and modality for teaching and learning. The newness does pose some problems for learners but also provides exciting new possibilities. MOOCs require learners to be more proactive in their education and in building their personal learning networks. Everyone can be successful in a MOOC, provided that certain steps are taken; and strategies devised before, during and after a MOOC program.

### Introduction to UTM-MOOC

The UTM-MOOC design is based on a few elements that involve student engagement. The structure begins with the course's introduction video that includes information of prior knowledge, core skills, learning outcomes/ impact/ application and closing. The duration of the introductory video must not exceed three minutes. The course outcome and synopsis must be presented at the beginning of the video including the pre-requisite. The course announcement for the start and end date shall be included in the course description page. The UTM-MOOC development process for each course must follow diagrammatic steps as shown in Figure 1.

### Authentic learning strategy through UTM-MOOC

Features of UTM-MOOC are designed to engage authentic learning that allows students to create a meaningful, useful shared outcome. There are real life tasks or simulated tasks that provide the learner with opportunities to connect directly with the real world. The

UTM-MOOCs design is based on a few features such as course promotional video, topic and subtopic, weekly learning outcomes, learning materials, learning activities, assessment and additional resources. Prospective students need to enroll in the course before they can continue to participate. Figure 2 shows the total number of enrolled students in the course.



Figure 2. UTM-MOOC: Web-Based Multimedia Development Course

UTM-MOOC via blended learning methods can be joined by anyone in the world (including local or international students). Students who are unable to participate in traditional university courses, for example, still have the opportunity to follow the same course through UTM-MOOC. Since there is no special conditions (or prerequisites) are required for UTM-MOOC at the moment, then this is an alternative learning medium that convenient and inexpensive. Students need only to register to participate in the learning activities. Figure 3 shows the designated modules and activities in UTM-MOOC Web Based Multimedia Development. Certificates of participation may be awarded after successful completion of the course and completing all assignments. With UTM-MOOC, education is no longer limited to the traditional classroom learning alone, but can be done anywhere and anytime.

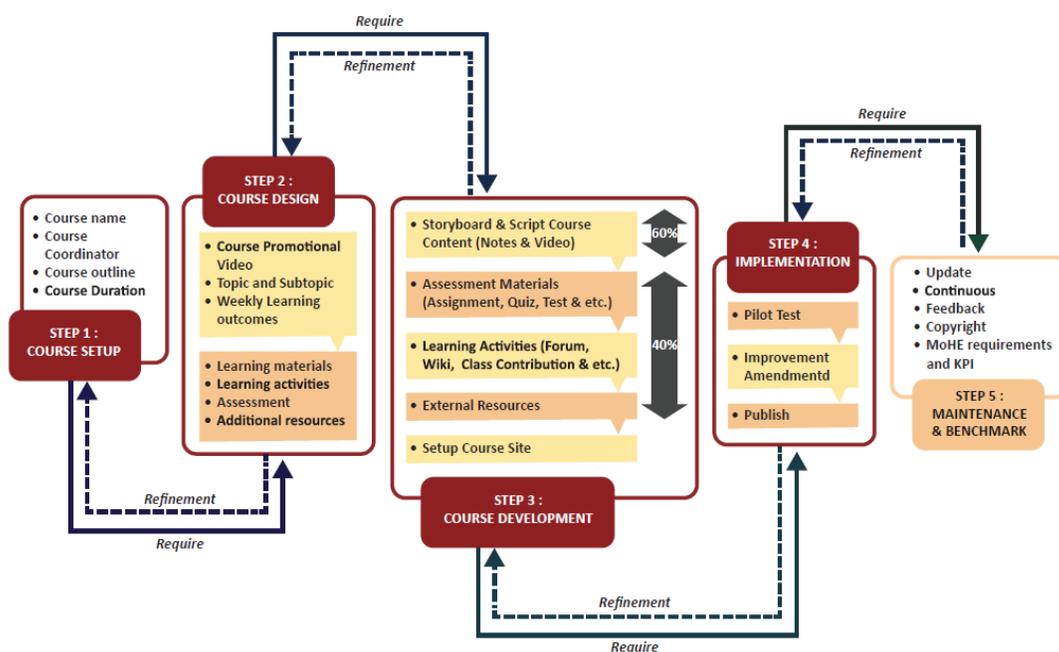


Figure 1. UTM MOOC Development process



**Figure 3. Web-Based Multimedia Development Course Features**

The benefits of UTM-MOOC based on authentic learning strategy are as follows:

- Students are more motivated and more likely to be interested in what they are learning
- Students learn to assimilate and connect knowledge that is unfamiliar.
- Students are exposed to different settings, activities, and perspectives.
- Transfer and application of theoretical knowledge in the world outside of the classroom is enhanced.
- Students have opportunities to collaborate, produce products, and to practice problem solving
- Students practice higher-order thinking skills.

### The evaluation of UTM-MOOC

A one-group pretest-posttest design was adopted to examine students' perceptions of implementing MOOCs in a blended learning strategy. Students were taught by lecturers using a blended learning approach. There were 55 students exposed to UTM MOOCs with blended learning strategy. This study employed quantitative research method utilizing cross-sectional as the method of data collection. Prior to selecting respondents for this study, it is essential that the characteristics of the groups must be similar. The respondents consisted of 55 undergraduate students from engineering faculties who were randomly selected through a quota sampling. All respondents were third year students who have registered the course Research Methodology (UPPP 3002) and are from Faculty of Chemical & Energy Engineering. The findings revealed that students with different pretest scores change differently during the course of their program. Those with lower pretest scores showed significant gains in the posttest, while students with the higher pretest scores demonstrated a significant decline in the posttest (Table 1).

Table 1. The Pretest-Posttest Mean Students Experience Difference Scores of the Groups

Groups	M	SD
Pre-test	0.82	0.77
Post-test	1.45	0.66

### Acknowledgement

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13.

### FACILITATING LANGUAGE TEACHING VIA TELEGRAM MESSAGING APPLICATION

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### Introduction

Mobile devices have become more sophisticated and have paved the way for more teaching applications, especially through social media applications such as WhatsApp, Telegram, Viber and so on. Language teachers are gradually utilizing mobile devices as a means of instruction for second language learning not only because “mobile learning is the next generation of learning” (Stockwell, 2008) but also because generation Y students are more comfortable using mobile devices in their everyday activities including learning.

There are 1.2 billion mobile application users in 2012 worldwide (Portio Research, 2013) and this trend is expected to increase to 4.4 billion in 2017. The Asia Pacific region contributed as the highest users with 30% in 2012 and the number is expected to escalate to 47% in 2017. Another interesting finding by Nielson (2012) highlighted that among the Southeast Asian countries, 77% of Malaysian consumer aged 15+ owned Internet-capable mobile phones in 2012 alone. Beside entertainment activities, communication, participation and negotiation are the central internet activities for the 12-19 years old (Pachler et al, 2010). If higher learning institutions do not leverage on this fact and continue to engage in traditional teaching and learning style, Malaysian graduates will be at a disadvantaged in this competitive world.

Mobile devices are just at our fingertips. There are several types of mobile applications available specifically for entertainment, utilities, security, games, learning and communication. This paper mainly focuses on mobile communication application, i.e. Telegram application for the purpose of language teaching and learning. Teachers commonly use the communication application for their daily communication purposes, but very few are adventurous enough to apply it for teaching and learning. Several justifications may help explain this phenomenon:

- a) Teachers' lack knowledge in applying the device for teaching purposes
- b) Teachers believe that not all students have Internet data for classroom use
- c) Teachers are unaware that most students have smartphones that are very sophisticated

### Research Problem

In this digital age, language teachers need to rethink of their pedagogy (Kukulka-Hulme, 2009) because learners are already using the new technologies to support their learning. Blackboards, audio-visual equipment and textbooks are gradually becoming irrelevant in today's classroom as students are more comfortable using mobile devices. Reinders (2010) endorsed that mobile phone technology facilitates language learning in many ways because mobile phone consists of expanding functions which most students are skillful in using. According to the Common European Framework of Reference for Languages: Learning, Teaching, Assessment (CEFR), language use is set within one of the following social life domains namely 1) personal, 2) public, 3) occupational and 4) educational domains. In many situations, more than one domain may be involved. This invention attempts to open up the interactions and language activities to domains other than public, occupational and educational because "the personal domain individualizes or personalizes actions in the other domains (CEFR: 45). This tallies Mahatanakoon's (2007) claim that individual personality characteristics play a significant role in how individuals interact with their mobile phones.

Continued development in language learning is highly dependent upon extended opportunities for linguistic interaction and collaborative learning activities. These

continued and sustained interactions can be applied via the use of the Telegram in teaching, a cloud-based mobile and desktop messaging application with a focus on security and speed. The messages in Telegram synchronize seamlessly across all electronic devices, including phones, tablets or computers (<https://telegram.org>).

## BASIS OF THE INNOVATION

### Theoretical Framework for Innovation

This invention acknowledges the behaviourist approaches to learning on one extreme, which is facilitated by the cognitive constructivism, and Piaget (1970) and social constructivism Vygotsky (1978) on the other extreme. The behaviorists believe that learning is all about the successive increase of skills and shaping learners' responses through demonstration and reinforcement of closer approximations to the intended response (Palincsar, 1998). The learning approach from this theory features the following major characteristics; repetitions, accuracy, observation, performance, stimulus response whereas the constructivist approach outlines the following qualities; acquisition, synthesis, collaboration, self-directed learning, experiential learning. The constructivists, on the contrary, believe in the importance of experience and concept application to learners' existing knowledge in order to construct meaning. Knowledge is constructed through active engagement in personal experimentation and enabled by teachers. Rather than simply memorizing and copying pre-packaged ideas, learners could construct their own understanding when they are involved in the learning process, discovering new concepts, and developing lifelong learning skills.

With reference to the activities performed via Telegram messaging application, learners are not only engaged in written and text messages, they are also allowed to use images, videos and audio recordings as means to complete their tasks.. However, the teacher still structures the scope in which the learners participate in the activities. By leaving the space for learners to engage in the learning material and the tasks, the behaviorists and the constructivist learning theories are applied as teachers allow more opportunities for the students to construct their own structures and cultural practices into repetitions and later realize their own learning habits.

### Innovation Features / Capabilities

- a) Use of mobile gadgets (tabs, e-book, smartphone)
- b) Supports the constructivist theory of learning whereby learning involves re-conceptualizing and reconstructing of meaningful knowledge based on several inputs that are derived from various resources. Telegram acknowledges students' cognitive constructivism i.e. their cognitive abilities and potentials as well as promoting social constructivism i.e. interactions between teacher-students, student-student, student-computerized learning materials, students-outsiders
- c) Promotes bi-directional learning through interactive

activities as well as teacher-student and student-student feedback

### Degree of Inventiveness

This application can be utilized in teaching various language skills namely:

- a) Vocabulary
- b) Pronunciation: word
- c) Pronunciation: Reading a sentence
- d) Pronunciation: Reading a paragraph
- e) Sentence construction practice
- f) Writing - Describing pictures, adjectives, tense
- g) Writing - Describing videos, adjectives, tense
- h) Take a photo and describe (15-20 words)
- i) Grammar exercise – Direct and indirect speech
- j) Grammar exercises – common mistakes
- k) Writing –Chain story
- l) Record a conversation
- m) Discussion

### Effectiveness of Innovation

- a) Telegram application can be used with any types of academic program, be it architecture, engineering, medical or social sciences.
- b) This invention is available for use by anyone with a smartphone with Internet data or Wi-Fi connection
- c) Low cost
- d) Photos, videos or documents uploaded in Telegram are stored in the cloud, hence it will save space and does not affect the phone memory for storage purposes
- e) Wider application, especially in terms of number of users and the various contexts of academic programs
- f) User friendly
- g) Promotes blended and flipped learning approach
- h) Encourages teacher-student communication, promotes class discussions and supports self-directed mobile application learning
- i) Immediate access and use
- j) Applicable before the class begins, during the class hours and after the class meetings
- k) Advocates distance teaching and learning approach
- l) An alternative platform for forum or discussion

### Contribution of Innovation

Generally, this innovation would be useful for the academics who teach all types of university courses. It can be used for self-directed learning and out-of-class activities, not restricted to just classroom activities. The use of Telegram conversation ensures effective knowledge and information transfer as this platform exploits the media-rich and image-capture capabilities of smartphones between its users. It enhances learners' learning as they saw that the learning

was fun and worthwhile besides promoting critical thinking skills, creativity & innovation as well as generic skills of Malaysian university students. Specifically, the contributions are:

- a) Teachers no longer have to conduct 14 weeks of face-to-face classroom teaching. Telegram allows structured virtual learning at the students' own pace.
- b) Telegram promotes fun learning whereby it can be used for teaching many types of language skills such as reading, pronunciation and writing, to name a few.
- c) Telegram allows the teachers to be creative and innovative in the classroom by applying multiple teaching approaches.
- d) With this invention, a teacher will be able to guide the students should there be situations where class has to be cancelled or the students are unable to attend the classroom

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14.

## DESIGNING TASK COMPLEXITY IN PROMOTING LANGUAGE PERFORMANCE

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### a. Problems in higher education that calls for innovation in learning and teaching

The concern over low English language proficiency and performance among Malaysian learners has been explored extensively. Among the reasons that have been highlighted for this problem are the emphasize on the teaching of grammar in comparison to the communicative use of the language, exam-oriented syllabus, lacks of English language literacy and rote learning among language learners. Moreover, Malaysian classroom teaching is greatly characterized by teacher-centered approaches in which chalk-and-talk dominates the learning and teaching context. Some English language teachers focus more on the drilling using past-year examination questions and exercise books. English language is seen as a subject, and the teaching and learning process are dominated by concentrating on language mechanics without making connections on how the language could be used in the real world. This situation calls for the innovation in English language teaching which is more practical and applies student-centered approaches. This paper therefore intends to examine the effects of task complexity on language performance using task-based instruction. Based on the empirical evidence of this study, teachers could gain more understanding of how tasks could be manipulated in learning English as a Second Language (ESL) via computer-mediated communication (CMC) to enhance language performance.

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

Over the past decades, task-based language learning and teaching (TBLT) has received extensive attention from second language (SLA) researchers, educational practitioners, language testers and curriculum developers. TBLT has emerged since 1980s and has provided a basis for second and foreign language pedagogy (Norris, Bygate & Van den Branden, 2009). Previous studies have shown that the application of TBLT has expanded and modified according to the needs of language learners. In language teaching, task-based instruction plays an important role and has potential in pedagogical decision making, language assessment, and syllabus design (Norris, 2015). In TBLT, learners engage in meaningful and authentic use of language through task and the outcome is measured through tasks completion. TBLT elicits various cognitive operations that people need to perform in order to function in real life. It allows meaningful language use as a primary mechanism and the final outcomes of an educational activity (Ellis, 2003; Van den Branden, Bygate & Norris, 2009).

According to Li, Ellis and Zhu (2016), in a condition where teachers are bound to apply the structural syllabus, it is essential for teachers to design tasks that construct contexts for the communicative use of specific linguistic features. In other words, TBLT offers a great deal of opportunities in various means for teachers and learners in promoting the acquisition and learning of language.

One of the major goals in TBLT research is to identify the criteria for designing tasks. Scholars have defined tasks in various ways. For example, Ellis (2003) defined a task as a workplan in which the main emphasis is on meaning while Skehan (1998) defined tasks from a cognitive perspective. According to Skehan, a task is: (a) an activity in which meaning is primary, (b) there is some communication problem to solve, (c) there is some sort of relationship to compare real-world activities, (d) task completion has some priority, and (e) the assessment of the task is in terms of outcome (p. 95). Meanwhile, Samuda and Bygate (2008) added a holistic dimension to the definition of a task in TBLT based on their research with tasks in general education as well as in language learning. Their definition of a task consists of five elements; a task (a) is a holistic pedagogical activity, (b) involves language use, (c) has a pragmatic, non-linguistic outcome, (d) is used in such a way as to create some challenge aimed at language development, and (e) is aimed at promoting language learning through process or product or both (p. 69). In summary, tasks can be defined as a meaning-focused language learning activity which could lead to a specific outcome at its completion. Tasks are means by which learners acquire new knowledge and learners can activate their existing knowledge of the language simultaneously. Hence, in teaching and learning environment, more attention should be devoted by language practitioners in designing tasks because there are a number of task characteristics deemed essential in designing a task. First, instructors have to ensure that meaning is the primary focus of the teaching and learning the target language. Next, the task should be related to real-world activities for learners to perform and complete. It means that the task performed reflects the way language is used in the real world. And finally, the assessment of the task is measured in terms of its specific outcomes. Hence, designing a task requires considerable amount of attention from language teachers and practitioners. This is to ensure that the learning objectives are attained at the end of the task completion.

A large body of research within the SLA discipline has provided empirical evidences of how task-based instruction could be employed to enhance language teaching and learning (e.g., Bygate, Skehan & Swain, 2001; Ellis, 2003; Samuda & Bygate, 2008). In addition, studies have shown that language performance could be promoted when the tasks are designed as a certain degree of complexity, or also known as task complexity. Robinson (2001, 2009, 2015) identified various elements of task complexity which he argues, should be the sole basis for tasks sequencing in task-based syllabus design. According to Robinson (2009), task complexity is represented as dimensions or continuums. Task complexity is a series of options which can be manipulated progressively to increase or decrease the cognitive demand of pedagogic tasks. It deals with the intrinsic, cognitive complexity of task features. Robinson in

his Triadic Componential Framework (2001, 2003, 2005, 2007a, 2007b) lists two main factors influencing the task complexity which is resource-directing (i.e. here-and-now, the number of elements, reasoning demand and perspective taking) and resource-dispersing (i.e. planning time, prior knowledge, task structure and independence of steps) dimensions. The resource-directing dimension creates increased conceptual demands. On the other hand, the resource-dispersing dimension creates an increase in procedural demands on learners' attentional and memory resources. In general, task complexity is the inherent characteristics of a task that may affect the learner cognitive ability in performing the task. As a result, the quality and quantity of language production and language performance may increase or decrease. Although there are studies on task complexity, there is little empirical evidence on how tasks can be manipulated on different dimensions of task complexity (resource-directing and resource-dispersing dimensions) and the extent to which task complexity influence language performance. As such, the current study is interested to explore how task complexity affects learners' language performance.

### c. Using TBLT improves the higher education system

From the pedagogical aspect, the findings of this study offer further understandings into the use of pedagogic tasks within TBLT environment. The results demonstrated that a certain degree of task complexity may lead to a higher language performance. Therefore, when teachers intend to concentrate on learners producing more linguistic features in TBLT environment, teachers may consider designing tasks by manipulating the complexity of the tasks.

In Malaysia, English language is taught and learnt in the context of ESL. Malaysian learners have learnt English language since their primary schools and for some students, they have been exposed to the language since they were a child. However, English language skill and proficiency of Malaysian learners, particularly at tertiary institutions are still questionable. Some learners are facing difficulties to write and speak fluently in English language, although they have gained exposure and learnt the language in their formal education since young. In due course, there is a need to examine and analyse the potential of TBLT to be part of the English language curriculum, particularly at tertiary institutions so that students would have greater opportunity to practice and learn the language in certain context. Consequently, the innovation of teaching and learning using task-based at tertiary institutions is hoped to stimulate and support Malaysian learners into reaching their language learning goals.

### d. Implementation stage

Task-based instruction has been implemented and tested in one of the public technical university in Malaysia, Universiti Malaysia Pahang particularly in the teaching and learning of the English language. For the purpose of the study reported, eighty-eight engineering and technical undergraduate students were selected as participants. The participants enrolled in one of the language and communication courses which is a compulsory course for all students at the university. The participants were divided into one of the four

groups and instructed to write an essay for sixty minutes. The topic of the writing task was on miscommunication issues at the workplace. The task complexity in this study was manipulated using two variables; causal reasoning demand and task structure as described in Cognition Hypothesis (2001, 2003, 2005, 2007a, 2007b).

The written data of each participant were measured in terms of the complexity of language production. The data were coded and analysed to examine the trend of the language produced by each group. Data analysis involved several measures which are T-unit complexity ratio (clauses per T-unit), dependent clause ratio (dependent clauses per clause), dependent clause per T-unit, sentence complexity ratio (clauses per sentence), the percentage of sophisticated words, Guiraud Index and word type ratio.

Findings show that learners produced more complex language in the condition in which task structure was not provided. In other words, the language production produced by the groups which received task structure was less complex than those produced by the groups which were not given the task structure. In this sense, the task structure may not direct learners to produce the more complex language production. In addition, the results also demonstrated that manipulating the variables: causal reasoning demand and task structure had a significant effect on the complexity of language production.

### e. Impact of the practice/ innovation in improving the higher education system

It has been a few years since the TBLT approach is implemented in the English language classes in which the study took place. Throughout the durations, several changes have been made in designing tasks appropriate to the need of the students' learning. For instance, the differences in task complexity as defined in Robinson's Triadic Componential Framework described earlier may work in certain part of language learning but not in others. Having this knowledge enables the language educators to adapt the tasks accordingly as to suit learning outcomes specified.

The majority of the students are engineering and technical tertiary students, and hence, their English language learning style is geared to the hands-on and communicative approach rather than lecture type and grammatical approach. The students' participations were higher when they were required to engage in the task completion. Their ability to complete the task is a success by itself.

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15.

### **E-PRASMO: YOUR DIGITISED SUPERVISION SOLUTION**

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#### **Introduction**

Teaching practicum is an idiosyncrasy of an education-based degree program. It is a way to uphold the quality of teachers – may it be for pre-service or in-service teachers. In a traditional manner, teaching practicum involves the supervisors to visit schools where the student-teacher under one’s supervision is located. The supervisor is physically in class carrying out observation of the supervised student-teacher (supervisee). Then, both supervisor and supervisee have a discussion on the strengths, weaknesses, points of

interest and ways to improve the lesson. It is a routine for a supervisor to be physically present at the location once or twice during the duration of the teaching practicum. This routine has caused a lot of money and taken up considerable time. Thus, it is the purpose of this paper to introduce e-PRASMO, a solution to the high consumption of money and time involved in doing supervision.

#### **e-PRASMO**

e-PRASMO stands for the electronic practicum assessment model. It is an online platform that contains a standard operational procedure to carry out the teaching practicum for the duration of 8 weeks (4 credit hours). The platform provides an e-workshop, an e-guide book, e-lesson plans, assessment forms and criteria, tips for video recording, steps for uploading on YouTube and samples of good lessons. Besides that, there is also a venue for the supervisors to give feedback and supervisees to ask questions. This is in line with the literature on best practices for practicum where support and feedback are important elements (Calderhead & Shorrocks, 1997; Marzano et al., 2011). These are done as the supervisee discusses the plans for his/her lesson with the supervisor via an online forum. Then, after uploading the recording of the first lesson, the supervisor gives feedback using the same online forum. Next, he/she will record the second lesson taking into considerations the feedback made earlier.

Besides that, the innovation of e-PRASMO is underpinned by the adaptation of the Discrimination Model of Supervision by Bernard. Bernard’s (Bernard, 1979; Bernard & Goodyear, 2004, 2014) supervision model puts forth a 3x3 celled matrix highlighting two aspects – the functions of the supervisors and the skills to be nurtured in the supervisees. Although the model is for counselors, the two notions of supervisor’s functions and skills that supervisees should gain through supervision, are in line with important aspects of the nature of the teaching profession. In other words, the supervisors play their roles by giving support and feedback to the supervisees in order to ensure that the latter are equipped with the pedagogical and other related skills to be effective teachers. Furthermore, the term ‘discrimination’ in the name of the model connotes that each supervisee is addressed individually by the supervisor (Bernard, 1979). This is done by the supervisors praising the supervisees’ strengths and finding ways to alleviate their weaknesses. Mapping all these onto e-PRASMO, it can be seen that the standard operating procedure for teaching practicum is uploaded in e-PRASMO and it provides support needed for student-teachers as they refer to it in conducting the teaching practicum. Meanwhile, supervisors play the roles of a teacher and a consultant in giving support and feedback to individual student via an online forum where the supervisees consult the supervisors on any aspect in their teaching practicum and also when supervisors give constructive comments on the supervisees’ recorded lessons. Thus, the function of e-PRASMO reflects the main aspects propounded by the Discrimination Model of Supervision by Bernard.

e-PRASMO has been utilised fully for two semesters for the in-service teachers undergoing their first degree program at the Faculty of Major Language Studies, Universiti Sains Islam Malaysia (USIM).

### Properties of e-PRASMO

e-PRASMO is designed to create a cost-effective, stress-free and flexible assessment scheme for the practicum; benefitting management, supervisors and supervisees. This method of practicum process and assessment is deemed essential because of its cost-saving benefits as well as reflecting the traditional practicum by including avenue for feedback and discussion or reflexivity. The faculty saves on money and time spent on the site visits. e-PRASMO enables saving up to more than 50% of the cost for the running of teaching practicum in the traditional mode. It is also stressed-free as supervisees are able to perform their teaching in a low-anxiety environment and supervisors are able to evaluate their supervisees' performance at any time that is conducive for grading purposes, ensuring both accuracy and professionalism in their grading.

It is also flexible as supervisees are able to manage their video selections and supervisors are able to revisit their reviews. Furthermore, the accessibility of information on the standard operating procedure of the teaching practicum is just a click away. In short, this online platform is definitely cost-effective, stress-free and flexible as it addresses the current needs of being technologically enhanced and the practicality in the assessment of teaching practicum in the 21st century. To add, the easy accessibility of information, the inclusion of reflexivity and the enhancement in technology among the users are also properties of e-PRASMO. Hence, it is best illustrated as seen in Figure 1.



Figure 1: The Properties of e-PRASMO

### Electronic/Online Platform

In terms of the electronic/online platform in managing e-PRASMO, although there are many platforms in the market, it leans towards a 'repository' portal where content related to the practicum is displayed after it is uploaded to the system called GOALS (Global Open Access Learning System) developed by USIM. Thus, a key personnel from GOALS has been approached and consulted in the quest of optimising this electronic/online platform. GOALS provides collective construction and interactive tools for educational purposes. The content could be accessed and downloaded by the supervisees. The GOALS' interface allows the users to view all the links to the contents on one page. Figure 2 captures the welcoming notes and beginning of the first week of practicum.

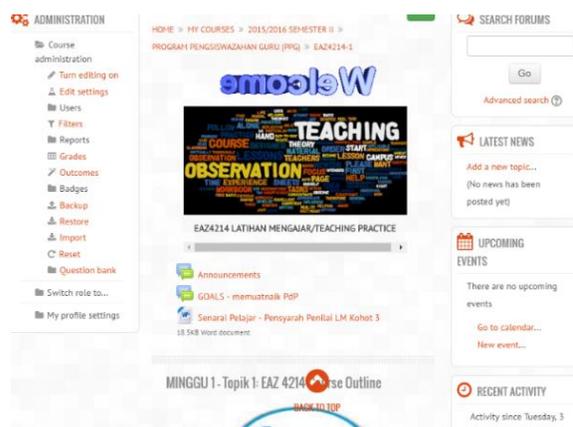


Figure 2: GOALS' Interface

On the GOALS' interface, there are links to among others, the e-guidebook, sample of good lesson plans, and tips on video recording. As for the assessment, there are buttons for submission of the video recordings and lesson plans. On the part of the supervisors/assessors, they can give feedback via the online forum which is in the asynchronous mode. This allows supervisees to make inquiries and further discuss arising matters related to the 8-week practicum.

To encapsulate, supervisors play different roles throughout the teaching practicum session and 'support and feedback' is delivered via the content, consultation and feedback sessions on the practicum requirements, assessments, references and other guides. Website links, glossaries, PowerPoint slides, texts are provided for students to access more resources such as videos and reading articles. In short, e-PRASMO promotes an effective way of supervising as it is cost-effective and practical; it embraces the cutting-edge technology, yet simultaneously upholds the two main tenets in teaching practicum – support and feedback.

### The Research

e-PRASMO has undergone continuous quality improvement through the research conducted. In the first phase after one semester of its utilisation, an online survey was conducted to get feedback from both the supervisors and supervisees. The first phase e-PRASMO was an online platform where there was just access to information and some links to samples of lessons and lesson plans. Furthermore,

supervisees were just required to submit two recorded lessons at the end of week eight of the practicum. The two main findings of the survey administered on both parties were firstly, e-PRASMO did not provide much information to assist their (supervisees) practicum, and secondly, it did not provide any avenue for interaction (both supervisors and supervisees). Thus, considering these findings and the literature on best practices for practicum and to uphold the notions propounded in the Discrimination Model of Supervision by Bernard, a new feature – reflexivity (refer to Figure 1), has been added in for the second phase e-PRASMO besides including more guidance and examples for the supervisees to excel in their teaching practicum.

### The Future for e-PRASMO

Being an electronic/online platform that manages supervision in an easy and cost-effective manner, e-PRASMO has the potential of being commercialised. Over time, e-PRASMO could be extended for use in Industrial Training, Industrial Attachment, Work Experience for Learning, Industry Engaged Learning, Programme Internship and any kind of practicum aspect in a learning programme that calls for supervision. Supervision is the guidance and support students'/supervisees' needs while on placement to ensure the learning experience is optimised and that they have the overall most positive experience possible. The supervisor fulfills various roles including teacher, counsellor, mediator and consultant. Thus, it is important to have a medium like e-PRASMO to support the running of practicum.

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16.

### AN ENGAGEMENT MODEL FOR CO-CURRICULAR SERVICE LEARNING IN PROMOTING SOCIAL AND EMOTIONAL SKILLS

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### Abstract

Academic service learning (ASL) is aimed to balance formal instructions applied in the classrooms with the opportunities to serve in the community. Co-curricular service learning (CSL) differs from ASL in that it is not connected to a specific academic course. Studies have shown that social and emotional skills are best taught when infused through student's experience. Therefore, CSL is a good platform for providing this experience. We present an engagement model for conducting CSL programs involving UTM students and local communities. The model has been applied successfully in organizing robotic-based programming competitions for the past five years. The engagement model considered the stakeholders' expectations and guides the process in providing engaging service learning in the local communities, such that the UTM students can learn the generic and social emotional skills effectively. The findings of this study suggest that the CSL has an impact on the cultivation of social emotional skills among the university students.

**Keywords:** Co-curricular Service Learning; Experience; Undergraduate Students; engagement model; generic skill; social emotional skill

### Introduction

Similarly with the Academic service learning (ASL) teaching approach, co-curricular service learning (CSL) allows students to participate in serving societies through local communities but CSL isn't aiming to enhance the academic learning of the students.

In many institutions, ASL imposes certain credit bearing to students who join the program, giving those students advantages in not only developing their soft skills, but also earning marks for their efforts. Furthermore, in some courses, service learning is offered as a part of co-curricular activities. Generally ASL and CSL are different with other common student community-based experiences. Report [1] distinguishes the characteristics of some common student community-based experiences as shown in Table 1.

Referring to the literature on ASL and CSL, the works on CSL are relatively unexplored as compared with the ASL. A community engagement model which can guide CSL programs and enable us to measure the skills gained by university students in organizing CSL programs is presented here. The model has been used to execute CSL programs since 2012, which involved 53 university students from Faculty of Computing, Faculty of Electrical Engineering and Faculty of Mechanical Engineering who participated as facilitators in teaching robotic programming module to school/college students.

Table 1: Service learning with other common student community-based experiences [1]

Community-Based Experiences	Community Service	Enhanced Academic Learning	Purposeful Civic Learning
Volunteering or	Yes	No	No

Community Service			
Co-Curricular Service Learning	Yes	No	Yes
Academic Service Learning	Yes	Yes	Yes
Internship	Yes	Yes	No

### The need of an engagement model for service learning

A mix implementation of generic and social emotional learning into service learning proves the enhancement of student's social and emotional development [2]. However, the lack of engagement from important stakeholders such as authority, community and funder always restricts the success of service learning implementation.

In this sense, works by Chung and McBride in [3] suggested that the involvement of these stakeholders together with a general student's development framework would accelerate the growth of generic and social emotional learning through service learning. Again, the absence of well-defined engagement model between universities/colleges and stakeholders would offer the drawbacks of mutual understandings among students and local communities, conflicting used of resources and shortcomings of well-trained facilitators.

### A Community Engagement Model

Figure 1 shows the proposed community engagement model which consists of three main elements: (1) the stakeholders involved, (2) the teaching and Learning strategy, and (3) the learning outcomes and assessment of generic and social emotional skills. The involved stakeholders are University Teknologi Malaysia (UTM), the State Education Department (JPN), the East-South Johor Rural Area Development Community (KEJORA), schools and colleges, matriculation departments, and local community authorities. Research funding from UTM were used to produce the innovative teaching and learning

materials (includes modules and mobile robot), and to train the UTM students to prepare them in CSL programs.

The UTM staffs are responsible to: i) train the UTM students; ii) prepare the contents of CSL programs; and iii) monitor the CSL programs and assessing students. KEJORA provided funding to schools, while matriculation department, schools and state education department provided support for students to participate in the designated programs. The local community authorities provide other supports to run the service programs smoothly.

The teaching and learning strategy in the model adopted the Kolb experiential learning theory with four stages of learning cycle involving concrete experiences, reflection, abstract conceptualization and active implementation [4]. Together with other elements, they support constructive alignment in the engagement model.

After each CSL program, postmortem sessions with the UTM's students were conducted to discuss and encourage students to process and relate what they learnt from the program. The reflection of student experience involves the measurement of the student improvements in terms of generic skills and social emotional skills.

Three important features of the model which lead to the development of the skills are:

- (1) Close collaboration among stakeholders. For example, for CSL programs targeting rural school students, KEJORA and UTM work closely under the Centre for Advancement in Rural Education Informatics (iCARE) as reported in [5].
- (2) The triad of teaching, research, and service activities. This community-based research enables the utilization of research funding and community funding to support CSL programs. The benefit of this strategy is an enhancement of scholarly teaching, advancement of research and opportunity of community engagement.
- (3) UTM students volunteer to participate. The recruitment strategy of the UTM students in the CSL programs is based on student interest through volunteering.

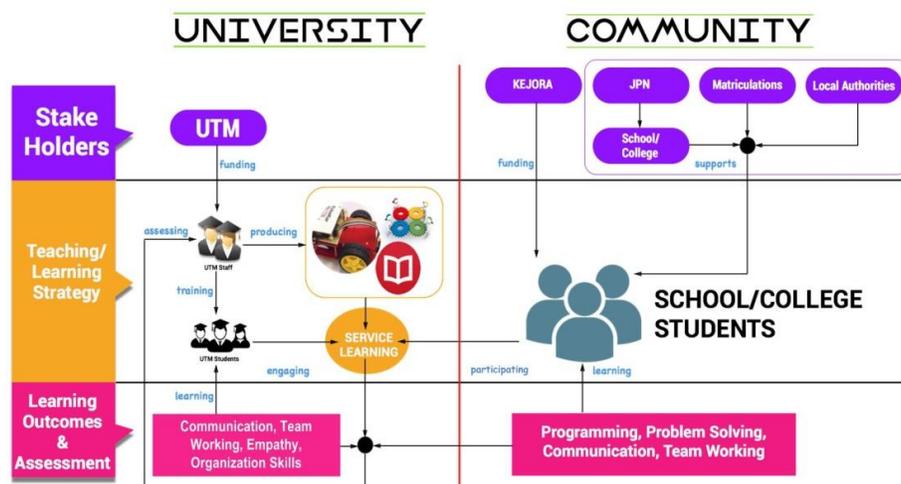


Figure 1: The Community engagement model

## Result Analysis

All 53 undergraduates involved as volunteers in the CSL programs served as the sample of this study. The students involved in a series of 15 CSL programs which were organized from years 2012 – 2016. During the CSL programs, the UTM students are responsible to organize and facilitate the teaching and learning activities. Having started in 2012 with 87 schools' students as participants, the total participants in all the 15 CSL programs have grown to nearly 700 participants in June 2016

The survey questionnaire was adapted from the sub-skills specified in [6] for the labor market social-emotional skills. Refinements were done with the questions to suit the CSL programs which focused on social-emotional skills excluding the generic skills that already defined in UTM graduate attributes [7]. The questionnaire was distributed to 53 undergraduate students and was completed by 33 students that is a 61% response rate.

Figure 2 shows the six sub-skills under the social-emotional skill surveyed. The 'strongly agree' and 'agree' responses are categorized as 'positive' response. Figure 2 shows that more than 85% gave positive response to all the sub-skills surveyed. These three social-emotional sub-skills: stress resistance; empathy and pro-social; and internal locus of control, scored above 90% positive response.

Figure 3 presents the school students' perceptions on the role the university students in mentoring the school students' team during the community programs with 136 samples of school students. The result shows that 93% of the respondents were positive, in which 68% responded strongly agree, while 25% agree. Only 1% out of the respondents did not agree whilst the other 6% were undecided. The results in Figure 2 and Figure 3 indirectly indicated that the CSL programs have successfully achieved the objectives and the university students had engaged well with good social-emotional skills with the community. Other perceptions survey results have been reported elsewhere [5], [8].

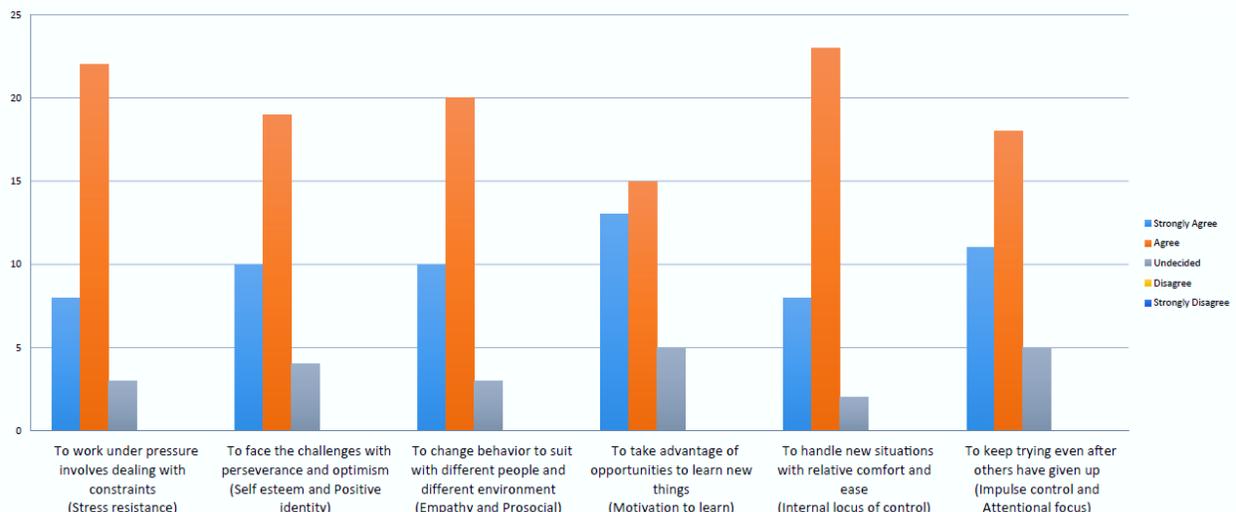


Figure 2: Social-emotional skills surveyed (Y-axis denotes number of respondents)

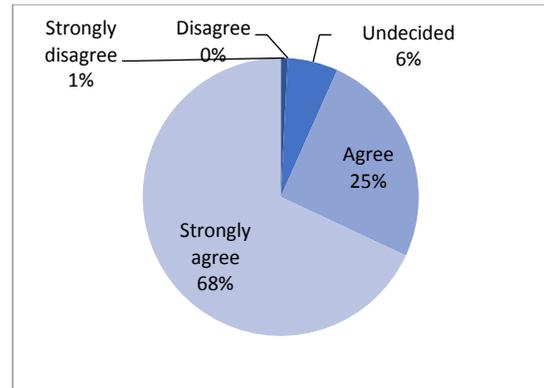


Figure 3: The school students' perceptions on the role the university students

## Conclusion

An engagement model for conducting CSL programs involving UTM students and local communities, particularly with schools and colleges in southern areas of Malaysia was proposed. The model considered the all stakeholders involved, the teaching and learning strategy and the students learning outcomes and assessment, and adopted the Kolb experiential learning theory. This model guides the process in providing engaging service learning to the local communities. The model has been applied successfully in organizing robotic-based programming competitions throughout 2012 – 2016 involving students from Faculty of Computing, Faculty of Electrical Engineering and Faculty of Mechanical Engineering.

## Acknowledgement

The authors would like to thank Universiti Teknologi Malaysia (UTM) and East-South Johor Rural Area Development Community (KEJORA) for their financial support in making this project possible. Our appreciations go to schools, matriculations, Johor State Education Department (JPN) and the community who supported our programs.

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17.

### **ENGAGING, INSPIRING AND MOTIVATING 1<sup>ST</sup> YEAR CHEMICAL ENGINEERING STUDENTS AT UNIVERSITI TEKNOLOGI PETRONAS VIA CHEMICAL ENGINEERING BOOT CAMP**

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## Introduction

Malaysia Higher Education Blueprint (2015-2025) has put a great emphasis to produce holistic, balance and entrepreneurial graduates, as stated in Shift 1 of the blueprint. One of the strategies for this shift is to strike a balance between the knowledge (*ilmu*) and attitude or values (*akhlaq*) [1]. This is a noble intention that should be translated into reality, to ensure the graduates that the country produced nowadays, do not only achieve excellent grades academically, but also developing some good values in them.

It is realized that, to instill good values among the students, the first approach that must be implemented is the engagement between the students and the lecturers at a very early stage of commencing their studies. This is important as the motivation of the students need to be nurtured from the early stage of study, as recommended by Quigley (1998) [2]. By developing a good bond between the faculty members and the students, a mutual trust can be built and a sense of respect can be instilled, thus instilling the right values that need to be cascaded to the students. Based on a study made by Christophel and Gorham (1995) [3], the researchers found that among young adults in college, motivation is perceived by students as a personally-owned state, but demotivation arrives from the teacher-owned problem. By engaging with the students at an early stage, this hopefully can sustain the interest and motivation of the students longer, by having an early interaction with the motivating and inspiring faculty members.

Universiti Teknologi PETRONAS runs three semesters in a year, with every student will only enroll in two semesters back to back and they will have a long 4-months break before entering a new study year. The total duration of study in chemical engineering program is four years. For the past five years since the three semester program was introduced, the chemical engineering department faculty members in Universiti Teknologi PETRONAS received some feedbacks that some of our faculty members were even not being recognized by the students, though they had already reached their final year. This is because, some of the faculty members may not be teaching the cohort of these students and may not be involved as the coordinator or supervisor in their final year project and plant design project throughout the duration of 4 years. Since UTP practiced on and off teaching semester for the faculty members, this may not allow any significant interaction to happen between the students and the faculty members. The students also felt that they had only chance to realize what is chemical engineering all about, only when they entered their penultimate year. Many of the students did not have a clear picture what is actually chemical engineering, only after few semesters they were on this program, hence ruining their motivation as they did not get the connection between one subject to another. This innovation is aimed to make an early engagement with the students, inspire them to perform extraordinarily and motivate them to endure for another four years to come.

## Innovation

One of the innovations that has been implemented since the year of 2015 at the chemical engineering department is a chemical engineering boot camp for first year first semester students. The boot camp lasts for two days and two nights during the weekend, and takes place in the first or second week of the semester. The activities are divided into lectures, workshops and outdoor activities, organized by the faculty members themselves, and assisted with selecting facilitators among the third or final year chemical engineering students. Prior to that, the students are required to fill up two surveys, which are personality study, according to Personality Plus tool, developed by Florence Littaur [4] and Index of Learning Styles, developed by Richard Felder and Barbara Solomon [5]. The findings will be shared with the students, so they will know their learning styles and their personality, which will be useful to assist them throughout the learning stages.

On the first day of the boot camp session, the students were greeted by the head of the department, and one of the faculty members (usually the deputy head of department), will give an overview of the chemical engineering curriculum. The majority of the faculty members attended this session and they took turn to introduce themselves. Later at the evening, the students attended the icebreaking and grouping session, which was conducted by the appointed faculty members. Heterogeneous grouping according to cooperative learning strategy was implemented to allow the students mingle with other than their own social friends [6].

On the second day, there were plenty of sharing sessions, for example, some tips given by the seniors, followed by the introduction of few chemical engineering clubs, including a briefing for the students to undergo an exchange program and internship overseas. On the same day, the students attended a workshop on study management, which included some hands on activities such as time management, according to Stephen R Covey model [7], note taking and study in group techniques. By late evening, the students will

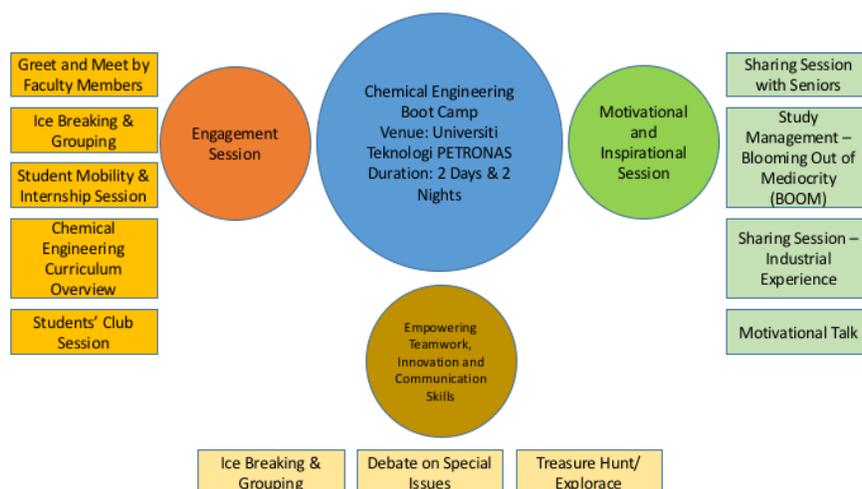
be doing some creative activities, including outdoor group activities such as treasure hunting or 'explorace'. On the last day of this boot camp, the students will be given chance to express their opinions and improving their presentation skills. Among the activities conducted are group debate on a certain topic that is close to them, but required additional research skills. The framework of this boot camp can be represented as shown in Figure 1.

## Output

A survey was conducted to obtain the feedbacks from the students who attended the boot camp, as to identify any area of improvement that could be made for our future boot camp. There were 128 students responded to the survey, which was given at the end of the boot camp. The questions in the survey are shared in Table 1, together with the mean score for each survey question.

**Table 1. Survey Questions to the Boot Camp Participants with Average Mean Score**

Questions	Mean
Objective of this course is (1 not clear, 5 - clear)	3.5
:Duration of the whole course (1 - Too Short/ Too Long 5- Just Nice)	4.3
Content of the course is (1- not useful, 5- very useful)	4.2
Content of the course is (1 - too complicated / easy, 5 – just nice)	4.3
This course introduces new areas to me (1- no new area, 5- a lot of new areas)	4.5
Knowledge acquired in this course is (1- not useful, 5 - useful)	4.4
I can immediately apply the knowledge/ method in completing my task/ research / studies (1 - need adaptation, 5- immediately)	4.4
Course facilitator is (1- lack of preparation, 5 - helpful)	4
Course facilitator presentation style is (1- difficult to understand, 5- easy to understand)	4.4



**Figure 1: Chemical Engineering Bootcamp Framework**

Based on Table 1, it can be clearly shown that the area of improvement that can be made is with regards to the objective of the boot camp, which may need to be re-emphasized to the students. However, for all other questions, it has shown that the majority of the students had given positive feedback since the first establishment of this chemical engineering boot camp in semester January 2015. Though the objectives may not be that clear to the students, many students realized that the boot camp exposed them to many new areas to be explored, and allow them to apply the knowledge immediately. In addition, when they were asked about which type of activities made them enjoyed the most, Figure 2 here illustrates their feedbacks with respect to the kind of activities that made them engaged and enjoyed this boot camp activity. We gathered all the relevant keywords and compiled them together to reflect which activities were enjoyed the most by these students.

From Figure 2, many students enjoyed the outdoor activities followed by the debate and the study management workshop. Additionally, they also enjoyed other activities, which involved their participations actively, rather than a one-way communication talk. It was found that this particular boot camp addressed the needs of all kinds of personalities and learning styles. None of the students had complained negatively on overall boot camp, except suggestions as part of the improvement. The students' motivation was boosted, as they felt safer to get involved in the future, which in return created a good community centered for the learners, fulfilling one of the lenses according to How People Learn's framework [8].



**Figure 2: List of Activities Enjoyed by the Students as Given Subjectively**

In short, the chemical engineering boot camp was found to be beneficial for the students where a better engagement between the faculty members and the students was fostered. This is followed by an increasing motivation among the students to learn chemical engineering and the series of talks had inspired the students perform extraordinarily.

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18.

## COMMUNITY TRANSFORMATION THROUGH SOCIAL ENTREPRENEURSHIP: A COMMUNITY-BASED LEARNING FOR SUSTAINABILITY

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### Introduction

Traditionally the field of entrepreneurship has been confined to the venturing development domain and commercial relations. Nowadays there are drives in entrepreneurship practice and research of expanding for wider spectrum of entrepreneurship, regaining it as communal phenomena and as potential force for social change through social entrepreneurship community-based learning (Steyaert, and Katz 2004; Johannisson, and Lundqvist 2009). The departure point is the innovative and positive efforts of a wide range of government agencies in community, also involving supportive perspectives like individual networks and communities. The broadening of social entrepreneurship perspectives in recent years towards community transformation through community-based learning perspectives open up potentials of constructing and reinventing community relations and communal associations through social entrepreneurial initiatives for effective rural communities' transformation.

In the Universiti Teknologi Malaysia (UTM) context, "social entrepreneurship community based learning" has recently emerged as a particular invention of an expanded and communally concerned understanding of entrepreneurship as innovative agency in community transformation and

social change. On the broad scale social entrepreneurship community based learning can be seen as breed of rural community transformation. This is in line with mission and vision of the Transformation of Rural Development of the Government through the Ministry of Rural and Regional Development Malaysia (MRRD) is the Entrepreneurship Development. It is constituted a strategic policy planning ministry as Philosophy and the New Strategy for Rural Development, the Rural Development Master Plan and MRRD Strategic Plan 2012 -2016. These efforts are supported by the establishment of the Rural Transformation Center (RTC) Program under the National Blue Ocean Strategy that until now led the creation of eight (8) RTC nationwide. This amount will be increased from time to time. The center is a one-stop service for the residents of nearby village communities in the implementation of activity-oriented high added value.

The Ministry of Higher Education Malaysia under its Education Strategic Plan 2020, intends to mobilize efforts towards the formation of human capital with first class mentality in overcoming the challenges of economic development based on knowledge and innovation. One of the attributes that they wanted to accomplish by UTM is creating the “entrepreneurial graduate”. Further, that the ministry also has signified the Blue Print for the Higher Education Year 2015-2025, where one of the 10 Shift is enhancing student learning to experience by expanding collaboration in the design and delivery of programs; increasing the use of experiential and service learning in order to develop 21st century skills, and leveraging technology-enabled courses. Thus, university students as part of an agent of change in the community should be able to learn to recognize the social and economic surroundings and show a more proactive competency and they can help and support towards the socioeconomic changes in various economic dimensions especially in entrepreneurial. What's more, local communities face many problems such as the crisis in economic development, in terms of sources of employment, income, health, housing and similar. Therefore, this paper design to conceptualize and clarify the specific pedagogy of community-based learning in relation to the UTM fast growing field of “Social Entrepreneurship”, and develop a strategic framework for community transformation.

### **The Need of Community-Based Learning**

UHAS 2012, Social Entrepreneurship, a University Course offers a thorough understanding of the field of social entrepreneurship. It's a mixture of lectures concerning the entrepreneurial principles which allows students to engage with real social entrepreneurs through assignments and practical work. From this course the student will gain a broad theoretical and practical knowledge about social entrepreneurship. The emphasis will be fulfilling the needs and obligations of social responsibility for building a sustainable society. They will know how social entrepreneurs work, what kind of challenges they face, and how these challenges can be met. Upon the module of the course, it has incorporated a project that has both learning

and community action goals. These are included, Social Entrepreneurial Activity, or Business Plan for Social Ventures or Social entrepreneurship consulting services for entrepreneurs.

The project design is via collaboration between faculty and community partners, such as non-governmental organizations or government agencies. The option of the project is asking students to apply course content and knowledge to community-based activities. This gives students' experiential opportunities to learn in real world contexts and develop skills of community engagement, while affording community partners opportunities to address significant needs through social entrepreneurs and the entrepreneurship module course. This course has been offered since Semester 2, 2014/2015 Session.

### **Community-Based Learning (CBL) - Learning Pedagogy and the Theories**

CBL fills a real need in the community— students perform a valuable, significant, and necessary service which has real consequences to the community. The 3 R's of Community-Based Learning are included rigor, reflection and reciprocity. In the rigor context, any high quality CBL courses successfully blend academic rigor with Community Service. Reflection, this is the profound bridge between experience and theory. The principal aim student learns from the community and the community benefits/learns from the student service.

Furthermore, CBL engages students by using their own communities as the source and focus of learning. The community provides a place to learn by drawing on the student's prior knowledge and exposing them to a vast array of issues for study and action. CBL gives students structured opportunities and the tools for physically exploring their communities and interacting with many kinds of local experts—residents, business owners, members of government and among others. It gives them opportunities to apply new skills and practice them in novel settings. Through community-based observation, discussion, and problem solving, students acquire both facts.

This CBL is an intentional pedagogical strategy to integrate student learning in academic courses with community engagement. This work is based on reciprocal and mutually beneficial partnerships between instructors, students, and community groups. The goal is to address community-identified needs and ultimately create positive social change. Critical reflection is an essential component of community-based learning; it serves to enhance students' learning of course content, understanding of the community, and sense of civic agency.

### **Impact of Community-Based Learning (CBL)**

Rethinking CBL to create inclusive and maintainable knowledge communities should give a crucial role to social entrepreneur. The CBL through social entrepreneur and

similar mechanisms needs to be carried out collaboratively with stakeholders in national learning and educational systems to achieve the graduate entrepreneur' and the wider objectives of sustainable development. CBL projects significantly impact on students by helping them to: Develop communication, interpersonal skills and critical thinking. Create understanding of course theory and gain more appropriate knowledge through discussions about the complexities of social inequalities and systemic challenges. Learn about the significance of community obligation through hands on work in a non-profit community environment, while gaining valuable work experience.

Conversely, CBL serves as a catalyst in exploiting human potential to partake in productive community enterprises, improving the well-being of families with a better capacity to resolve local issues and challenges. It also offers the participating community opportunity to benefit from the service offered because some those service projects will improve local non-profit agencies' abilities to deliver services to their clients and areas through direct indirect service work and social action research. It further provides support to communities in discovering, sustaining and creating culture for the public value, while respecting diversity in gender, age, ethnicity, religion and languages.

On the other hand, it inspires an educational partnership between UTM and the non-profit community, build a commitment to lifelong civic responsibility among UTM students, faculty and staff. Finally, it will benefit the staff and the University to develop more powerful curricula by providing students with a "real world" context of academic theory and engaging students in discussions that invite new perspectives and relevant personal experiences. Identify new areas for research and publication, thus rising prospects for professional recognition and reward.

### **Learning Environment Arrangement Adopting HPL and CA Framework**

"How People Learn" (HPL) and "Constructive Alignment" (CA) framework provides non-traditional classroom approaches that are different from the techniques of teaching and assessment employed in the classroom. Therefore, to achieve the needed results of inculcating CBL in effective and cognitive domains, the general design of the classroom environment is centred on How People Learn (HPL and Constructive Alignment (CA) framework. The HPL framework can be employed for evaluating and arranging learning environments adopting four overlapping lenses: community centred, learner centred, assessment centred and knowledge centred (Schwarz et al., 999; Bransford, 2004). On the other hand, CA needs the results to be appropriately aligned with task assessment and teaching

and learning behaviours centred on the constructivist method, where pupils' vigour through a learning environment that provide them construct knowledge or skills opportunities for a identified in the anticipated results (Biggs and Tang, 2007). Since the CBL framework is also underpinned on both principles, adopting HPL and CA to develop the entire learning environment becomes normal.

The problem must be developed such that pupils will be able to understand CBL framework and policies in the country and globally and for the concept to have the desired influence on how they behave. Students also recommend a social entrepreneurship approach that helps to alleviate the challenges. In line with the HPL framework learner centred lens, the problem is given as a competition to find social entrepreneurship solution for questions related to CBL that is operational and cost effective for the community, which students can recognize with relevant stakeholders and agencies are sought and included in the CBL to make it effective.

The students in a class were normally arranged between 25 to 30 students per class, facilitated by lecturers. In the class, students are divided into groups of three to five students. CBL ethics demonstrated to the students to develop practical learning teams. After a CBL cycle each phase, students suggest on their team functioning to see what the best approach that should be retained is, and what to be enhanced. They are stimulated to collaborate in learning, not only in their own class, but also between all students, to form a learning community, as suggested by the HPL framework to encourage students in attaining the needed depth in knowledge.

### **Community Transformation through Social Entrepreneurship (CTSE) Project- The Innovation on Problem Based CBL**

Organizing 'Community Transformation through Social Entrepreneurship (CTSE) Project', could be the best in providing the opportunities for communities to enhance their point of development through the community small business. It goes well with the learning outcomes of the course to the students, like the personal outcomes, the social outcomes, career development, and relationship with the institution. Students through teaching and learning (T & L), particularly in this course gaining the benefit in the context of social responsibility. The students are given the opportunity and the challenge to act to help the local community in the form of a business growth and development and innovative business ideas through developing the Business Plan as shown in Figure 1.

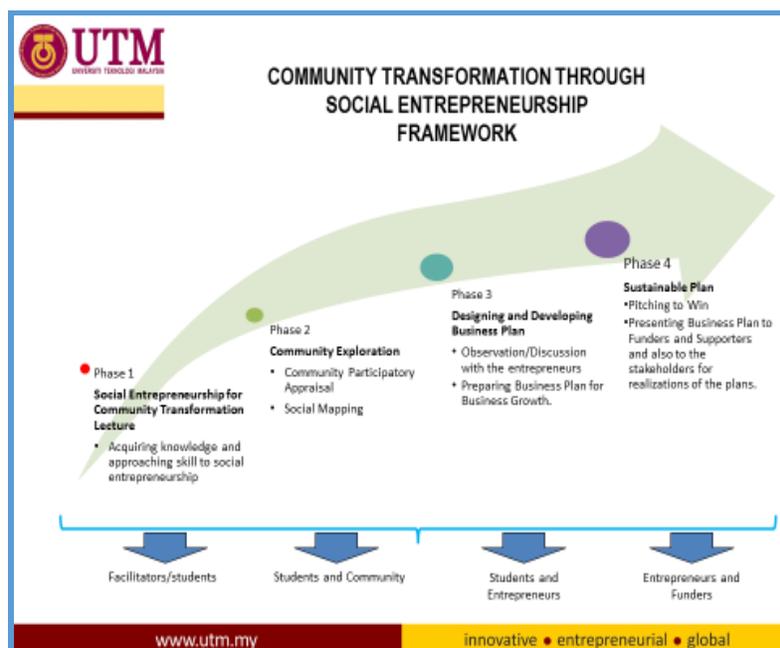


Figure 1. The CTSE Framework

The CTSE program provides opportunities to students who attend the CTSE project, getting 'credit point' (2 credits) for UHAS 2012 course title, Social Entrepreneurship, after successfully completing participation of CTSE project and submit reports in a group assessment, evaluation and reflection. Students or group/team of students relates to the community as 'consultant' working for a 'client' by drawing up the summary of Community Participatory Appraisal and Developing Business plan for the small business community. In this sense, we presume that students should have some knowledge they can draw upon to make recommendations to the community.

The uniqueness of the CTSE is the opportunity given to entrepreneurs to present their business plan to funders. Training for pitch is given in slot 'Pitch Perfect' and their presentation is tabled in "Pitching to Win" slot. In the plan, they would propose for business growth and success through among others, expand the business horizon; to find new markets; exploit outlet/branch; business financing; obtain skilled staff and manage a thriving business.

CTSE project has provided opportunities for developing personality of students through teaching and learning (T & L), in particular Social Entrepreneurship. It is put in the context of social responsibility as one of the main points of the present study, in which students are given the opportunity and the challenge to act to help the local community in the form of a business development and growth.

### Making a Real Difference of Teaching and Learning

CTSE project brings out the role of stakeholder in supporting the Entrepreneurs Communities. Their help and assistance is in the form of training, branding, funding, coordinating, and reporting and among others. Figure 2, shows the list of

active and proactive stakeholders involved. Those participative entrepreneurs having mostly problems of absence or lack of financial management knowledge, lack of capital for expansion, long-life food products, high cost of raw material and etc.



Figure 2. The Stakeholder in CTSE

Thus the community has accepted the CTSE through their head of villager and the office of Mini RTC. They can be said as considering well and positively welcome the knowledge given through the consultation from the students. As a result, the entrepreneur communities have given positive comments and compliments. They really value the connectivity between students and them. They are ready to be empowered and can independently sustain the best practice of running a business for the purpose of business sustainability.

### Conclusion

In this paper, we initially examined the means of clarifying the conceptualization of the need for community-based learning through social entrepreneurship and explained its

specific components. Secondly, we described the community based learning (CBL) pedagogy that was designed as a pedagogical strategy to integrate student learning in academic courses with community engagement. This work is based on reciprocal and mutually beneficial partnerships between instructors, students, and community groups in order to achieve communal change. Thirdly, we applied the framework of "How People Learn" (HPL) and "Constructive Alignment" this framework is adopted for evaluating and arranging learning environments involving four overlapping lenses: community centered, learner centered, assessment centered and knowledge centered community. This framework further aimed at stimulating collaboration in students learning, not only in their own class, but also between all students, to form a learning community, as suggested by the HPL framework to encourage students in attaining the needed depth in knowledge. Which is in line with community based learning that emphasize the development of communities through social entrepreneurs to aspired for something more than their current position by chase a life-changing venture to tackle a social challenge after a visceral experience of poverty and marginalization.

The Community Transformation through Social Entrepreneurship (CTSE) is centered on the particular mechanisms of context, features and outcomes. The context is that of providing opportunities for communities to enhance their point of development through a community small business project and to features activities of a passionate, dedicated and ambitious individual, known as the social entrepreneur. The result is the actual community change which may be in large or small-scale local. The community transformation can start at the individual level, with social entrepreneur providing the leading role to achieve sustainable social solutions through a self-sustenance aspire by community based learning. This may be seen as the development of a pragmatic, community problem solving approach. It is not only a matter of depoliticizing community challenge by reducing poverty through social entrepreneurial means, and contribution of creative, problem solving through community based learning. We believe this can contribute to the development of Social entrepreneurship and community development as a force and practice for sustainable communities. One might ask what community based learning through social entrepreneurship and its influence into community transformation domain is essentially adding to debate and practice in a field already engaged by a diversity of operators and researchers.

### Acknowledgement

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Development Authority (KEJORA), Micro Financing Agencies (Majlis Amanah Rakyat and Tekun), Centre for Community and Industry Network (CCIN) UTM, UTM SHAF and SHAD Programme Students and Faculty of Management, UTM.

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### ADDRESSING STUDENT OUTCOMES ON ENGINEERING PROBLEM SOLVING USING MODERN TOOLS IN AN APPLIED PROGRAMMING COURSE IN CIVIL ENGINEERING

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### Introduction

The demand for engineering schools to address student outcomes of engineering programs as a requirement for accreditation (e.g. Accreditation Board for Engineering and Technology or ABET or Washington Accord) requires innovative approaches and strategies in designing the curriculum. With the rapid development of fast, powerful and affordable microcomputers and the internet, engineering educators, now, have options to introduce innovations in the teaching-learning process. How can computer technology be used effectively in the classroom to enhance the understanding of engineering concepts? How can the students' interest be increased and how can learning be made as a fun activity through the use of computers?

There are various strategies where computer technology (hardware, software and the internet) can be integrated into

the curriculum to enhance the teaching and learning process. Among these strategies are the use of computer-based exams, virtual laboratory, online lectures and tutorials, specialized software and web-based resources. Software development using a programming language is another avenue where the student outcomes in engineering can be addressed. Computer programming has a technological part and a creative part [Martinez et al. 2011]] and the process involves various levels of thinking skills.

This paper describes an applied programming course (CIVCOMP) in civil engineering (CE) which is offered at De La Salle University (DLSU), Manila for third year students. The course is designed following an outcome-based framework where the content, teaching and learning activities and assessment methods align with specific student outcomes. The main feature of the course delivery is the used of Problem-Based Learning (PBL) wherein students, developed simple application software in engineering mechanics, structural analysis, mechanics of deformable bodies, fluid mechanics, hydraulics, surveying and other third year level CE related courses using Visual Basic as the programming language. The developed application software demonstrates the achievement following student outcomes: (a) an ability to apply knowledge of mathematics, physical sciences, engineering sciences to the practice of civil engineering, (b) an ability to use the appropriate techniques, skills and modern engineering tools necessary for the practice of civil engineering, (c) ability to recognize, formulate, and solve civil engineering problems.

### **The Teaching and Learning Strategy**

The programming language used in the course by the author has evolved from Turbo Pascal in 1995 to C++ in 2000 and Visual Basic since 2006. The syllabus was also revised using outcomes-based framework since 2010. To achieve the course learning outcomes, teaching and learning activities (TLAs) must be designed so that the students are engaged in the learning process. TLAs must also address the different levels of Bloom's Taxonomy of cognitive thinking – the lower level thinking skills (remembering, understanding and applying) and the higher level thinking skills (analyzing, evaluating and creating). The challenge to educators according to Biggs and Tang [1999] is addressing the “full range” of higher levels of cognitive skills resulting to a “deep approach” in learning. An “active learning” approach where students “learn by doing” was adopted. The TLAs consist of (a) Lectures and Tutorials, (b) Hands-on Exercises and (c) Computer Projects.

At the start of the term, lectures and online tutorials are conducted to introduce the students to the fundamentals of Object Oriented Programming using Visual BASIC (VB). After the introductory lecture at the first meeting, students learned VB by themselves in the succeeding meetings. Hands-on programming exercises are scheduled every class meeting. Hands-on exercises are practice sessions for the students to learn the fundamentals of VB. Each exercise illustrates a basic feature of VB which the student will use later in the writing of application programs.

After learning the basic syntax of VB from the assigned hands-on exercises, students are required to develop application programs or computer projects to demonstrate their proficiency in VB programming and their ability to integrate knowledge in mathematics, physical sciences, and engineering sciences in solving basic civil engineering applications through software development.

### **Problem-Based Learning using VB Programing**

In this course, the problem is to develop VB software application for solving basic civil engineering problems. There are three computer projects required; the degree of difficulty increases as they learn more VB syntax, commands and functions. The student identifies the solution by researching or recalling the concepts learned in basic and advanced mathematics, engineering sciences and basic civil engineering courses. The course is conducted after the third year level. Hence, the civil engineering-related programming problems are limited to basic courses in fluid mechanics, engineering mechanics mechanics of deformable bodies, structural analysis, surveying and hydraulics.

In Problem-Based Learning (PBL), only the objectives, given inputs and required outputs of the program are given and the students must conduct independent research to create VB program to solve the problem. In PBL, the students are expected to do the following: (a) review the theory, (b) derive and apply equations, (c) use an appropriate numerical method if necessary, (c) formulate an algorithm, (d) design a VB graphic user's interface (GUI) which will accept input data and display the output, (e) write VB programs using the correct syntax, (f) execute and debug the program, and (g) check the correctness of the results of the program. Through the computer projects, students demonstrate their creativity and integrate concepts, methods and skills learned from previous courses in mathematics, basic engineering and specialized civil engineering.

### **Software Applications in Civil Engineering**

The students' projects in this course are simple visual basic software applications related to civil engineering courses in the third year level. Examples of these application software are deflection and elastic stress on beams, open-channel flow and unsymmetrical bending. The following figures show examples of the GUI and descriptions of the programs of the students in the past years when Visual Basic was introduced in the course.

**Figure 1** solves the elastic deflection of a cantilever beam, a problem in Mechanics of Deformable Bodies. The inputs to the program are the cross-section dimension and properties of the T-section and the beam loadings and lengths. At a specified section X from the left end, slope, deflection and moments are computed.

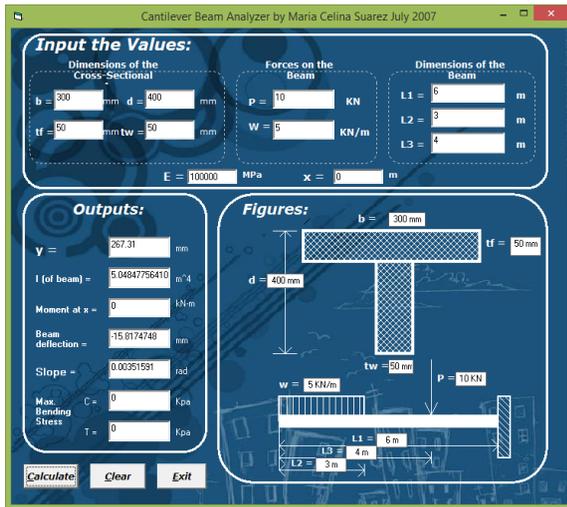


Figure 1. Elastic Deflection of a cantilever beam (2007)

Figure 2 is an advanced mechanics of deformable bodies problem on unsymmetrical bending of beams. The maximum bending moment and stresses of a purlin given the cross-section and loads are determined.

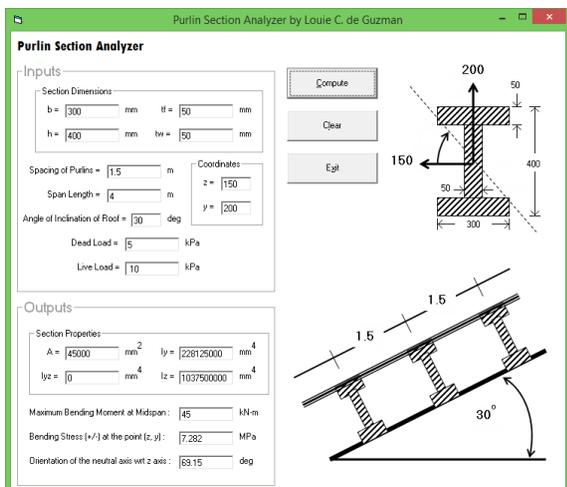


Figure 2. Purlin Section Analyzer (2008)

Figure 3 which is a Hydraulics problem determines the normal depth of an open channel of various shapes (rectangle, triangle and trapezoidal). The solution to this problem requires solving roots of a nonlinear equation. VB control statements are extensively used in this program since there are options on units and the shape of the channel.

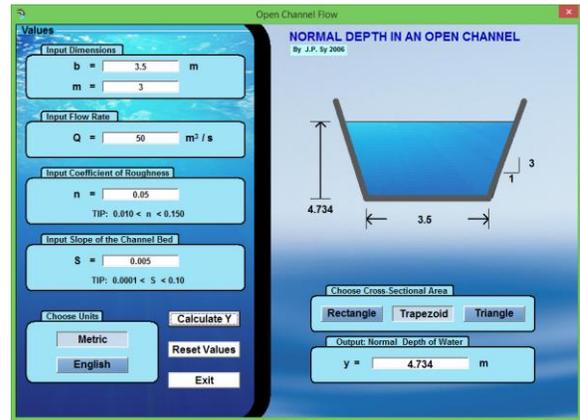


Figure 3. Normal Depth of an Open Channel (2010)

Figure 4 is an unsymmetrical bending stress calculator which solves the bending stress at any point of the cross-section for various shapes. Advanced Visual Basic objects such as vertical and horizontal scroll are used in this program.

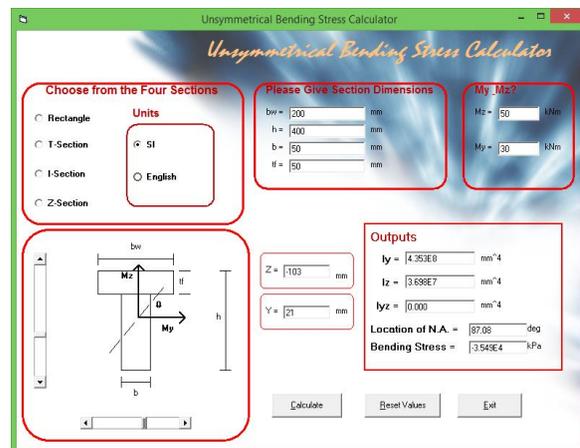


Figure 4. Unsymmetrical Bending Stress Calculator (2012)

### Indirect Assessment of Learning

A student evaluation in the form of a survey is conducted at the end of the course to get feedback from the students about their learning experience. Shown in Box No. 1 are the results of one survey. The first two questions show that after completing the course, the students' proficiency on object oriented programming using VB has increased ("Poor" responses in A changed from 38% to zero, while the "Good" responses in B changed from 15% to 54%). Positive feedback by adding the "Agree" and "Strongly Agree" responses were obtained in the other questions on the hands-on exercises (C: 70%), application of previous knowledge (D: 92%) and developing analytical skills (E: 77%).

### **Box No. 1. End-of-Course Evaluation Survey**

#### **A. Before you enrolled in CIVCOMP, rate your ability on object oriented programming using Visual Basic 6?**

(1) Poor=38%, (2) Fair=23%, (3) Ave=23%, (4) Good=15%, (5) Excellent=0%

#### **B. After taking up CIVCOMP, rate your ability on object oriented programming using Visual Basic 6?**

(1) Poor=0%, (2) Fair=23%, (3) Ave=23%, (4) Good=54%, (5) Excellent=0%

#### **C. The examples and hands-on exercises are effective in learning and understanding the use of Visual Basic syntax, objects, controls and commands in developing an application software.**

(1) Strongly Disagree=0%, (2) Disagree=15%, (3) Neutral=15%, (4) Agree=62%, (5) Strongly Agree=8%

#### **D. Developing a software application (project) enhanced my ability to apply knowledge of mathematics, physical and engineering sciences in solving basic civil engineering problems.**

(1) Strongly Disagree=0%, (2) Disagree=0%, (3) Neutral=8%, (4) Agree=69%, (5) Strongly Agree=23%

#### **E. The course helped me developed my analytical skills in solving civil engineering problems.**

(1) Strongly Disagree=0%, (2) Disagree=8%, (3) Neutral=15%, (4) Agree=77%, (5) Strongly Agree=0%

With regards to the professor's assessment of the students' performance in the hands-on exercises and the computer projects, the following observations and reflections are noted:

- The students were able to integrate the knowledge of courses in mathematics, numerical methods and the specialized civil engineering subjects in designing a program on a basic civil engineering problem,
- The students discovered by themselves the most appropriate way of presenting and solving the problem using the techniques learned from the computer exercises – an outcome expected by the “learning by doing” approach,
- The different designs of the graphical user's interface (GUI) using colors, various objects such as buttons, text box, check box, labels and images illustrate the aesthetic talents and creativity of the students, and
- The student's active involvement in the process: starting with the identification of the problem, formulation of the solution, algorithm development, interface design, writing and execution of the VB program up to the checking of the output, resulted in meaningful experiences that develop higher thinking skills.

### **Conclusion**

How can computer technology be used in the classroom in engineering instruction so that the student outcomes of the program are addressed is a challenge to engineering educators. This paper presented a course on applied programming in civil engineering where the course was designed focusing on student outcomes of applying and integrating knowledge and skills in mathematics, physical sciences, basic and specialized engineering sciences in developing software application on basic civil engineering problems using modern computing tools. Student-centered teaching and learning activities in the form of tutorials,

hands-on exercises and problem-based learning by developing software application were adapted in the course delivery. The student outputs in the form of simple software applications on civil engineering problems demonstrate the achievement of the student outcomes. Their proficiency in programming will be useful in the senior years especially in the specialized courses and thesis.

### **Information on Publication**

A paper about this course, entitled “Demonstrating Students' Skills on Integrating Knowledge of Math and Engineering in an Applied Programming Course in Civil Engineering” by Andres Oreta and Alden Paul Balili was published at the *Computer Applications in Engineering Education*, Manuscript No. 14-089, 2015, Wiley Periodical, Inc.

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### **LEARNING THROUGH ETHICS**

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### **Introduction**

Of late, efforts on bringing innovative changes in engineering education are gaining importance. This is because of the need to bridge the gap between industry and institution, and to create awareness in graduates on the societal needs. The other important aspects are to address the issues on improving performance of engineering students and their interest towards learning the course more effectively. Some of the practices that can be embedded in the individual courses have been discussed in this work. One important technique may be developing student affection towards the course and course co-ordinator, which in turn can help him/her undergoing the course more effectively and in inducing characters concerning the societal needs and responsibilities in the personality. Presently including Professional Ethics as one of the courses in Engineering education has merely given an exposure on creating awareness about best practices to be followed in their professional life. But there are issues which clearly show that, the efforts have not been achieved as the students struggle to cope with studies as well to sustain their professional career. This work aims at analyzing the existing

issues with engineering education and developing a five point systematic approach to overcome the issues related. This approach aims at building guidelines and practices needed to be embedded in the courses studied at the undergraduate level.

**Common issues with engineering education:**

1. There has been decrease in percentage of marks scored by top rank students.
2. Students face shortage of stamina in attending classes, as shown by their absence, lack of interest in attending classes.
3. Learning activities conducted in classes are giving scope to more disturbances and dragging students away from the topic.
4. Answers presented in the examination / tests are less effective in terms of technical contents. (Graphs, Sketches, and Equations etc.).
5. Declined interest towards participation in technical cultural events. It has been observed to an extent that, many students register to the competitions and do not turn up to participate.
6. More emphasis is on getting marks, placement instead of looking for recognition, appreciation.

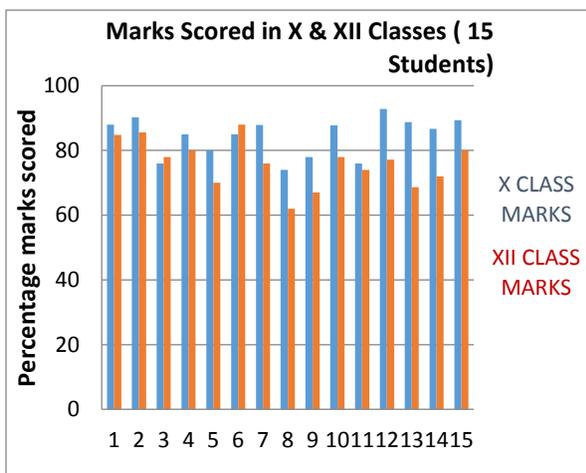


Fig.1 % Marks scored by sample (15) students Class X & X11

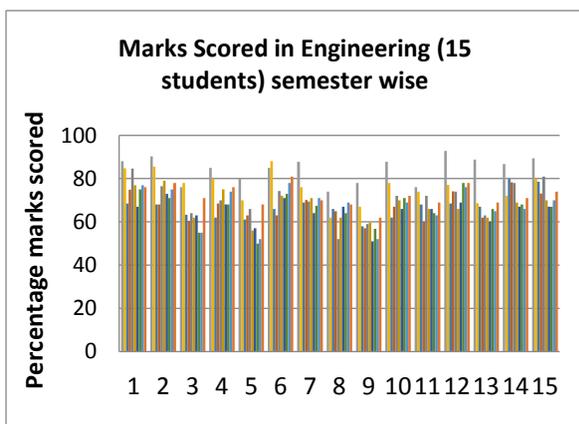


Fig.2 % Marks scored by sample (15) students in Engineering Course (Semester I to VIII)

As shown in the above figure most of students are happy to settle down for lower percentiles of marks and their inclination towards learning the subject is also diminishing. The number of students falling in a range of second class grade is also a real concern that needs to be addressed.

The above issues show the real need of developing student likingness towards the course and course co-ordinator. Ethically speaking, one who does not love, value what he is doing, may not deserve best results. Embedding ethics in individual courses and to make the students to practice principles of ethics by involving them in every stage of teaching learning process would be one ideal solution. This work concentrates on developing common guidelines for addressing the above issues by, selecting a five point approach (fig.3) that encourages students to improve their bonding with the course and course co-ordinator. Bringing ethics into the learning process is to make everyone to like, love and enjoy what they do in the campus.

**Five Point Practice:**

**1. Course-Student bonding:** To learn the course and score good marks, student must develop an affinity towards the course. To make it possible he/she must be involved in all stages from framing the curriculum of a course to the evaluation process. To what extent the involvement has to be encouraged can be decided by a core committee. Having a say of students in framing the curriculum can definitely build attachment and interest in the course. We can start the practice while framing the curriculum for one or two courses of higher semesters. Final fine tuning and developing it to the university standards can be done by the experts.

**2. Course Co-ordinator – Students bonding:** Lack of attachment and disliking concerning the teacher have been sources of slow learning and failures. A well made plan involving each course co-ordinator interacting with a small group of students (five or less) would be ideal in developing interest in students. Proctoring system can work in a different way by addressing personal issues and tends to tackle the general issues. Each subject teacher should compulsorily interact with a small group of students and bring the fine points in the subject and bring their relevance to the real world problems. Of course the interaction has to be very casual and dealt in manner to open up each student into the topic and developing a liking towards the Subject. As Thermodynamics course co-ordinator, I would like to bring in a topic like entropy and fascinate them by bringing its change and effect on the universe.

**3. Question Paper and Student:** Consulting students in setting a question paper is only to encourage their involvement which can be done by different ways. One of the interesting methods is to make a few groups and assign them to develop one or two innovative questions and to give an opportunity for the best question to be included in the test papers. Even going a step ahead and getting a friendly question paper pattern in consultation with students would be of great benefit. But compromising with the quality or depth of questions should never become an intention of the proposed idea.

**4. Student and Evaluation:** Involving students in evaluation of test papers could benefit them in creating more interest and command over the subject. Students can be allowed to evaluate their peers' test papers and asked to point out mistakes and write critical comments. Discussions can be conducted later on common mistakes and the best answers by the course co-ordinator. This brings more confidence in students and they start thinking to present their answers in a better way.

**5. Class Room Activities:** Biggest challenge in framing and executing class room activities is encouraging the involvement of students. As the likings of each student differ, identifying individual interests and forming clusters is crucial. Some students can perform on stage and some off stage. Some are good in writing report and some in enacting. Making use of their skills in planning and executing each class activity will be dealt in detail in this paper.

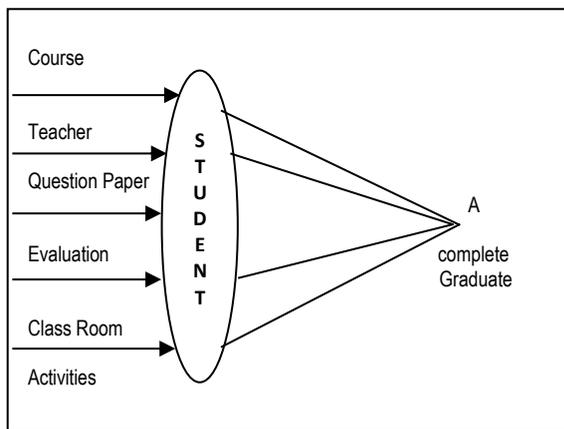


Figure 3. Five Point Utilization

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## FLIPPED LEARNING MODEL FOR NON-TECHNICAL COURSE SUBJECTS

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### Introduction

The 21<sup>st</sup> century learning has produced many advanced methods of learning that are on student-centered, such as blended learning, of which, flipped classroom is one of the models available.. Flipped learning is a type of learning, where the students are given reference materials, to be manipulated prior to the real teaching and learning (T&L) session. Exposing the students to the learning materials outside the classroom, the T&L provides an opportunity for them to conduct hands-on activities, such as, problem-based learning, game-based learning and the ubiquitous learning. Flipped classroom, despite its proven potential to be executed in higher level education, has a number of aspects to be improved to make it even better. This paper discussed critical issues related to the flipped learning model aimed at ensuring its optimized benefits and effectiveness. .

### Issues Faced in Teaching and Learning in Higher Education

Flipped learning can be understood as an independent learning process that happens before the actual teaching and learning session in the classroom begins (Baker, 2000). This new method has been used extensively, especially in other countries and its implementation has been proven to increase students' academic achievements (Azlina A.Rahman, Hasnah Mohamed, Baharuddin Aris, & Norasykin Mohd Zaid, 2014; Strayer, 2012).

The various implementations of flipped learning have obviously created positive impacts in many disciplines and levels, primary to tertiary. The suitability of applying flipped learning at the tertiary level is unquestionable. However, its execution which does not consider restrictions and obstacles can be its own downfall, not to mention its being a relatively new method with some limitations yet to be overcome (Azlina A.Rahman, Hasnah Mohamed, Baharuddin Aris, Zaleha Abdullah, & Norasykin Mohd Zaid, 2015; Embi & Panah, 2014). . Among the critical issues identified during the execution of flipped learning were, the lack of guidelines in its implementation, theories in education not being taken into account and low quality of the learning content (Embi & Panah, 2014) and the fact that there were only a few models that explained the flipped learning method thoroughly (Azlina A.Rahman *et al.*, 2014; Embi & Panah, 2014). , Flipped learning has the potential to be executed not only for engineering education subjects, but also for non-technical course subjects in order to equip students with various knowledge required to become competent and competitive individuals.

Therefore, the researchers took the initiative to develop a new flipped learning model that is able to help educators to conduct the flipped learning method in their own institutions of higher education, more effectively. This model was developed by taking into account several important issue to be observed and addressed, based on the literature reviews and previous studies conducted by past researchers.

### Educational Theory Underlying the Innovation

Effective and meaningful learning is gained through interactions with more competent friends under the tutelage of several educators (Vygotsky, 1978). Unlike the normal conventional methods, where the lecturers only give lectures while the students receive the inputs passively, flipped learning is centered on the students, where the students lead their own learning, especially when they are outside the T&L environment (Baker, 2000). Therefore, learning in classrooms can increase interactions between the students and the lecturers and also among the students themselves. Thus, learning under minimal guidance and interactions with more competent friends, based on the social constructivism theory, is the backbone of this innovation. Social constructivism theory stressed on the learning aspect through interactions between friends, where the 'more knowledgeable other' or in this case, more knowledgeable friends assist and support peers in the learning process.

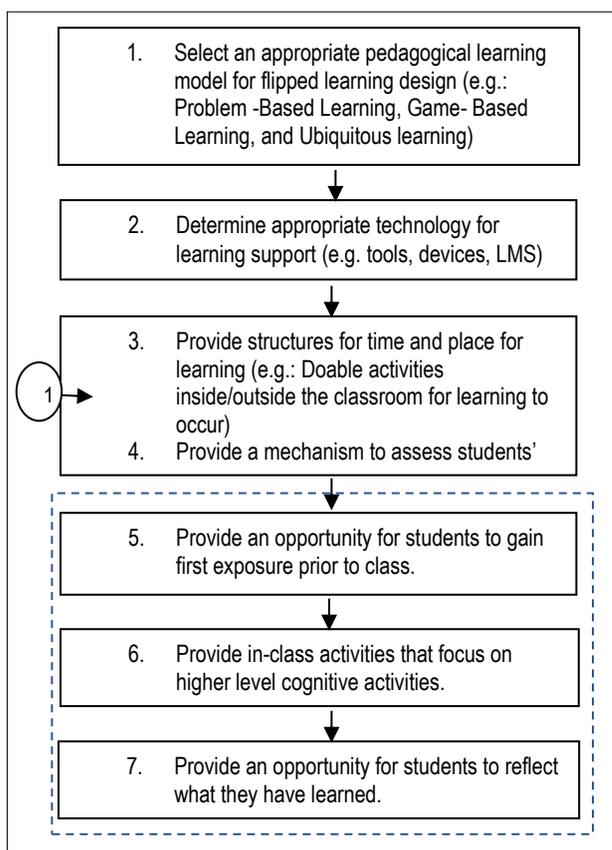
### The innovation details and how it solves problems in teaching and learning

The aim of this innovation was to encourage the use of flipped classroom method for non-technical subjects, such as history and religious studies by educators and researchers, without a hitch. Presently, the flipped classroom method is popularly used for technical subjects, such as Science, Mathematics, Geography and others. Table 1 shows the flipped learning model constructed based on the needs and current issues explained previously.

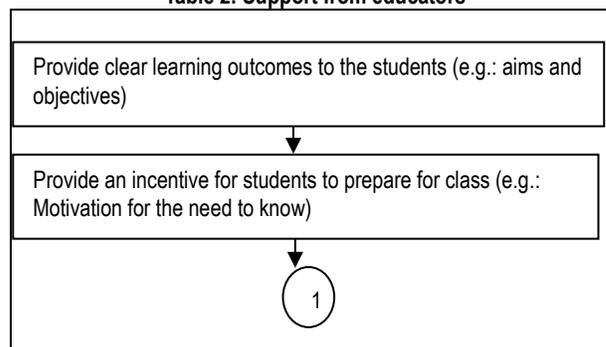
Based on Table 1, in order to execute flipped learning, firstly, the educators need to select an appropriate learning model for the flipped learning design, for example, problem-based learning, game- based learning and ubiquitous learning. Secondly, the educators must determine the appropriate technology for learning support, including devices, tools and Learning Management System (LMS). In order to ensure that the learning towards manipulative materials occurs outside T&L in the classroom, the educators must make sure that the T&L venue and time are suitably selected besides providing mechanisms to assess the students' understanding.

At this stage, the educators should ensure that the students understand the learning objectives clearly, so that, they can prepare themselves for the new approach to learning, namely, flipped learning. This is aligned with the research conducted by Bijlani, Chatterjee, & Anand (2013), which stressed that the students need to be informed and explained about the learning objectives, as shown in Table 2.

**Table 1: Flipped Learning Model for Non-Technical Course Subjects**



**Table 2: Support from educators**



Thirdly, the educators need to provide the students with the opportunity to manipulate the assessable materials. Hence, higher level activities can be conducted in the classroom before the session is ended with students' self-reflection on their learning. Self-reflection is one form of change towards increasing the skills and rectifying weaknesses.

### Research or evidence of the impact of the innovation towards teaching and learning

This research was conducted on Master students registered in Organization and Resource Management subject. There were two groups involved in this research, namely Group 1, comprising students from the 2014/2015 session (semester 2), and Group 2, comprising students from semester 2, 2015/2016 session. The first group, being the control group, studied the material using the conventional approach,

namely, doing the assignments at home, while the second group was assigned to apply the flipped classroom approach.

The overall results showed that, Group 2, achieved a significant difference in the assignment scores and final examination results, compared to Group 1. Table 3 shows the results of the analysis conducted on both groups, for their assignment and final examination, at a significant level of  $p=0.05$ . The results shows that there is was significant difference between the two groups from the assignment and final examination aspects with  $p=0.00$  ( $p<0.05$ ).

## Conclusion

This research successfully proved that, Flipped Classroom Method could be used for teaching and learning non-technical subjects, as effectively as it has been widely used for technical subjects. The model proposed can be used to assist educators in using the Flipped Classroom Method for non-technical subjects, such as Organization and Resource Management, which contains many theoretical concepts.

**Table 3 : Results of ANOVA analysis between Group 1 and Group 2**

	Sum of Squares	df	Mean Square	F	Sig.
Assignment					
Between Groups	369.846	1	369.846	28.355	.000
Within Groups	299.994	23	13.043		
Total	669.840	24			
Final					
Between Groups	309.693	1	309.693	22.389	.000
Within Groups	318.147	23	13.832		
Total	627.840	24			

## Acknowledgement

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## 22.

### COMPUTER-ASSISTED TUTORIALS AND ITEM ANALYSIS FEEDBACK LEARNING: FRAMEWORK FOR ENHANCING AND ENGAGING STUDENTS' LEARNING IN MATHEMATICS

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## Introduction

While the Gen Xers grew up in a physical world where human interaction demanded mostly real-time human contact, the Gen Yers and Millennials grow up in a digital world, pampered with the vast array of gadgets and software to stay connected. The relentless technological advances and diffusion have affected all aspects of human life. Needless to say, the educational landscape is not spared.

As a result, the teaching-learning environment has undergone a tremendous paradigm shift, mostly stemming from these technological advances and the rapid rise of computer-assisted learning programs. Online learning and massive open online courses (MOOC) are some of those computer-assisted teaching-learning pedagogies which are currently trending. Computer-assisted learning transcends all levels of learning, from early childhood education to graduate school and even workplace training. Educators are currently embracing this revolutionized learning and many may have successfully engaged students in their own learning. As the quality of student learning outcomes is frequently associated to student engagement, educators are conscientiously finding ways to increase and motivate students' participation in purposeful learning activities. Computer-assisted learning enables to a great extent, individualized students' preferences of knowledge, content delivery, place, time and pace of learning. It also enhances the overall learning and human-computer interaction which may allow students to engage in higher order thinking skills.

## Research Problem

Calculus, a mathematics course, is mandatory for all Engineering students and must be taken and granted a pass before they could enrol in any engineering courses in our university. From the authors' teaching experience, it was found that most students were not prepared to solve critical thinking questions and had insufficiently adequate foundation in mathematics. These students who did not excel in mathematics may have further concomitant complications in other engineering subjects. Moreover, the students had difficulties in retaining mathematical concepts and achieving the learning outcomes of the subjects.

Traditional tutorial-based methods used previously did not help either; they did not provide significant improvement in student learning and engagement in mathematics. In the traditional method, students were given tutorial questions a week before class and were expected to solve them at home. Further discussion would then be done in classes. However, most students did not even try to attempt the questions and only attended the tutorial sessions to obtain the solutions to the exercises. This clearly indicated that the students were not motivated or engaged to participate in learning. Without proper motivation, students tend to regress in learning and finally not able to cope with the studies.

Thus, to engage and help students toward learning mathematics independently and progressively, a computer-assisted tutorial system was introduced to allow students to learn at their own pace. The system was also used to track students' learning and engagement of their weekly homework and assessment. Furthermore, the learning ability of the student was continuously monitored through item analysis feedback reported in the system.

### Educational Conceptual Underpinning

Hackman and Oldham's Job Characteristics Model (Hackman & Oldham, 2005) forms the basis of reference for this study. Even though this model espouses a set of principles to enrich jobs and increase job motivation in organizational settings, it is very relevant to the learning settings.

Hence, as an extension of this model, learning can and should encapsulate the core dimensions of the skill variety (through preferences of knowledge and content delivery), task identity and significance (through meaningful results), autonomy (through individualized place, time and pace of learning), and feedback (through immediate, real-time feedback). A modified Learning Characteristics Model is illustrated in Figure 1.

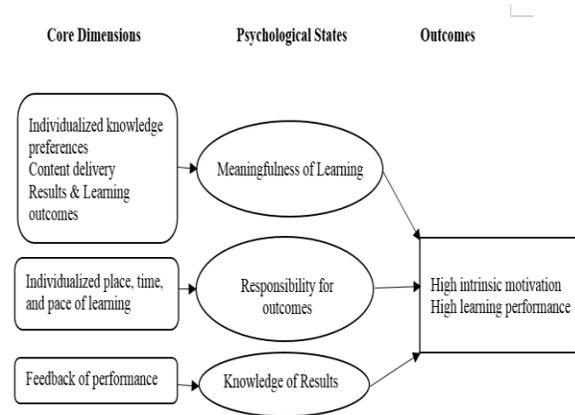


Figure 1. Modified Learning Characteristics Model

### Teaching and Learning Innovation

Underpinned by the learning characteristics model, this study executed innovative computer-assisted tutorials which emphasized on an integrated approach of student-centered learning with suggestive feedback and online monitoring, focusing on critical problem solving skills for mathematical analysis. This computer-assisted learning model is illustrated in Figure 2.

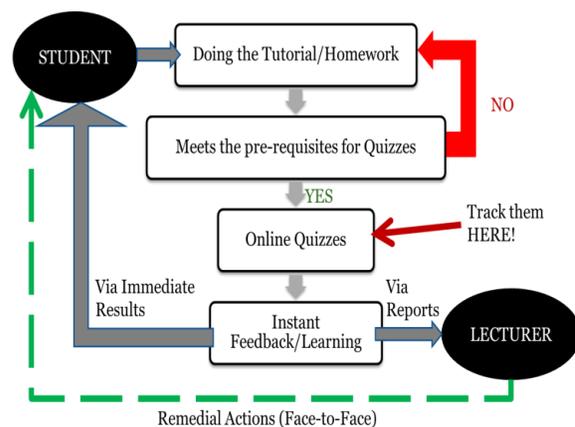


Figure 2. Model of Computer-assisted Learning via Online Assessment and Feedbacks

The overall objective of computer-assisted tutorials is to promote independent student-paced learning and self-improvement through the use of guided tutorial questions and assessment (Greenhalgh, 2001). It was first implemented in Calculus for engineering students in 2014 and subsequently extended to Trigonometry and Geometry in 2015.

The computer-based tutorials were designed to provide a series of weekly homework for students to improve their understanding independently throughout the semester. Datelines were given to ensure students' learning pace were in line with the subject learning plan. Each student in the group was assigned a variety of questions with the same learning objective, but differed in terms of question variables. Questions with randomly generated variable were unique to each student and thus eliminated the issue of

copying among students. The idea behind computer-assisted tutorials was to allow the students to be responsible for their own learning and to create awareness of their level in mathematical thinking, with some control element by the facilitators.

During the online tutorials, students may seek help by requesting for an example to help them solve the question. The examples provided could be in the form of video or text-based, whereby step-by-step instruction would be given for further understanding. They were also able to email or had an online discussion with the lecturer, whichever was available. In addition, the system also allowed students to do repetitive practice on the same learning objective by attempting similar exercise but with different variables. The accessibility of online tutorials provided flexibility for students to learn at their own pace, any time of the day. Furthermore, the availability of learning support and instant feedback further motivated students in attempting difficult questions independently and equipped them with prior conceptual knowledge before attending the formal tutorial sessions.

Subsequent to the computer-assisted tutorials, a formative e-assessment was conducted weekly to gauge the students' level of understanding and to make constructive reflection on the topic (Nicol & Macfarlane-Dick, 2006). The e-assessment was conducted in the university's lab computers to eliminate the risk of discussion during the assessment. A pre-requisite of 100 percent completion in the online tutorials was also set up to ensure the students in the controlled environment attempted and completed the online tutorials according to schedule. This was also to ensure that the e-assessment grades were not biased in terms of students' prior knowledge in mathematics. If the students did not complete the pre-assigned homework, the system would not allow them to partake the e-assessment. The advantage of using e-assessments or online quizzes is the ability to provide instant feedback to the students after completion of the assessment. It was found that students learnt best from mistakes and through instant rectification process (Clark, 2012). For paper or manual-based assessment, students usually would not be able to obtain their results immediately and rectification of errors cannot be done instantly. Thus, prolonged rectification would undermine the students' motivation and give an assumption to the students that the unsuitable conceptual applied in the assessment was correct and may be repeated in future examinations.

The rectification process was usually done through active and cooperative learning in the classroom environment. Students could work in pairs, in groups or in a one-to-one session with the instructor. Previous studies (Freeman et al., 2014; Herrmann, 2013) showed that students' engagement and performance tend to improve significantly when there was active and cooperative participation among students. Therefore, we adopted both active and cooperative learning approaches in the classroom, and similarly, we observed that students tend to learn better by working together in solving more challenging problems.

The essential part of any learning process is providing feedback to the learners (Hwang, Chu, Yin, & Lin, 2008).

This is crucial as learners usually learn better through corrective measures and continuous support throughout the learning process. In line with the continuous quality improvement (CQI) philosophy, the usage of item analysis was introduced in teaching and learning mathematical subjects in the university. Item analysis is a process of analyzing class-wide performance based on individual assessments. This task can be time and energy consuming without a proper e-management system. In most cases of past assessments, corrective measures were provided to the students in class in terms of discussion and corrections of the questions in the assessment only. The students, mostly, would attend the class for solutions without further clarification of the problem. By using item analysis feedback, the lecturers would be able to view the overall performance of the students. An item analysis table usually consists of the learning objective of each question assigned, total number of attempts, total number of correct attempts, total number of incorrect attempts, and average time spent. The analysis is essential to study the learning behavior of the students and can be used to gauge their level of understanding in relation to their learning objectives. The data collected from item analysis was then applied for reinforcement of conceptual theory in subsequent classes. We find the item analysis feedback helpful for lecturers in understanding students' conceptual understanding in selected learning outcomes. Through conceptual reinforcement, students can learn hints on solving problem critically and concretize their conceptual understanding. Likewise, lecturers can also choose to view each student's progress throughout the semester for performance monitoring. Remedial classes were conducted for students with low-to-moderate performance for personalized learning. We find that the usage of computer-assisted tutorials clearly helps to boost student motivation and engagement to learn mathematics throughout the semester.

The implementation of the computer-assisted learning framework showing engagement among students, lecturers is illustrated in Figure 2. The motivation behind the implementation of this innovative learning includes setting appropriate learning goals, collecting and tracking student performance throughout their learning, providing feedbacks on learning outcome in comparison with student performance, and making use of the item analysis report for conceptual reinforcement to improve long-term learning.

### **Significance and Impact**

As mentioned earlier, the computer-assisted learning framework was first implemented in Calculus subject for engineering students in 2014. It was implemented for more than 3 semesters and received positive feedback from students. The same framework was further adopted in Trigonometry and Geometry subject in 2015. It was found that students with a weak mathematical background in pre-calculus performed well in these subjects after using the computer-assisted tutorials.

In the first implementation, the students were divided into two groups. The first group was taught using the traditional face-to-face tutorials, whereby the students were given paper-based tutorials to be completed and discussed in the

classroom and the second group of students was taught using the online computer-assisted tutorial framework. At the end of the trimester, it was observed that the mean of the students' results under the computer-assisted learning (CAL) group was higher than the mean of the students' results under the traditional learning (TL) group (CAL: 51.7%, TL: 43.7%). Furthermore, the overall results showed 70% of the students in the CAL group passed the course, while only 55% of the students in the TL group managed to achieve the passing grade. From the analysis of the computer-assisted feedback, it was observed that most of the students who failed the subject did not complete their tutorial and quizzes and this could be the main reason they were not able to cope with the subject. The analysis clearly shows that computer-assisted tutorials have significant impact on student performance and its ability to engage students in learning mathematics.

The second implementation was conducted for all 110 students undertaking the Calculus course. During this full implementation of computer-assisted learning, the failure rate of the subject dropped significantly from 40% to 19% as compared to the previous trimester. Moreover, the percentage of students that obtained grade A has also increased from 14% to 31%, while the other 33 students (30%) and 22 students (20%) have obtained grade B and C respectively. We found that the students tend to perform better when they are engaged in their learning through computer-assisted tutorials. Additionally, feedback and reinforcement of conceptual theory are particularly essential to ensure students go through the course successfully.

### Conclusion

This study discussed an attempt to improve learning in mathematics by introducing a computer-assisted learning framework which incorporates the core dimensions of learning variety, independent learning and instant feedback on performance. It has been designed to provide a conceptual shift from rote learning of mathematics toward appreciating the beauty of mathematics through independent self-motivated learning with feedback. The positive results can be discerned.

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23.

### INCORPORATION OF GENERIC PROJECT-ORIENTED PROBLEM-BASED LEARNING (POPBL) FRAMEWORK INTO SOFTWARE ENGINEERING (SE) EDUCATION

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### Introduction

Software Engineering education poses particular challenges for the instructor. Generally, Software Engineering subject that is multi-faceted in nature requires its instructors to make a reasonable trade-off between the theories and practical aspects of software development. It is quite impossible to deal with software engineering's complexity that originates from the intricacy of its software problems during a lecture session in a teaching and learning (T&L) environment.

In addition to that, instructors also need to constantly expose the learners with fundamental knowledge and theories in software development field such as: software development life cycles (SDLC) (i.e. requirements engineering, analysis, design, development, testing, deployment and evolution), cost-effective practices, as well as the most recent techniques and technologies used to develop quality software.

Thus, in order to become good software engineers, learners must be trained not only to be able to technically solve real-world problems elicited by their stakeholders, moreover, they also need to have certain non-technical abilities or soft skills, in specific, on how to efficiently manage and plan software development projects as well as learn about how to cooperate and communicate well with other team members.

Apart from that, promoting creative thinking is another perspective that should be considered when teaching courses related to Software Engineering education. This is because creativity is an essential factor in the field of software development. Software creativity occurs when the learners took their time to explore the possible design spaces, rather than immediately got fixated on the first solution that comes to mind. Additionally, learners must be prepared to learn about how to think creatively, perform

scientific problem solving, and explore newly developed methods in order to cope with the rapid changes occurring in today's computing environment. Hence, the current lecture-based curriculum in Software Engineering education needs to be revamped to a more learner-based engaging curriculum.

### Generic POPBL Framework for SE Education

Project-Oriented Problem-Based Learning (POPBL) is a model that utilizes projects as the means of learning. Learners are exposed to and got involved in real industry projects where they are required to propose a solution and develop a software project as per request by an actual client. Integration of POPBL in Teaching and Learning (T&L) environment for Software Engineering education could encourage the development of learners' personal technical and non-technical skills. Currently, the challenge is that the majority of the POPBL existing is only suitable to be implemented in a single course, and very few of them are generically tailored to different courses in Software Engineering education.

Generally, POPBL approach is a teaching pedagogy model that is basically adapted from Problem-Based Learning (PBL). This study designs and proposes a generic POPBL framework for Software Engineering education, thus, have its basis of the PBL model. The same important and inter-related components that make up PBL are also used in the POPBL model, namely i) problems, ii) project, and iii) teamwork.

The designed POPBL framework also reflects the elements of PBL learning principles. The principles involve three components, i) cognitive learning, ii) collaborative approach, and iii) content approach. The designed generic POPBL framework consists of three stages: onset, execution, and closure stages. Each stage has its own tasks to be executed in order to have a systematic POPBL implementation which are sequentially arranged directly from the SDLC phases. The project is conducted in stages (1 to n assignments) with gradual increase in complexity. The overall project is mapped to the designed curriculum and course syllabus.

### Description of the SE Courses

The proof of concept of the proposed framework was put into practice in the teaching of undergraduate students of Bachelor of Computer Science (Software Engineering) as its learners, from their first year to their second year. The courses involved are: Programming Technique I (Semester I, First year), System Analysis and Design (Semester I, First year), Software Modeling and Requirements Engineering (Semester I, Second year), and Software Quality and Testing (Semester II, Second year). These four courses were chosen due to their applicability as core courses for Software Engineering education that cover fundamental SDLC phases aforementioned.

Table 1 (in Appendix) presents a detailed summary of the courses involved. These courses are described further in terms of: the course aims, the technical and generic skills addressed during the POPBL implementation for each

course, the aspects of learner assessments, example of projects conducted, and related implementation cycles.

### Findings and Summary

Based on the survey conducted and learners' responses, the overall feedbacks are positive and promising. Overall, most learners agreed that implementing POPBL in the taught courses has improved their non-technical skills such as planning, communication, teamwork (leader and peers); and their technical skills to creatively solve the real problems of the assigned application systems for the case study projects.

Despite the positive feedbacks received on the method, from the instructors' point of view, adopting the POPBL approach in T&L, however, demands extra preparation time, immense work, and greater participation, especially in monitoring group progress which includes giving prompt feedbacks and providing recommendations for each deliverable submitted.

It is believed that the incorporation of POPBL into relevant core courses in the Software Engineering education will provide a better alternative of developing learners' soft skills and technical skills compared to the traditional T&L environment.

### Acknowledgement

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## APPENDIX

SE course	Course Aim	Skills Addressed	Example of Project And Assessment	Implementation Cycles
PT1	This course equips the learners with theory and practice on problem solving techniques using the structured approach. Learners are required to develop programs using C++ programming language in order to solve simple to moderate problems.	<ul style="list-style-type: none"> <li>Technical and knowledge competencies: understanding the knowledge and technical theories of Computer Science</li> <li>Generic skills: critical thinking and problem solving</li> </ul>	<p>The problems are determined for each team with six case studies applications (Apps.) related to current trends in mobile application to study. The case studies were selected based on students' routine and lifestyle, for example: Success Calculator Apps., Priority Quadrant Apps., Monthly Budget Apps., Learning Style Apps., Daily Calories Calculator Apps., and Daily Water Intake Apps.</p> <p>Normally, 1 mini project with 3 assessments consisting of 3 iterations are conducted during POPBL approach implementation for this PT1, that are:</p> <ol style="list-style-type: none"> <li>Problem analysis and design document</li> <li>Small-sized software application and test cases document</li> <li>Enhanced software application and test cases document</li> </ol>	<ul style="list-style-type: none"> <li>Semester 1, 2012/2013 session</li> <li>Semester 1, 2013/2014 session</li> <li>Semester 1, 2015/2016 session</li> </ul>
SAD	This course intends to provide a practical approach of systems analysis and design skills for system development using structured development methodology. Hence the course enables learners to study information system requirements for any application system within an organizational context. The contents are sequentially and directly organized from planning, analysis, designing and implementation phases.	<ul style="list-style-type: none"> <li>Technical and knowledge competencies: understanding the knowledge and technical theories of Computer Science, as well as solving real problems using Software Engineering principles and methodologies.</li> <li>Generic skills: communication and teamworking</li> </ul>	<p>Learners have to identify and propose one system as the case study for the team's project with suitable stakeholders who are willing to help them during the early phases of their problem definition.</p> <p>Scopes of the system are limited to UTM business environment domain, health care domain or government sector domain. The proposed case study should either be a newly developed system or enhancement of the current available system in the said domains.</p> <p>For assessment, this SAD course applies 4 iterations based on the planned SDLC, namely:</p> <ol style="list-style-type: none"> <li>Problem analysis and design document</li> <li>Project planning and cost-based analysis document</li> <li>Requirement analysis and design document</li> <li>Software prototype, presentation, and overall project charter</li> </ol>	<ul style="list-style-type: none"> <li>Semester 1, 2012/2013 session</li> <li>Semester 1, 2013/2014 session</li> <li>Semester 1, 2014/2015 session</li> <li>Semester 1, 2015/2016 session</li> </ul>

SMRE	<p>This course highlights good RE practices in a software project that allow the software developer team - especially the requirements analysts - to appropriately communicate with related stakeholders in order to capture the needs of stakeholders in solving their business problems and achieving the organisation aims.</p>	<ul style="list-style-type: none"> <li>● Technical and knowledge competencies: understanding the knowledge on theories of Computer Science as well as solving real problems using Software Engineering principles and methodologies</li> <li>● Generic skills: communication and teamworking</li> </ul>	<p>In this course, learners are technically exposed and trained to experience the systematic process and activities that occurred during the RE phase namely elicitation, documentation, validation and negotiation, as well as management. Learners interact with real stakeholders (IT system development consultants) particularly in field of Plantation Management System and e-Campus Learning Management System.</p> <p>For assessment, this SMRE course applies 4 iterations based on the RE phases in producing the following software artefacts:</p> <ol style="list-style-type: none"> <li>User requirement document (URD) – analysis on business process (As-Is and To-Be)</li> <li>Requirements model document – goals model, UML use case model, use case specification, UML domain class model, UML activity diagram, UML sequence diagram</li> <li>Software requirements specifications (SRS)</li> <li>Prototype development &amp; presentation with peer evaluation</li> </ol>	<ul style="list-style-type: none"> <li>● Semester 2, 2014/2015 session</li> <li>● Semester 2, 2015/2016 session</li> </ul>
SQT	<p>To provide learners with a practical approach and in-depth knowledge of software testing and its process. The course covers the basic principles of software testing and test activities that include the test plan, test design, monitoring, implementation, and test closure. The learners will also learn various categories of test design techniques and methods used in both black-box and white-box testing. At the end of this course, learners should be able to recognize various types and levels of testing as well as categorizing and applying software testing process and techniques.</p>	<ul style="list-style-type: none"> <li>● Technical and knowledge competencies: understanding the knowledge on theories of Computer Science, as well as solving real problems using Software Engineering principles and methodologies</li> <li>● Generic skills: communication, teamworking, and leadership.</li> </ul>	<p>The case studies were selected based on real world projects that the students develop in their Application Development (AD) course being concurrently conducted in the same semester. Learners will conduct three main testing techniques namely static testing, black-box testing and white-box testing.</p> <p>For assessment, this SQT course applies 5 iterations to conduct various software testing techniques in implementing the POPBL approach as follows:</p> <ol style="list-style-type: none"> <li>Static testing (code analysis using Findbugs tool) and report review</li> <li>Black-box test case design - 2 cycles (using equivalence partitioning, boundary value analysis, decision table, and state transition) based on requirements and design documents</li> <li>White-box test case design based on developed program codes</li> <li>Automated test (test scripts using JUnit) and report review</li> </ol>	<ul style="list-style-type: none"> <li>● Semester 1, 2014/2015 session</li> </ul>

**Table 1** Summary of POPBL Incorporation in SE Courses Involve

24.

### **WEB CLICKER INTERVENTION TO ENHANCE ACTIVE LEARNING IN LARGE CLASSES WITHOUT PURCHASING CLICKERS**

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#### **Introduction**

Active learning is one of the student centred learning approaches to engage students in the learning process through learning activities. It is the process of engaging the students in activities that promote analysis, synthesis, and evaluation of what they learn rather than simply listening or watching passively. There are a number of active learning approaches to engage students in the learning activity individually and as a team. Among the variety of active learning approaches, we used think-pair-share (TPS), concept questions, 3-2-1 method, closure review and 2 minute papers (Felder & Brent, 2009).

As the number of students increase, it becomes difficult for the lecturer to engage each and every one of the students in a class. In addition to ensuring the active involvement of the students in the learning activities, it is equally important to assess students learning and retention of the studied concept as formative assessment and provide timely feedback. Clickers can be one of the possible options to enhance active learning process in large classrooms.

Clickers are interactive instructional technologies in which students use hand held devices/transmitters to provide electronic responses to a given question. Clickers provide a mechanism for students to participate interactively in learning activities anonymously and express their own views and ideas promoting active learning in a classroom. Once the students response to posed questions, automatically generated graphs illustrate the distribution of their response providing immediate feedback on their learning and understanding. However, conventional clickers requires purchasing hardware (Clickers) and associated software license, which might be costly both for the lecturer and the students. In addition, the conventional clickers can only be used during class. In recent years, there are a number of web-based technologies and a variety of clickers in the market such as iclicker (<https://www1.iclicker.com/>), poll everywhere (<https://www.polleverywhere.com/>) and web clicker system (<http://www.webclicker.org>) to name a few. The iclicker is subscription based while poll everywhere has a free option for limited number of participants (25) and hence cannot be used for large classes. To overcome these issues we used freely available platform, with unlimited number of students, and no additional cost to purchase the clicker from <http://www.webclicker.org> (Bao, 2012).

#### **Underpinning Theory of using Clickers to Enhance Active Learning**

Clickers are used to increase students' participation and assist the lecturer to quickly identify misconceptions. It also promotes engagement, especially in large classes. There are a number of success stories in the literature where the use of clickers has a positive impact on the students' learning. The study conducted by (Blasco-Arcas, Buil, Hernández-Ortega, & Sese, 2013) showed clickers positively influences active/ collaborative learning and engagement. Using clickers which provide immediate response together with cooperative social interaction has positive impact in motivating them and contributed to understanding the topics covered (Cotes & Cotuá, 2014). The study conducted by (Tlhoale, Hofman, Naidoo, & Winnips, 2014) on the impact of interactive engagement activities using clickers on a control group to assess student motivation and performance compared to traditional lecture shows significant improvement in terms of motivation and performance.

A study by (Freeman et al., 2014) shows that average examination scores were improved by 6% in active learning sections compared to traditional lecturing where the failure rate is 1.5 times more likely compared to students in active learning classes. Active participation of students in the learning process is much better than traditional lecture style teaching where the students are passive recipients of information. To investigate the effect and benefits of clickers in enhancing the student learning performance, (Blasco-Arcas et al., 2013) proposed framework that consists of interactivity, active collaborative learning and engagement as the key underlying forces. Accordingly, high level of interactivity using clickers positively influences active learning and engagement leading to better performance were observed in their study.

#### **Description of the Course and Implementation**

Dynamics is a three 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 enrolled for this course. In the course delivery, we are use active learning methods for our lecture class and cooperative learning for the tutorial sessions. The overall teaching and learning activities were divided in to three main parts as lecture, tutorial and guided learning activities (GLAs). The lecture and tutorial sessions are face-to-face with the lecturer and the GLAs are done by the students outside classroom. The lecture class is conducted using active learning approaches.

The use of clickers is embedded in the lecture through concept questions. The lecturer set up course on web clicker (<http://webclicker.org/>) and each student register with the course code given by the lecturer. All lecture materials were posted on e-learning one week before the lecture. After reading the material, the students are expected to answer concept questions posted on web clicker related to the lecture material as pre-lecture activity. This helps the lecturer to prepare for the lecture class addressing the misconceptions from the response. Additional concept questions or the same concept question (pre-lecture) can be posed during the lecture to assess the students learning and

understanding. Furthermore, after completing the lecture, the students are encouraged to answer further conceptual questions as a post-lecture activity. The level of difficulty for post-lecture questions is higher than the pre-lecture. It should be noted that none of the students in our class had used clicker before.

### Teaching Innovation

Web clicker platform works on any internet accessible device such as phones, pads, PCs, Laptops without the need to purchase the clicker (hardware). Almost all students in our class have smart phones and Wi-Fi facilities are available within the campus to access internet. Hence, there is no additional cost or limitation on class size to implement what is reported here.

Hand phones are considered as distractions to learning activities by some faculty members. Some even tried to bar the use of mobile phones. On the other hand, current students are very much dependent on these devices. A recent survey shows that 84% of people worldwide said they couldn't go a single day without their mobile phone (Duerson, 2012). In another study mobile users can't leave their phone alone for six minutes and check it up to 150 times a day (Spencer, 2013). Here we use their precious device towards our advantage to engage them in the learning process and get immediate feedback on their learning.

It is a well-known 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). But how do we ensure the participation of each and every one of the students in large classes? How can we get immediate feedback if there is a misconception on certain topics? How can we motivate students to prepare for class by reading the learning resources and take the ownership of their learning? All these can be addressed by integrating web clicker in the teaching and learning process. We used the web clicker to gauge student understanding before, during, or after formal lecture using concept questions. Hence, clickers can be one of the possible options to enhance active learning process in large classrooms.

### Study on Impact of Web clicker & Active Learning

To assess the impact of active learning on student learning we conducted survey on two batches of students. There were 35 respondents in the first batch (May 2015 Semester) out of 52 students and 47 respondents out of 127 students in the second batch (September 2015 Semester). The overall response from both surveys was positive despite the fact that the students have experienced for the first time the full implementation of these approaches.

The impact of web clickers in enhancing the active learning approach and student perception was conducted using a questionnaire adopted from (Richardson, Dunn, McDonald, & Oprescu, 2015). There are five questions with five point Likert scale ranging from strongly agree to strongly disagree. The survey result is positive with most of the respondents in

agreement from the mean and standard deviation of response shown in Table 1.

**Table 1 Summary of the statistical analysis of survey (n=47)**

Survey Questions	Mean	SD
Web Clicker made me read more before class	3.79	1.041
Using Web Clicker helped me to think more deeply about course materials	3.66	.984
Web Clicker used in this course motivated me to learn	3.6	1.035
I found this method of interaction between students and lecturer effective	3.72	1.036
I would recommend Web Clicker to be used in other courses	3.36	1.241

In addition to survey question, we have used open ended question to get student feedback on overall course delivery after they complete the course. Sample student feedback is shown in the following snippet.

Question: In teaching this course, what do you want me to continue?

Sample responses:

- *webclickers, tutorials, in class exercises... everything is good and very effective method of continuous learning*
- *The usage of web clicker is good to learn the fundamental concepts of the subject...*
- *webclicker.. tutorial and all of them..*
- *Pre.&Post-Class quizzes; they really get the students to engage with the subject.*

These feedbacks are similar to what was pointed out by (Mayer et al., 2009) where clickers encourage students to participate especially in large classrooms. Through continuous quality improvement, it is possible to further improve this approach and use in other courses.

### Acknowledgement

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25.

### EXPERIENTIAL METHODS OF USER-CENTERED DESIGN IN THE CLASSROOM (An innovative student centered learning approach)

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#### Introduction

The Design EPICS Program at Colorado School of Mines (CSM) is an introductory course sequence in user-centered design methodology. These courses provide first and second year engineering/science students with a basis for open-ended problem solving through an iterative process, a process which highly values users' perspective and feedback for continuous improvement of the proposed solution. The purpose of this poster presentation is to provide compelling rationale and to present experiential methods of incorporating user engagement with the engineering design/problem solving process, specifically for the purpose of enhancing first year engineering education.

In the 1980s, Donald Norman's co-published paper, "User-Centered System Design: New Perspectives on Human-Computer Interaction (Norman & Draper, 1986)," was the first to place the users and stakeholders of a design problem

at the center of the design process (Abrams, Maloney-Krichmar, & Preece, 2004). Scholars such as Jakob Nielsen continued to solidify guidelines for "usability engineering" (Nielsen, nd) while design consulting firms such as IDEO and Frog Design assisted ambitious companies in meeting their goals in creative and successful ways. Through significant strides in the '80s and '90s, users/stakeholders were framed as essential to the design process, rather than passive receivers of the end solution.

The EPICS program incorporates these design principles into Colorado Schools of Mines' cornerstone engineering problem solving course through the following methodology:



Figure 1. Problem Solving Methodology in EPICS, CSM

#### Activity: User Empathy Exercise

After explaining the scope of the problem, instructors provide students with a simulation of an environment/activity mimicking the problem from a user's/stakeholder's perspective. This is what we call the 'User Empathy Experience'. Students reflect on the experience through a written deliverable, which at the minimum seeks to compare how students viewed the problem initially and how they viewed the problem from a user's perspective after the experience. An in-depth analysis would discuss consideration of the design based on the experience.

Course instructors implement user engagement throughout the process by experimenting with different activities in the classroom, a few of which are highlighted in the pictures below.



Figure 2. During the user empathy exercise, first year student Z. Errazi is trying to put on clothes while being in a wheelchair (Hennen, 2015)



**Figure 3.** During the user empathy exercise first year student Z. Wang is trying to open a door while in a wheelchair (Hennen, 2015)



**Figure 4.** During the user empathy exercise, first year student A. Sholsberg is trying to move out of the wheel chair, and into his chair (Hennen, 2015)

### Discussion

The user empathy exercise pictured above was introduced to students after the problem definition stage and before the exploration stage. The project was to retrofit a wheelchair to make it suitable for use in Africa. In the beginning, students were instructed to identify stakeholders and clarify project goals. Students were also asked to list opportunities for improvement (“bug list”) from the perspective of the wheelchair’s designer. Before the user empathy exercise, students were to expand the bug list and imagine what the challenges would be for users in a wheelchair performing daily tasks (“anticipated bugs”). During the exercise, students were to observe their teammates as well as list the challenges they personally experienced (“observed bugs” and “experienced bugs”).

### Outcome

Following the exercise, students assessed their experience through a user empathy reflection essay. Many of the students stated the importance of literally putting themselves into the users’ context to better understand the problems. Some indicated the anticipated bugs turned out to be exponentially harder than imagined. Others talked about how this exercise helped them prioritize the project goals within the design process which would hopefully make the retrofit more valuable for the users. Finally, a specific first-

year student (A. Miller) who excelled in this exercise made the following comment: “From this empathy user experience, empathizing can be applied to future classes, internships and careers as it is important to understand the needs of people, allow for a broader, non-personal perspective, create clear spoken and unspoken communication and allow for more accomplished and productive team work.”

### Qualitative Results

Through these classroom activities, the instructors found that bringing user engagement exercises to the problem solving process achieved a number of results:

- Increased student engagement, as observed by energy level and enthusiasm in students in the weeks after the user empathy experience
- Enabled students redefine and gain a sense of ownership over their problem statement, as observed in their Design Proposal Presentation
- Motivated students to create prototypes which were more engaging, interesting, and effective

Baseline data and other substantial evidence of the results will be presented during the poster presentation. An official student assessment is still under development. Additionally, in the I-PHEX 2016 poster presentation, the instructors will present two more user empathy activities completed in the subsequent semesters (Fall 2015 and Spring 2016), related to two different projects.

### Acknowledgement

The authors would like to acknowledge the leadership and administrators in our College of Engineering and Computational Science, for the continuous support towards the Design EPICS program’ initiatives in innovation.

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26.

### INTEGRATED PROJECT AS AN AUTHENTIC PLATFORM TO ENHANCE ELECTRICAL ENGINEERING STUDENTS’ LEARNING AND ENGAGEMENT

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### Introduction

Several engineering tertiary institutions have focused their concerted effort on curriculum integration in order to build and develop interconnectivity and relevance between topics.

This effort was also undertaken by Electrical Engineering (EE) Division at Ngee Ann Polytechnic in Singapore. The design and development work focused on second year Electrical Engineering curriculum. The key development is an integrated student-centric project (ISCP) that leverage on the use of authentic real-world application as a bridge to link topics covered in three core second year modules.

### Current Challenges

A major challenge in many engineering curricula is that courses are taught as individual topics in isolation, disconnected pieces or in silo. As argued by Traylor, Heer et al. (2003), in the context of engineering, courses are separated like remote islands, implying by silence that each topic has little or no relation to any other and that they are only in some yet undisclosed way related to the practice of engineering. The system view or 'big picture' of a particular engineering discipline and how the constituent pieces relate to each other is often not assimilated by the student until later in their education, if ever. Students are often 'thrown into the deep end' as they embark on their final year capstone projects. They are often required to 'piece together' the knowledge and skills that they have learnt in the elementary years and embark on their perceived daunting 'major engineering project'. It may be evident that some students are not well prepared for an authentic real world problem or project they are required to solve and let alone applied learning.

Facing the same challenge where students from the Electrical Engineering (EE) Division at Ngee Ann Polytechnic. Feedback from students revealed that they were unable to see the 'big picture' or the purpose and meaning of learning a particular topic in a module. Very often, the real-world problems are entrenched and perceived as complex and intricate from the students' perspectives. Besides, a review of the EE curriculum showed that lesson delivery was predominantly didactic, which is essentially a passive learning approach. This can present a challenge to EE students who are predominantly visual-kinesthetic learners, as reported by Alex See (2013). Such mismatch between the teaching style and student learning preferences, if not managed, can disengage students for their learning (Felder & Silverman, 1988).

In response, a more experiential, integrative and active learning approach was introduced in the 2<sup>nd</sup> year EE curriculum through an integrated student-centric project (ISCP).

### Teaching Innovation

The integrated student-centric project (ISCP) leverage on authentic real-world everyday objects to link three core second year modules, namely the Micro-controller Applications (MA), Power Devices & Applications (PDA) and

Sensors & Instrumentations (SIN) modules. Students have to apply, draw and integrate learning from all three modules for their integrated project. Figure 1 depicts the ISCP within the three years Electrical Engineering curriculum.

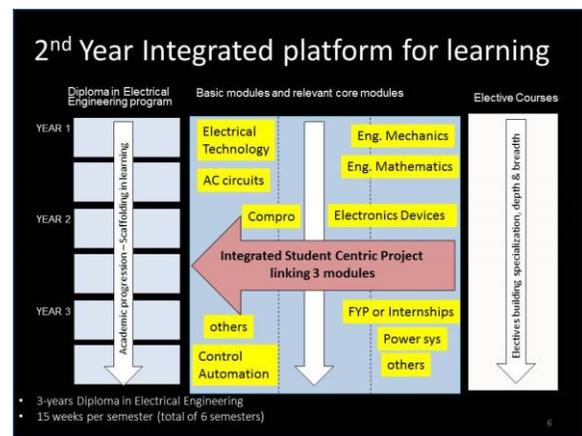


Figure 1 depicts the ISCP (Integrated Student Centric Project) within the three years Electrical Engineering curriculum

The real-world everyday object used to be purposeful, redesigned washing machine. It is a common household appliance familiar to students, and contains essential components that are related to topics covered in the three second year core modules. To illustrate, the usage of LDR (light dependent resistor) as a simple sensor for teaching may be commonly found in PDA, MA and SIN modules. In the PDA module, students' knowledge of using the LDR as a sensor were scaffolded when they use and apply this to their mini-project on the Automatic Light Dimmer circuit. Similarly, in SIN module, students learn and appreciate the use of the LDR as a sensor from the lecturers. Subsequently, they would use it for their washing machine mini-project for the detection of the washing machine lid-cover. This would be similar in the case of MA module, where students also learn to apply their knowledge of different types of sensors for such application.

Figure 2 depicts the tightly weaved inter-connections of topics from the three different year 2 modules. The relations and learning between topics becomes distinctive and clear when viewed from the perspective from the authentic washing machine learning platform.

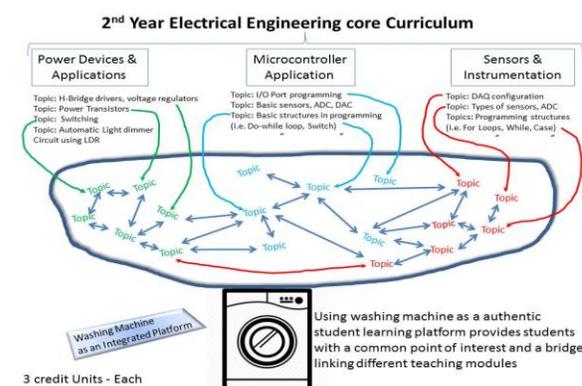


Figure 2 depicts the linkages for the different topics from 3 different modules

## Implementation

The three second year modules, PDA, MA and SIN adopt a typical Lecture-Workshop teaching model. Prior to implementing ISCP, content was delivered during lecturer before the workshop sessions. Each workshop session was designed separately with little connection across modules, PDA, MA and SIN. Students struggled with making firm connections with the lecture content during the hands-on workshops as well as topics learnt across modules.

With the introduction of the ISCP, a custom-made learning artifacts, the washing machine was used to provide a common platform to help students relate the theory and concepts learnt during lecture to an everyday engineering object. Specifically, the workshop sessions for PDA, MA and SIN were re-designed to make use of the washing machine as the anchor integrating platform with which they apply their knowledge acquired in the modules to design parts of the washing machine.

In addition, a different pedagogical approach, blended learning model, was used. The weekly mini workshop activities were supplemented with supporting video instructions that are related to the workshop activities (i.e. MA and SIN modules). This reinforces learning and provides just in time information to help students with their hands-on practice, which research have shown to have a positive impact on learning compared to traditional face-to-face lecturers (Wieling & Hofman 2010). These mini workshops scaffold students' learning and enable them to apply their skills acquired in the culminating mini-project where they are required to design different functional parts of the washing machine.

### *ISCP in Sensors & Instrumentation (SIN) Module*

In this module, students learn about virtual instrumentation, sensor technologies and develop skills on how to make use of graphical programming software (e.g. LabVIEW) to create virtual instrumentation systems.

Figure 3 depicts a student applying what he has learnt in SIN about Queued State Machine design architecture or design pattern to implement a washing machine controller using LabVIEW. Students were guided to develop a basic state machine architecture or algorithm to control various states of the washing cycles and the speed of the rotating motor/drum.



Figure 3 A student developing a state machine programming

### **architecture/algorithm to control the various states or washing cycles of the washing machine**

#### *ISCP in Microcontroller & Applications (MA) Module*

In MA, students learn about microcontroller, how to program it using assembly language and its interfaces with hardware systems.

In this module, the culminating mini-project requires students to apply what they have learnt about microcontroller and its programming to design the washing cycles and control algorithms of the washing machine. Figure 4 shows a purposefully designed and developed Microcontroller board with INTEL 8051 microcontroller chip and a small 12V DC motor attached. Students make use of this board and motor to test their program before interfacing it with the driver unit which they will build on the PDA module.



Figure 4 depicts a standalone In-circuit microcontroller programmer along with a purposefully designed and customized circuit board with INTEL 8051 microcontroller.

#### *ISCP in Power Devices and Applications (PDA) Module*

In the PDA module, the emphasis on learning involved teaching students how to use different kinds of electrical switches (BJT, MOSFET), Thyristors, power electronics devices and H-bridge power drives circuit. Students worked on various mini-projects to scaffold their learning towards their final development of their power circuit board for the real washing machine project.

Therefore the culminating mini-project requires students to apply what they have learnt about various relevant power devices and circuits to develop a purposeful power circuit board to operationalize the washing machine. The power circuit board will control the motor rotation speed and direction.

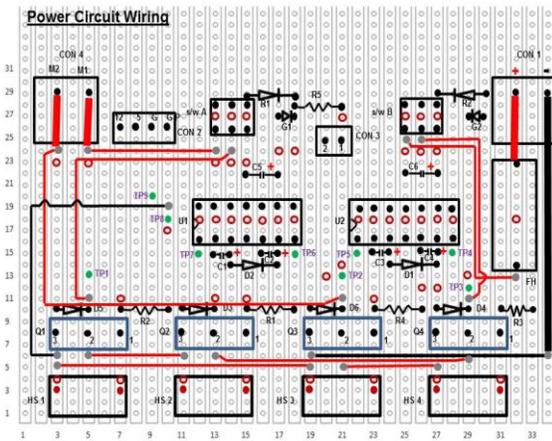


Figure 5 depicts a prototype power circuit wiring board design

### Survey Summary and Key Findings

The inception of the first ISCP in the second year EE curriculum took place in semester 1, April 2014. This ISCP washing machine project has been experienced by four cohorts of students to date, till October 2015.

Google survey was administered to obtain feedback on students' experience of ISCP in the three modules. There were seven questions in the survey, two of which focus specifically on their experience of ISCP in terms of engagement and impact on learning in the module. The survey questions were based in the form of five levels Likert items/scales Strongly Agreed (5) to Strongly Disagreed (1), and nominal Yes/No scale.

The actual survey results for each module were conducted towards the end of the semester 1 and 2, April 2014 and October 2014 respectively.

The numbers of respondents in each module are as follows:

- MA – 84 students' respondents
- SIN – 66 students' respondents
- PDA – 56 students' respondents

Overall, the students responded favourably to the ISCP work in their second year of EE curriculum. In relation to a binary response (i.e. YES/NO) question, "This project helps in my overall learning experience", the following positive responses were garnered:

- SIN module (90.9%) responded positively (YES)
- MA module (75.0%) responded positively (YES)
- PDA module (75.0%) responded positively (YES)

In another binary response (i.e. YES/NO) question, "This project helps in my understanding of the module", the following positive responses were garnered:

- SIN module (81.8%) responded positively (YES)

- MA module (73.8%) responded positively (YES)
- PDA module (66.1%) responded positively (YES)

A comparative quantitative survey analysis was performed between April 2014 (SEM 1) and October 2014 (SEM 2). This involved examining the students' surveyed responses for only two modules, namely, the MA and PDA modules. The SPSS descriptive statistical analysis results are briefly presented.

The total number of student respondents (i.e. MA and PDA) for semester 1 and 2 are 140 each. Figure 6 shows the responses received for the question "This project is interesting". The data show that 26.6% (SEM 1) and 28.6% (SEM 2) of the students' responses (i.e. Disagreed and Strongly Disagreed) had inclined to disagree that the integrated washing machine was interesting. Overall, the data revealed encouraging and positive results that a majority (i.e. >70%) of the students found the integrated washing machine project interesting.

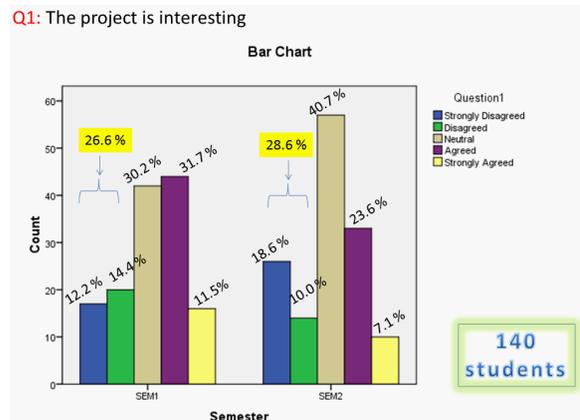


Figure 6 Both MA and PDA modules combined students' survey responses to question 1.

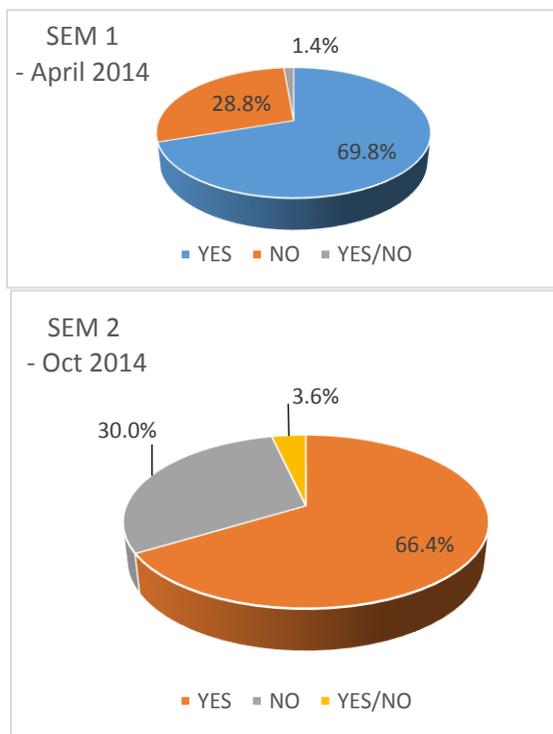
In relation to the question, "This project helps my understanding of the module", figure 7 shows that 69.8% (SEM 1) and 66.4% (SEM 2) of the 140 students' responses had inclined to support the fact that the integrated washing machine ISCP does give aid to enhance their understanding of the modules. This positively suggests, that an average majority (i.e. 68.1%) of the students found that they were able to learn from the project, theory and practical to assimilate to real world application.

In addition to the survey, feedback from University professors and industry also shows support to this authentic learning platform. Some of their comments were included below:

"The strong attributes of an authentic real world platform for learning through the use of a washing machine significantly provides an integration of knowledge for the engineering students. This carefully designed learning platform that has been adapted by the faculty teaching team from the Electrical engineering division (SoE) at Ngee Ann Polytechnic is a demonstration of the team's commitment to

enhance the engineering curriculum. The tight integration of theory/concepts and hands-on practices is fundamentally crucial and extremely relevant and appropriate in developing both practical engineering skills and knowledge for students. This purposefully designed real-world platform of the washing machine provides the conceptual 'glue' linking or weaving topics or subjects that spans across the three teaching modules in the second year electrical engineering curriculum. Further, this useful, scalable model or framework should be strongly advocated in engineering curriculum and possibly duplicated to other engineering disciplines. Lastly, I can envisaged that there is a strong potential for scalability of this framework or model and the high value and impact it can potentially deliver to the students' learning."

**Mr Chandran Nair, Vice-President of National Instruments (Asia Pacific Region). National Instruments is a top 25 multinational corporation in the world. A Renowned leader in the Measurement and Instrumentation**



**Figure 7 Both MA and PDA modules combined students' survey responses to question 6.**

"The multidiscipline approach integrating several areas of electrical engineering through the use a real-world sophisticated whiteware product as a learning platform that has been adopted by the team from the School of Engineering at Ngee Ann Polytechnic in teaching of their Diploma of Engineering program is extremely useful and well-focused towards developing practical engineering skills. By running the practical exercises in parallel with the theory, it improves the students understanding of the theory at the same time as developing application and design skills. The implementation of the approach has got the highest importance in the cognitive domain such as evaluation and link together state-of-art engineering techniques and synthesising appropriate technical solutions. The proposed platform has got an excellent potential for further expansion

into a number of other engineering areas like material science, mechanical engineering, ergonomics and engineering product design, while taking into account such important considerations as manufacturability, project and cost management, industrial automation, and of course very crucial issues of sustainability and environment protection".

**Professor Serge N Demidenko PhD, FIEEE, FIET, CEng**  
**Associate Head of School of Engineering & Advanced Technology**  
**Cluster Leader - Electronics, Information & Communications Systems**  
**Massey of University, New Zealand**

## Conclusion

This project advocated and emphasis on the development of an integrated student centric project that leverages on an authentic real-world washing machine to help students connect theory to practice. The project has shown a positive impact on students' learning at the Electrical Engineering Division. Moving forward, the curriculum development team will continue to explore new integrative platforms, such as electric vehicle, to expand the range of authentic learning artifacts.

## Acknowledgement

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## AN ENHANCEMENT OF MOODLE LEARNING FRAMEWORK WITH SUPPORT ADAPTIVE FEATURES - utmsmartlearn.com

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### Introduction

Nowadays, the enhancement of technology has enabled students from all around the world, having new learning experiences by using learning management system (LMS). Due to the limitation of traditional classroom, LMS become a primary platform as a medium for teaching and learning process (Herman Dwi, 2014; Hannay, 2006). LMS become the platform that support web based learning for content development (Ahmad et al., 2010). LMS not only a platform for course management but also has many functions and features.

The general functions in the LMS are content publishing and management, assessment and grading, administration, user interaction, teaching and learning content (Giguruwa et al., 2012). The functions provide space for communication between students and teacher, and for the teacher to monitor student. In the past few years, LMS which incorporates adaptive features are on demand. The features aid the students acquire suitable materials and are able to fit their learning pace and style. Two important factors in supporting adaptive features include student learning style and knowledge level. Learning style reflects how a student learns and prefers to learn and it indicated an instructional strategy informing the cognition, context and content of learning (Keefe, 1987; El-Bishouty et al., 2014), while the knowledge level shows various levels of student's knowledge about certain subjects (Brusilovsky, 2003).

Therefore, our utmsmartlearn has been developed by enhancing Moodle framework, the existing popular learning system framework and most likely to be chosen open-source learning platform in the current web environment. This recommendation mechanism is attempting to accommodate to a possible variation in student's learning style and knowledge level.

### Picture of the Product

Can be accessed via <http://utmsmartlearn.com>



Figure 1. System Front page

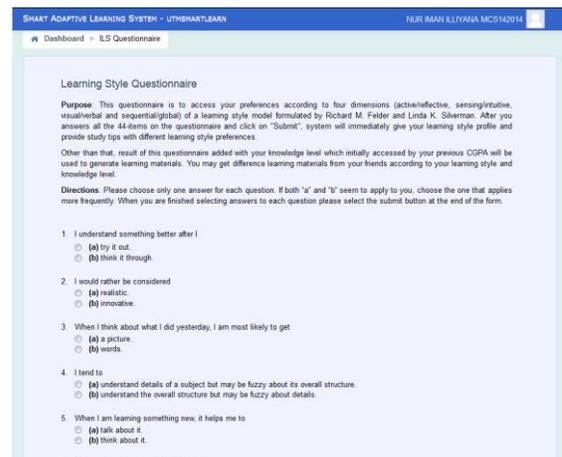


Figure 2. Index Learning Style (ILS)

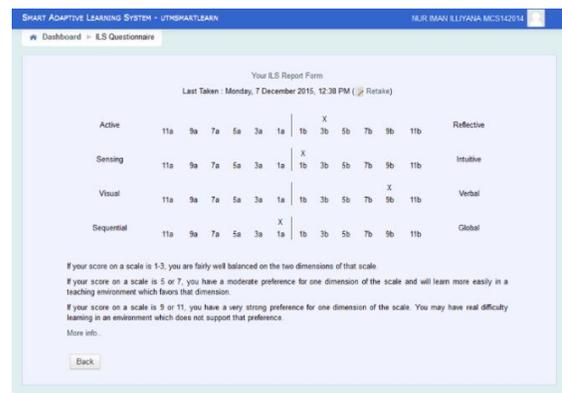


Figure 3. ILS Report Form

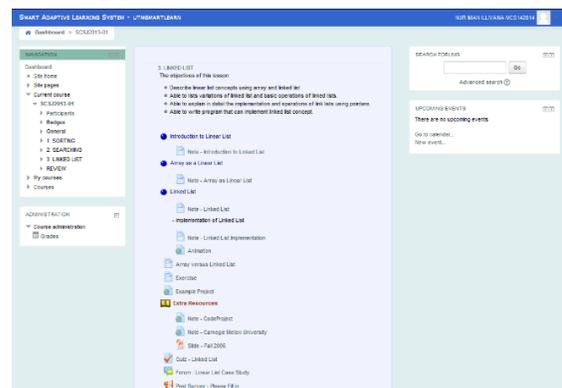


Figure 4. Sample Student Dashboard

## Theoretical Foundation

Felder-Silverman Learning Style Model (FSLSM) is a model used to describe the student's learning style and classifies it between preferences of four dimensions (Felder and Silverman, 1988). FSLSM is a well-known model applied in many research related to learning styles with advanced learning technologies. FSLSM is creating an association between learning style and relevant teaching method that can be used to support student's learning preferences. FSLSM categorized students into four learning style dimensions; perception (sensing or intuition), input (visual or verbal), processing (active or reflective), or understanding (sequential or global). Based on this model, this study emphasizes on the preferred way students are inputting or receiving information, with two poles (visually and verbally). For instructor it is very important to know what mode of presentation to be used. Visual learning style is understanding new information better by seeing it as pictures, demonstrations, diagrams, charts, films while verbal learning style is understanding new information better through written and spoken words (Feldman et al., 2014). Table 1 shows the recommend types of learning materials based on the student's learning style.

Felder-Soloman Index of Learning Style (ILS) is created by Soloman and Felder (n.d.) is an ideal model to identify an individual dimensions of learning styles by asking 44 questions. Each question has possible two possible answers, a or b which corresponds to either one of the categories related to the dimension. The rating of each dimension ranging from -11 to +11. The ILS is often used as a medium to identify learning style (Graf et al., 2007). To identify students' learning styles in an online learning environment, the ILS has been automated in the system. This technique has been used by many researchers to identify initial student's learning style (Limongelli et al., 2009; Graf, 2007; Yang et al., 2013; Tseng et al., 2008; Canavan, 2004; Graf & Kinshuk, 2007; Esichaikul et al., 2011). On this platform, student will get suitable learning materials based on the student's learning style identified using automated ILS, content adjusting principles and recommended activities set in the system.

Table 1. FSLSM toward online environment

Learning style	Content adjusting principles (Yang et al., 2013)	Recommendation activities (Graf, 2007)
Visual	Provide the students with more visual materials, such as diagrams, sketches, schematics, photographs, or flow charts.	<ul style="list-style-type: none"> <li>Graphics, tables, flow charts, images, videos, demonstrations, conceptual maps, color notes with highlighters, slides with multimedia and animations.</li> <li>Slideshows, a digital library, case studies and a focus on</li> </ul>

		synthesis.
Verbal	Provide students with more text materials.	Text-based material, also including audio objects, lesson objectives, hypertext, slideshows, a digital library, conceptual maps, and hypertext.

## Teaching Strategy

This system has been implemented and tested in the web hosting to allow users to access. Six versions of learning materials based on learning style and knowledge level has been uploaded into the system including additional resources. An experiment was conducted to explore the effect of adaptation to different learning style and knowledge level. Twenty-eight students from undergraduate of Computer Science at Faculty of Computing, UTM for session 2015/2016 semester 1 were participating in the Data Structure and Algorithm course.

Students need to answer ILS Questionnaire for first time access to the system to identify their learning style and the student's knowledge level is initialize based on their current CGPA. During the learning progress, the system will monitor student's progress and update the knowledge level during the fruition of the courses, taking into account results from quizzes and tests. The system would provide the student with suitable learning materials based on individual attributes and adaptive features. So that, every student may get different materials and activities with their friends.

At the end of the course, students were given a survey that contained thirty 5-point Likert Scale items to measure the acquired knowledge after having surfed the proposed system. The questionnaire was designed by adapting from several studies which using questionnaire in evaluating adaptive learning system and usability (Mustafa & Sharif, 2011; Hassan et al., 2012; Esichaikul et al., 2011; Ng et al., 2002; Marković et al., 2013).

## Innovation Features / Capabilities

- **The automated online ILS was developed using a combination of PHP language and MySQL database for identifying and storing the result collected.**
- **The result achieved help students know and understand their preferred learning style.**
- **The data that is stored and collected would be used and analyzed by agents scripted in PHP language which would then presenting relevant learning materials to the student.**
- **The modification in the existing Moodle code improves the LMS features and reduce information overload for the student.**

## Impact

From the results received, it was found that the student had a positive feedback to the proposed system, especially on its user satisfaction and adaptive capability. The respondent feedback results are shown in Table 2. It is observed that students are easy to choose suitable learning materials and feel convenient to study and understand the course content compared when using the LMS without supporting adaptive features. As many researchers found that, considering learning style and knowledge level in traditional or online education can impact individual performance.

**Table 2. Feedback results from proposed system, utmsmartlearn**

Component	Mean**	Standard Deviation
System access	3.67	0.93
System navigation	3.33	0.75
Adaptive capability	3.76	0.59
Learning materials provided	3.61	0.64
User satisfaction	3.91	0.57

\*\* Based on a five-point Likert scale with "strongly disagree" (1), "neutral" (3) and "strongly agree" (5)

## Conclusion

To conclude, it is believed that utmsmartlearn can be implemented as an alternative technology for other organization, educational institution, individual instructors and private organization in the education process by proposing a suitable and relevant learning material to the student. However, there are still many points and room for review and improvements. The team will continue to review and improve the system, such as:

- **Enhance the framework by taking more adaptive features into consideration that might affect student's learning performance.**
- **Developed an authoring tool that can embed in the proposed system to assist the instructors in developing various versions of learning materials based on personalization information.**
- **Evaluating the proposed framework using other evaluation methods that may give more precise results.**

## Acknowledgement

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28.

**USING ON-LINE MULTILITERACIES PROJECT APPROACH (e-MULPA) IN A BLENDED CLASSROOM: A CASE OF ENGLISH FOR COMMUNICATION COURSE**

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**Introduction**

The issue of unemployment among university graduates in Malaysia is actively discussed among academia, government officials as well as the public, in which 161, 000 graduates were reported to be unemployed (Bernama, 2015). Studies (Hairuszila, Hazadiah, & Normah, 2009; Yahya, 2006; Morshidi, Chan, Shukran, Seri Rahayu and Jasvir Kaur, 2012) indicated that the issue of unemployment among Malaysian university graduates may be caused by the lack of employability skills and 21<sup>st</sup> century skills among the graduates. In the 21<sup>st</sup> century, education has taken a new turn due to the transformations caused by globalisation and the advent of technologies in the 21<sup>st</sup> century.

In addressing an important Malaysian government policy to enhance graduate employability competence among university graduates, a popular approach is to provide learning using online tools. Nevertheless, we contend that posting documents online (lecture notes and exercises) as a repository is not sufficient to generate multiliterate graduates as required by the 21<sup>st</sup> century and the Malaysian government. Focus should also be put on the knowledge process and 21<sup>st</sup> century skills such as communication skills, technological skills, creative and critical thinking skills as well as collaborative learning skills. As such, a learning model is needed as a framework of reference for teachers and students to incorporate learning using online tools, 21<sup>st</sup> century knowledge process as well as the authenticity of classroom learning to generate multiliterate graduates.

Hence, e-MULPA is being initiated. This novel teaching and learning approach focuses on the online multiliteracies project approach that would combines the authenticity of classroom learning with learning using online tools. E-MULPA combines three established teaching approaches which are: the multiliteracies approach (Fariza Puteh-Behak, 2013, The New London Group, 2000), task-based language teaching (Ellis, 2009; Ramiaida Darmi, 2013), and project-based learning.

**Teaching Innovation**

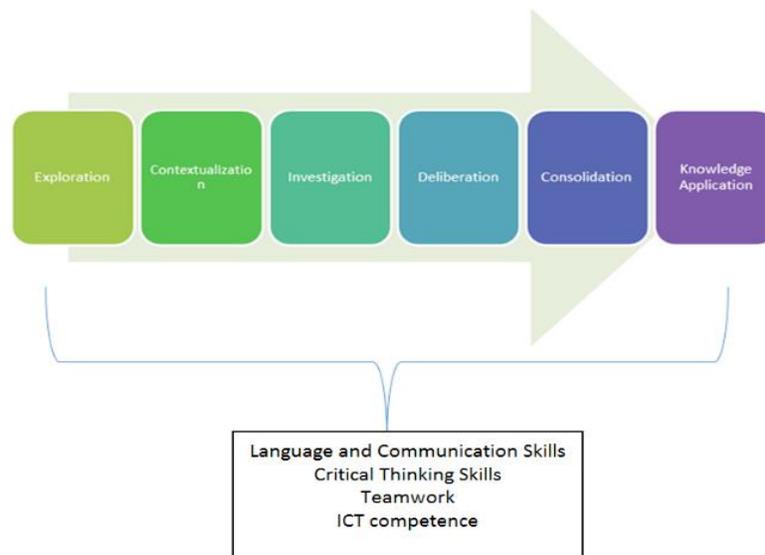
**e-MULPA Framework**

Unlike other teaching methods, e-MULPA implements a new teaching and learning approach using an on-line multiliteracies project, which combines three established teaching approaches to be utilized in an ESL classroom setting. The approaches are:

- i. multiliteracies pedagogy
- ii. task-based language teaching
- iii. project-based learning

The fundamentals from these three established teaching approaches were combined and extended to create a new teaching model called online multiliteracies project approach (e-MULPA). E-MULPA not only focusses on the use of multimodal resources, but also focuses on the cultivation of 21<sup>st</sup> century knowledge processes such as applying, analyzing and creating something new based on existing knowledge.

Based on the framework, a module was produced. The module aims to assist English lecturers in producing interesting on-line and classroom based activities which are relevant and engaging for learners. e-MULPA is different from other learning modules as it provides students with a meaningful learning experience. All lessons in the classroom are connected to the completion of the main multiliteracies project, in which the students will be involved in a variety of knowledge process such as communication skills, technological skills, creative and critical thinking skills as well as collaborative learning skills. The project-based lessons are specifically designed to equip the students with the necessary skills to be effective graduates. Below are some parts of the e-MULPA framework:



This adaptable e-learning model or e-MULPA is utilizable not just in language classrooms, but also by educators from all disciplines. With the help of USIM's Learning Management System (LMS), i.e. G.O.A.L.S (Global Open Access Learning System), e-MULPA has been a success in a blended classroom.

### **e-MULPA Study**

The e-MULPA framework has been implemented in a few English as a Second Language (ESL) classrooms in Universiti Sains Islam Malaysia for two semesters. This paper discusses the first stage of the implementation.

The first stage of implementation was carried out in two English for Communicative Purpose class, involving 58 students. The students were in their first semester in their undergraduate program. Their main multiliteracies project was to create a documentary based on a mini-research regarding a special issue in their own community. The project was called 'Majalah USIM'.

This study was a mixed-method study. Data was collected through questionnaire, observation, semi-structured interview as well as reflective journal. Data from the questionnaire were analyzed using SPSS. All qualitative data were analyzed through thematic analysis.

The e-MULPA framework was then adopted by a English Language teacher in USIM's Matriculation Centre. It was implemented in two ESL classrooms in 2015/2016 session.

Preliminary findings show that the students considered learning through e-MULPA framework as something new and different from their regular examination-based English language classroom. Some students described their learning experience as challenging and adventurous as evidenced in the following excerpt from the students' journal reflection:

*"Yes, I do the learning experience through research and survey. And producing video presentation because it is challenging to me"(BS1).*

In addition, most students provided positive feedback on their experience in conducting mini-research and producing videos as evidenced in the following excerpts :

*"I like learning about research survey using Google Form because before this I have never use it. I like producing video because I have a deep interest on video editing and such. Thus, this experience help improve my video producing skills for future use"(BS3).*

In short, most students claimed that they have learnt so many aspects other than the English language skills, including communication skill, technological skills, problem-solving skills as well as teamwork skills.

### **Novelty of the Study**

#### *Society*

Traditionally, learning is made up of separate and disconnected pieces, causing students to have a disrupted view on the subject matter. Through e-MULPA, learning is made more meaningful as all lessons are interconnected and arranged to involve the students in a meaningful learning experience. In being part of a meaningful learning experience, the student will have a better understanding of the subject matter and have the opportunity to practice 21<sup>st</sup> century skills. It is hoped that these learners will be able to polish their employability competence.

#### *Economy (Commercial Potentials)*

An e-MULPA module is being published. The e-MULPA module is a first of its kind in providing references for English language lecturers to incorporate online tools, 21<sup>st</sup> century skills and the authenticity of classroom learning in order to generate multiliterate graduates for the 21<sup>st</sup> century workforce. This module is comprehensive as it will guide

educators in designing a multiliteracies project approach in their own learning context. The module will also outline how to interconnect the lessons to make learning more meaningful.

#### Nation

The e-MULPA module and lecturer's guide are beneficial as they assist lecturers in producing unique on-line lessons aimed at generating skilled university graduates who possess 21<sup>st</sup> century skills and are able to meet the demand of modern employment.

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29.

#### **WHAT-HOW-WHY: A FRAMEWORK FOR THINKING AND DIRECTION FOR LEARNING THROUGH LEARNER-GENERATED QUESTIONS TO ENHANCE TEACHERS AND STUDENTS CRITICAL THINKING**

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#### Introduction

The essential needs for the teaching of critical thinking skills in higher education have been widespread discussed due to the growing needs of a knowledge-based economy (Lai, 2011). It is no longer enough for higher institution's graduates simply know basic facts and skills. To be successful, students must master decision making, prioritising, strategising, and collaborative problem solving (Limbach & Waugh, 2014). Saido, Siraj, Nordin and Al-Amedy (2015) note that many assumed that thinking skills develop automatically as students go through their schooling years, critical thinking, specifically, needs to be taught, either implicitly or explicitly. In taking a closer look to the development of students' higher order thinking skills in higher institution; many graduates are not able to reach the goal of learning to think critically (Smith & Szymanski, 2013). To address this dilemma, the What-How-Why was introduced as a supporting framework that can be used in typical courses, workshops or colloquium for enhancing students in developing critical thinking skills as well as a professional enhancement program to prepare teachers to teach higher order thinking skills. This framework is not only for a deeper level of understanding, but at the same time, aims to support students learning by cultivating curiosity, engage students in their learning and empowering students to take ownership of their learning thus encouraging creativity and stimulating critical thinking. The framework has some fundamental relationships to social constructivist approach to learning. According to Bruner (1974), when students learn, they should develop concepts and create categories to distinguish objects with various types and forms found in the environment. Through the formation of these concepts, students will compile the information gathered into meaningful units. In this process, students will understand the environment and the concept continues to grow in line with the maturity of a person.

#### What-How-Why

The What-How-Why framework consists of three levels of questioning: identifying, processing and reasoning. The identifying question is a question to gather facts or ideas that is being observed and considered as the lowest level of Bloom's Taxonomy. For example, question begins with 'What is the meaning of..', 'Is the..' and 'Can a...'. It involves concrete observations and pertinent to developing the concept. Next, the processing question is concerned with the processing of information that is based on the relationship between questions and responses (answers). The questions begins with 'How..', 'Is it possible..', 'What will happen if..'. Processing questions help to facilitate thinking. It uses a higher level of the taxonomy Bloom that require students to qualify their responses. The questioner is encourage to use a response to guide other questions. At this level, it involves observation between the concrete and emotional point. The final level of questioning is reasoning question. At this level students are encouraged to apply the concept beyond the scientific text and to evaluate the concept based on a set of criteria. Reasoning questions should cause students to think about the scientific text-based concept in a broader perspective than the limited scope of the text selection. The question begins with 'Why..'

'What causes.', and 'What is the purpose.'. This level also involves a higher level of the taxonomy Bloom that require students to evaluating arguments and formulating or evaluate a plan of action. Moreover, the questions demand an explanation that can be obtained from the sources of knowledge.

All questions in the What-How-Why are generated from students helping them explore the scientific-text based information in depth. Each question serves as another piece of the exploration of learning – setting the direction for learning – so when questioning is concluded students understand and create understanding of the concept.

### Implementation of What-How-Why

Currently in UTM, the What-How-Why framework has been used in every semester in the chemistry education (MPPK1323 & MPPK 1343) and innovation in learning and teaching (MPPU1003) courses since 2015. The framework is used in several educators and student's program as well as during the service learning course. The What-How-Why is implemented by dividing students into small groups consist of four members. Students will be assigned roles as questioner and the rest as panelist. To develop a what-how-why, 'questioner' will read a given scientific statement. The scientific-text based concept is use as a framework for generating three levels of questions. The questioner will begin by designing questions for the identifying level, since this level provides direction for developing appropriate processing and reasoning questions. Ordering the questions in this manner will help students to direct to the need finding and to formulate the concept and finally applying the concept. Along the process, questions and answers need to be written to illuminate the scientific text-based concept.

### Study of the impact

Research has proven that questioning is among the most powerful thinking tools (Tofade, Elsner & Haines, 2013). The What-How-Why framework stimulated learners' thinking (CorriennaAbd-Talib, 2016). To study of the impact of the framework, teachers who used the What-How-Why find it helpful for effective questioning tools. Also, we found that students of the courses become more engaged and cultivate curiosity with their subject and encouraged students to frequently used higher order thinking questions. In conclusion, the framework aims to serve as the exploration of learning environment–encouraging student's curiosity to think critically while participating in active team learning.

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30.

### EFFECTIVENESS OF PEER TUTORING USING MMU-FET MODEL FOR CHALLENGING ENGINEERING SUBJECTS

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### INTRODUCTION

Different types of student-centered education methods have been implemented in many higher learning institutions in recent time. One among such methods is the peer tutoring which is the process between two or more students in a group where one of the students acts as a tutor for the other group-mate(s) (Burnish, Fuchs & Fuchs, (2005). Peer tutoring can be applied among students of the same age or students belonging to different age groups. It is beneficial not only to those being tutored, but also for the tutors themselves (Lassegard, 2008). Peer tutoring works best when students of different ability levels work together (Kunsch, Jitendra, & Sood, 2007). Peer tutoring is an advantageous teaching strategy and it can be incidental or structured (Greenwood et al., 1988). Incidental peer tutoring often takes place, whenever students are cooperating, playing or studying and one guides the others. An example of incidental peer tutoring is a student asking his classmate for tips on how to improve his performance in learning a specific subject while playing a game. Whereas, structured peer tutoring refers to peer tutoring implemented in specific cases and for specific subjects, following a well-structured plan prepared by the lecturer (Greenwood et al., 1988). The model used in this paper belongs to a structured peer tutoring category.

### OTHER WORKS ON PEER TUTORING MODELS

According to Brittany Hott and Jennifer Walker. (2012), some of the most frequently used peer tutoring models are Classwide Peer Tutoring (CWPT), Cross-age Peer Tutoring (CAPT), Peer Assisted Learning Strategies (PALS) and Reciprocal Peer Tutoring (RPT).

Classwide Peer Tutoring involves dividing the entire class into groups of two to five students with differing ability

levels. Students then act as tutors, tutees, or both tutors and tutees. Typically, CWPT involves highly structured procedures, direct rehearsal, competitive teams, and posting of scores (Maheady, Harper, & Mallette, 2001). The entire class participates in structured peer tutoring activities two or more times per week for approximately 30 minutes (Harper & Maheady, 2007). In Cross-age Peer Tutoring older students are paired with younger students to teach or review a skill. Peer Assisted Learning Strategies (PALS) is a version of the CWPT model, involves a teacher pairing students who need additional instruction or help with a peer who can assist (Fuchs, Fuchs, & Burish, 2000). Reciprocal Peer Tutoring (RPT) makes two or more students alternate between acting as the tutor and tutee during each session, with equitable time in each role. Often, higher performing students are paired with lower performing students. RPT utilizes a structured format that encourages teaching material, monitoring answers, and evaluating and encouraging peers. The model used in this paper is a combination of PALS and CAPT with the exception that more than one tutee is assigned to each tutor.

### PROBLEM FACED

It was found that the students passing rate of some challenging engineering subjects such as engineering mathematics, computer programming etc. is consistently low. In order to solve this problem, the slow learning students who cannot perform well in the exam have to be given special attention even after regular face to face contact hours. But lecturers often hesitate to give extra time to such students after office hours because of their tight schedule in this competitive and fast world. This extra attention could be provided by special innovative programs like MMU-FET peer tutoring.

### THE MMU-FET PEER TUTORING MODEL

Peer-tutors worked in pairs with small groups of no more than 10 students, on voluntarily basis (figure 1). Only academically sound and self-motivated senior students are eligible to be a peer-tutor. The peer-tutor must have passed the subject, for which they applied, with A or B+ grade. They focus mainly on selected text book questions, past year exam questions and tutorial questions. The coordinator for a peer-tutoring program will be responsible for the selection of tutors. The subjects offered for peer tutoring program will be announced on the faculty website depending on the availability of peer-tutors for the subjects. The students who want to enroll for the peer tutoring program need to register themselves through the faculty website. All peer-tutors and tutees will be given the required briefing about the program. Subject lecturers will be consulted by the peer-tutors to obtain the OBE lecture plan and past year exam solutions. The peer-tutoring classes will be conducted for four to five weeks of two hours per week duration. Upon the successful completion of the peer-tutoring program, all the peer-tutors will be invited for an appreciation session to receive their certificate of excellence.

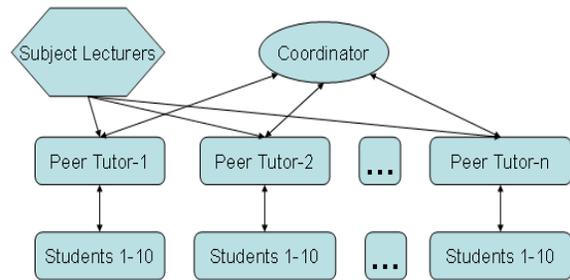


Figure1. The working model of MMU-FET peer tutoring program.

The program is intended for repeating students who failed the subject first time and expecting assistance on how to study effectively to improve their grades. However, students appearing first time, but experiencing difficulty in understanding course material are also allowed to join a peer tutoring program.

### BENEFITS

In general, students may feel more comfortable and open to discuss and seek advice from peer-tutors. Other benefits of peer tutoring for participating students include higher academic achievement, improved personal and social development, increased motivation and improved relationships with peers.

Peer-tutors who have volunteered themselves are expected to be benefited from this program in the following ways. The preparation makes them to reinforce their own understanding of the subject, and increase their self-confidence and knowledge. It also enhances peer-tutor's soft-skills, such as knowledge sharing, teaching and coaching and communication skills. Their sense of responsibility can also be improved through their participation in this program. While reviewing peer tutoring programs, researchers found that students involved as tutors in the tutoring process were far more effective and experienced significant gains in achievement (Topping, 1996).

It also befits the faculty by improving the overall academic performance and the passing rate of the engineering students of the faculty.

### EVIDENCE FOR THE USEFULNESS OF THE MODEL

Graph in figure 2 shows the passing rate of the students attended in the peer tutoring program for the past three years. The number of subjects to be offered for peer tutoring in a particular trimester depends on the demand and the availability of peer tutors. The value on the top of each bar shows the percentage of students who passed the subjects after attending the program. The graph also indicates that the benefit is consistent over the past 10 consecutive trimesters.

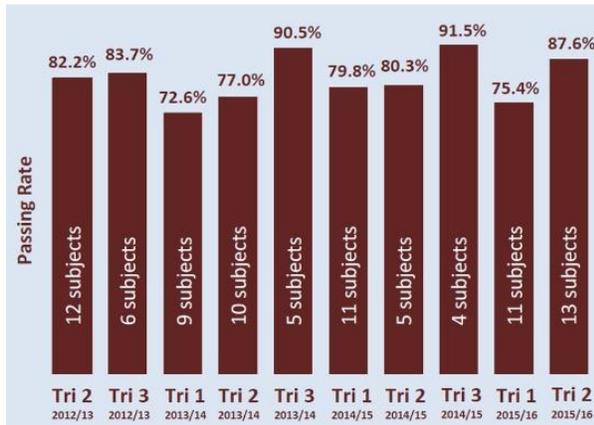


Figure 2. Passing rate of the students attended the peer tutoring program.

The feedback received from the tutees as well as tutors show that they are truly benefiting from this MMU-FET peer tutoring program. Graph on figure 3 shows the positive response of the tutees when they are asked whether this peer-tutoring programme changed their attitude towards studies. One of the tutor says that this peer-tutoring programme enhanced his soft skills as it requires the communication between the students and the tutors. Hence this innovative peer tutoring program is one of the successful initiatives taken by the faculty of Engineering and Technology of MMU Melaka campus.

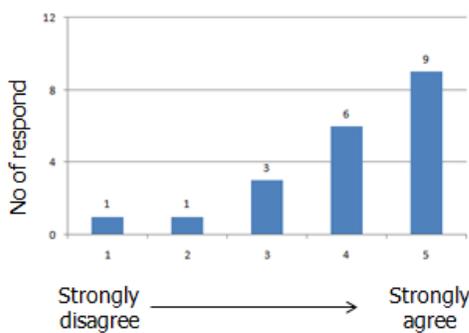


Figure 3. Positive feedback from students.

## CONCLUSION

The effectiveness of peer tutoring was experimented and analysed using the MMU-FET model for the challenging engineering subjects. Results show that the performance of the students attended the peer tutoring program have increased considerably in the past 3 years. Hence the MMU-FET model of peer tutoring may be considered even in higher learning institutions as one of the effective tools to improve the performance of slow learning students in engineering subjects.

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## 31.

### OUTDOOR CASE-BASED LEARNING EXPERIENCE FOR CIVIL ENGINEERING STUDENTS

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## Introduction

Case-based learning (CBL) is a form of flipped learning that enables students to develop skills in analytical thinking and reflective judgment by discussing complex, real-life scenarios. The CBL through outdoor cases for instance, allows students to stimulate interest in a particular area of the curriculum especially in the engineering field. Why do we use case-based learning? Learning and remembering engineering theory is much easier when students can link it to real life engineering problems and get a genuine feel for how essential it is to the engineering world. As far as student's long life learning experience is concerned, the

sooner students start engaging and applying the theories and relating scientific knowledge to real engineering practice, the better.

The innovative practice presented in this I-PHEX 2016 showcase the application of outdoor CBL in the teaching and learning of Civil Engineering, particularly for the Hydraulics course. The outdoor CBL herein portrays the activities carried out through internal site demonstration and external field trip. The practice has been carried out for more than two years now. The rationale for using case studies with specific examples, the process of choosing appropriate cases, and tips for how to implement them will be shared, part of which are briefly explained in the following sections. Qualitative and quantitative assessment in addressing students' response and reflections are also presented.

### Internal Site Demonstration: Existing Wet Channel

The site demonstration was held in the Universiti Teknologi PETRONAS (UTP) campus at a nearby open channel flow (drain) with water flowing in it, as shown in Fig. 1. It was a supplementary outdoor classroom for lectures on *Introduction to Open Channel Flows (OCF)*. This topic was delivered in the first week of lecture, thus portrays the very important basics of Hydraulics. The intention of the site demonstration was to allow students to understand the concept of *velocity profile* in OCF. The lecturer could further enhance theories covered in the previous lectures using a demonstration tool (velocity meter) used to measure velocity of the flowing water. Through this activity, students were able to witness how velocity changes along the vertical section of a particular drain.



Fig. 1. Sample of activities during site demonstration on an existing open channel flow (drain) in UTP campus

At the end of the demonstration, students were individually assessed through a simple exercise to be submitted instantly, for example,

Students are required to observe the profile of flow velocity measured at a section in the open channel (drain) and later to submit a brief summary of this by comparing the measured values to that of the theories.

Sample of students' reflections on the activity:

- "This trip was held on the first week of lecture. So it was a good introduction and gives us a good impression about the course"

(Mohamed Hyrul Amry, Muhammad Alif, Nur Heiyqal Hidayat, Mohd Fatehah, 2015)

- "...it was conducted in the first week of lecture when we had no knowledge about hydraulics. It gave us bigger picture if open channel flows, as we need it to compute other flows throughout the course."

(Ahmed Mohammed Elamin, Muhanad Elshahie Mohamed, Mohammed Omer Ali Elhassan, Anas Khaled Ali, Sahet Muhametnizov, 2015)

- "...good initiative as we can interact better at outdoor compare in classes. This activity is also good to start new bonding between lecturer and students."

(Mohamad Hakim, Wan Mohamad Aiman, Nur Muhamad Hadri, Mohamad Bakhit Aiman, 2015)

- "...it was a good start to attract students attention on hydraulic subject and build our interest to study and know more about water flow. ....This site visit is an interesting way to study about hydraulics."

(Hans Hazairi, Nor Lizdayatul Syazwani, Nurul Asyiqin, 2015)

### Internal Site Demonstration: Existing Dry Channel

Students were brought to an existing (dry) drain that was no longer in use in the UTP campus, as shown in Fig. 2. It was a supplementary outdoor classroom for lectures on *Uniform Flows*. It was a group project where students were instructed to redesign the channel using other types of open channel drains so as to improve the performance of the existing drains.



Fig. 2. An existing unlined channel in UTP campus

At the end of the activity, a group assessment question was given,

Students are required to transform the existing unlined channel located near Block 13 UTP into a lined channel by proposing two designs, with one designed for a simple channel while the other a compound channel. Students are to compare the construction cost for both designs. Critical discussions are to be provided based on the costs as well as the guidelines provided in the designs for an open channel.

Sample of students' feedback on the activity:

- "We can improve the critical thinking of student in transforming the existing unlined channel to lined channel."

(Aufa, Aina Farzana, Noranaty, Nur Atiqrah, 2015)

- “Besides the challenge, it was a good experience because we could see the design process in real life”  
(Agnes Ho Yin Yee, Boo Yee Ying, Hugo Aureliano da Costa Gaspar, 2015)
- “...we can look and learn practically rather than only learning theory and calculation in class...”  
(Nor Haslinayati, Nurun Najihah, Nur Hidayah, Aifaa Balqis, 2015)
- “..the information given in the questions given were very limited, so we were struggling to get the right design that fulfill the requirements. We learnt a lot from this project.”  
(Farida Hamimi, Fatin Azureen, Fazira, Ummi Anisah, 2015)

### Internal Site Demonstration: Existing Consultancy Project

This is a supplementary outdoor activity for lectures on *Energy Dissipation System*, another topic of *Hydraulics Structures*. The main objective of this activity is to introduce students to the elements of physical modelling on a re-regulating Pergau (dam) pond and its associated structures such as stilling basin, weir and spillway (refer Fig. 3).

Previously the Pergau pond model was used for a consultancy work carried out in 2006. The scope of the consultancy was to investigate factors contributing to erosions at the bed of the pond as what shown in a small image in Fig. 3. After the work completed, the pond was utilized for learning as shown in Fig. 4.



Fig. 3. Pergau pond energy dissipation system model in 2006

Students are brought to see a demonstration on the operation of the pond, which also imitates the actual things that happened in the real life. At the end of the demonstration, students will be given an individual assessment question, sample of which is given below:

Students are required to compute the corresponding values of the operating parameters [discharge (Q), velocity (v), water depth (y) and area (A)] in the

prototype of *Pergau re-regulating pond* from the operating parameters of the model using the knowledge of *Dimensional Analysis and Similitude*. The prototype has been modeled in the laboratory with a scale ratio of 1:36.



Fig. 4. Lecture session utilizing the model in 2015

Questionnaires were distributed to the students in order to get some insights on their response towards the visit to the model. This would allow the lecturers to understand the effectiveness of such activities and at the same time to improve the methods of delivery of the demonstration in the future.

In general, the analysis of the questionnaires revealed positive feedbacks about the laboratory demonstration. Out of the 54 respondents, 78% strongly agreed that the consultancy physical model portrays an example of a real world hydraulic design project. 75% of them had never seen/visited such model before while a minority of them had more or less acquainted with such structure (Fig. 5). When asked whether the model was able to provide better understanding on the theories learned during lectures, 81% strongly agreed to the statement, as shown in Fig. 6. In conjunction to this, 52% strongly agreed that the laboratory demonstration enhanced their interests further in the subject of hydraulics (Fig. 7). This supports the idea that the model is an example of an innovative approach in teaching undergraduate studies, with 61% strongly agreed to it. Overall, 65% of the students felt delighted while the remaining 35% were satisfied with the site demonstration. All of them strongly recommended other civil engineering students to visit the model.

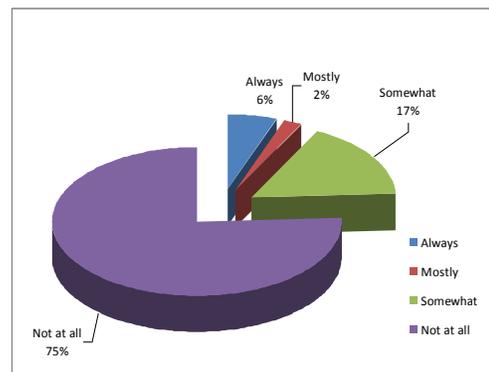
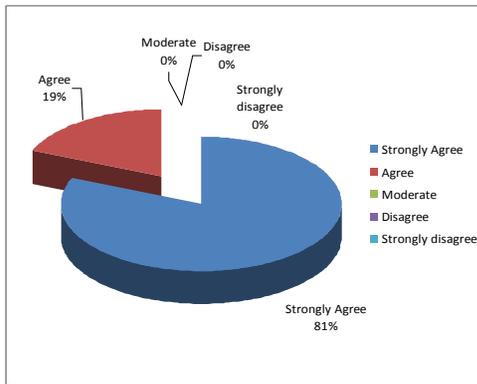
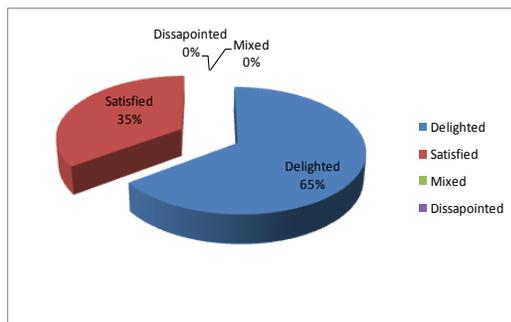


Fig. 5. Student's experience in encountering (visit/seen) similar structure to this model



**Fig. 6. Model being able to provide better understanding on the theories learned during lectures**



**Fig. 7. Students reflection on the site demonstration activity**

Also, sample of qualitative students' feedback on the activity:

- "We could observe and measure velocity of the flow released from channel. We saw how the energy is dissipated by the blocks."  
(Nyanambikai, Dalila Sarah, Mohd Kamal, Muhd Azmi, 2015)
- "...nice to visit the Pergau pond model as it is a scaled model..very fun to learn hydraulics better"  
(Ahmad Faiz, Faiz Hashemi, Muhd Zamri, Amirul Ashraf, 2015)
- "We can know how the works for real. The visit is an example of the type of failure that can be found in hydraulics structure."  
(Ain Syafinaz, Norfatin Najwa, Nur Izzati, Nur Ilyana, 2015)
- "...the visit overall is quite good. Finding from the visit is very useful for the last chapter. The quiz is very effective because we can apply what we observed and learnt directly from the visit."  
(Ahmad Izzat Asyraf, kelving Wong Toh Kiak, Nur Zaherah, Fatin Nabilah, 2015)

Based on the internal positive response and acceptance of students within UTP, the experience in teaching and learning Hydraulics through site demonstration activity has been made public recently, for which a short clip as shown in Fig. 8 was produced and uploaded on the YouTube.



**Fig. 8. Pubic sharing through Youtube**  
(source: <https://www.youtube.com/watch?v=ztJ0obhjtIE> )

The analytic response on the clip can be directly captured from the website.

### External Field Trip: Redesign of Existing Dam

This was an activity to support lectures on *Dams* which is part of *Hydraulic Structures*. Every semester, students will be brought to join field trips to a dam in Malaysia. UTP has the experience bringing students not only to dams in operation (Temenggor, Kenyir, Chenderoh, Bersia, Kenering dams) but also to a dam that is still under construction (Paya Peda dam, refer Fig. 9).

During the day of visit, students will be exposed to the background information about the dam. Assessments were given to students through two projects (individual and grouping). The individual project requires students to apply the low level *Outcome Based Education* (OBE) approach through knowledge and comprehension. This could be achieved through interview session with personnel during the site visit or from simple theories taught in class. The grouping project on the other hand, students were required to apply the data obtained from the individual project and later to analyze into the dam design stage.



**Fig. 9. Group photo during field trip to the Paya Peda dam**

Upon returning to UTP, students were given a group project, as summarized below:

Students are required to check the stability of the dam per unit length against overturning, sliding, and stresses. The analysis should focus on forces contributed by the weight, hydrostatic and hydrostatic uplift only.

The success of the design could be achieved with thorough evaluation on the aspects of economic as well as stability of the dam. Students were required to prepare a critical

analysis to support their justification for the said design parameters. Sample of students' feedback on the activity are given below:

- "We like the fact that you use real case scenarios for the dam and related this to the situation in Malaysia"  
(*Agnes Ho Yin Yee, Boo Yee Ying, Hugo Aureliano da Costa Gaspar, 2015*)
- "Good effort and we appreciate that. We learnt a lot about the theory and applying them. We give a deep thought on our project"  
(*Oh Jia Wei, Wong Wai Leong, Lim Wai Loon, 2015*)
- "...students are able to implement theory learnt in lectures and apply it to solve the problem. This project promotes teamwork and cooperation between students."  
(*Nawal Nadia, Zaty Amirah, Hafizul Fahmi, Raja Rosenani, 2015*)
- "Very good initiative in teaching. Allow students to be more open minded in providing solutions to a problem. It makes students appreciate themselves as a civil engineer..."  
(*Muhammad Nur Iman, Mohamad Irwanizal, Ahmad El Afify, Farelle Charles Joseph, 2015*)
- "... Students can experience how to create the best design by applying their knowledge regarding dam calculations which are quite difficult. "  
(*Ahmad Izzat Asyraf, Kelvin Wong Toh Kiak, Nur Zahirah, Fatin Nabilah, 2015*)

## Conclusions

Four outdoor case-based learning approaches have been formulated and introduced at the undergraduate Hydraulics course in Universiti Teknologi PETRONAS (UTP), Malaysia. This is because graduating students need to be experienced and competence in real-world engineering problems through assessments which are similar to real-world design problems. These initiatives, which were not incorporated in the syllabus of the course, have been found to be successful in keeping positive response and sustain interest among students on the content of the course. Overall, the activities have received good feedbacks from students.

## Acknowledgment

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32.

## PROMOTING POSITIVE ATTITUDE TOWARD MATHEMATICS THROUGH THINKING MATHEMATICALLY

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## Introduction

An important outcome of mathematics education for engineers is for students to acquire flexibility in mathematical thinking so as to be able to solve routine and non-routine problems. Alas, it is acknowledged as the most elusive of goals. There are genuine concerns that there is a need to improve engineering undergraduates' mathematics learning as their learning difficulties have been well documented over the years (Tall & Razali, 1993; Kashefi et al., 2012; Firouzian et. al., 2015). Students should not only be able to understand the mathematical concepts and techniques, but should also be able to use this knowledge in solving engineering problems.

Studies (see eg. Anthony, 2000) have indicated that positive attitudes and good study skills could improve students' learning. 'Attitude toward mathematics' is seen as a construct which plays an important role in mathematics education (Zan & Di Martino, 2007) and has been a factor that is known to influence students' achievement in mathematics. However, most research on attitude has given more emphasis on creating measurement instruments rather than elaborating on a theoretical framework (McLeod, 1992; Ruffell, Mason & Allen, 1998; Wilson, 2011; Hannula, 2012).

Earlier work carried out (Yudariah, Roselainy & Mason, 2007; Sabariah, Yudariah & Roselainy, 2008) had brought about improvements to the teaching of mathematics to engineering undergraduates. However, further study is required to clarify a framework for attitude in mathematics learning. A rigorous study of real practice had informed us on teaching strategies for incorporating thinking in the mathematics classroom (Roselainy, 2009). The framework had guided us in the design of the classroom instruction and tasks to support students' use of their own mathematical thinking in diverse learning environment to encourage participation and motivation such as active learning environment as reported in Roselainy, Mason & Yudariah (2012), in blended learning environments (Yusof et. al, 2013) and in cooperative learning environment (Sabariah et al., 2015).

## The Underpinning Educational Principles

The conception of mathematical thinking was based on the ideas of Mason, Burton & Stacey (1982; 2010) who described it as a way to improve understanding and extending control over the study of mathematics. The description of how low and high achievers managed their mathematical knowledge (Gray & Tall, 1994) was used to determine the content advancement. Skemp's (1993) description of the learning situation was used to create an environment that would support problem solving. Watson & Mason's (1998) ideas on what constituted mathematical

thinking powers and mathematical structures were found to be very useful in developing the lesson plans.

'Prompts and questions' were adapted, modified and created based on Watson & Mason (1998) to draw students' attention to the mathematical processes and structures involved in facilitating their understanding of concepts learnt. The use of the prompts and questions would enable students to guide their own thinking and use as tools to engage with new problems. In this way, students were provided with a vocabulary to master their own thinking as well as engage in new ones. An example is shown in Figure 1.

Theme: Doing and Undoing Activities: Comparing, Sorting, Organizing, Characterizing	
Problem: Finding areas using double integrals	Focus of Attention: setting up iterated integrals, determine order of integration, determine limits of integration and evaluation of integral
Doing: Find the area of the region $D$ , in the first quadrant bounded by $y = 4 - x^2$ , $y = 3x$ and $y = 0$ .	<p><b>Prompts and Questions</b></p> <ul style="list-style-type: none"> <li>• What do you know about area?</li> <li>• Does the order of integration matter?</li> <li>• How do you determine the limits of integration?</li> <li>• Would evaluating the integral in polar coordinates be more efficient?</li> </ul>
Undoing: The area of a region $D$ , is given by $\int_0^4 \int_{x^2}^{4-x^2} dy dx$ .	<p><b>Prompts and Questions</b></p> <ul style="list-style-type: none"> <li>• Can you describe the region by giving equations of the curves that form its boundaries?</li> <li>• Can you sketch the region of integration?</li> <li>• How do you determine the new limits of integration?</li> <li>• How do you evaluate iterated integrals?</li> </ul>
i) Evaluate the integral with the order of integration reversed. ii) Can you give one other example of the same kind?	

Figure 1. Making Connections

### Teaching Innovation

The teaching and learning approach implemented aims to support students' use of their own mathematical thinking powers as a means to enhance their understanding and improve their attitudes in mathematics learning. The Input model of teaching and learning by Norman and Prichard (1994) was used as a base to describe the learning situation in the class. In particular, the nature of the changes in the teaching was to provide educational opportunities for students to use their mathematical thinking powers and communicate their mathematical knowledge. It is anticipated that these activities would support changes in students' attitudes towards learning in Engineering Mathematics. Naturalistic data (such as participant observation, conversation, critical reflection and observation of colleagues teaching) of class interactions collected was analysed to determine how they influence students' motivation and attitudes towards learning.

It was found that the factors outlined by Norman & Prichard were in fact interconnected whereby students' motivations were affected by the lecturer's actions and sometimes vice-versa. The factors affecting students' learning behaviour include prior knowledge, motivation, opportunities to learn, working on mathematical thinking and obstacles to student changing. The data had contributed to a more detailed description of the various factors in the model. The summary of our findings is visualised in a modified version of the Input Model (see Figure 2), which shows influences of lecturers' actions to the students' motivation.

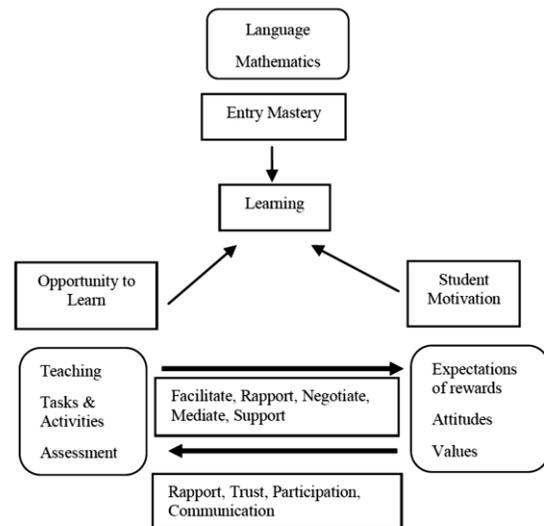


Figure 2. Input Model of the teaching and learning of Engineering Mathematics

### Model of the Change Process

Analysis of the data has contributed more detailed information on the nature of the students' change process and interaction with the lecturer and the mathematical learning materials and environment. Thus Figure 3 is a proposed model that describes in greater detail how the interaction and the various phases that the students undergoes before meaningful engagement takes place. The change process is depicted as a process in a time continuum with three different phases, Entry phase, Activity phase and Adopted phase, with clear identification of the domains of lecturer's and students' influence as well as when both are influential simultaneous. Two boxes, in red and blue, around the keywords represent the lecturer's domain of influence (red) and the students' domain of influence (blue).

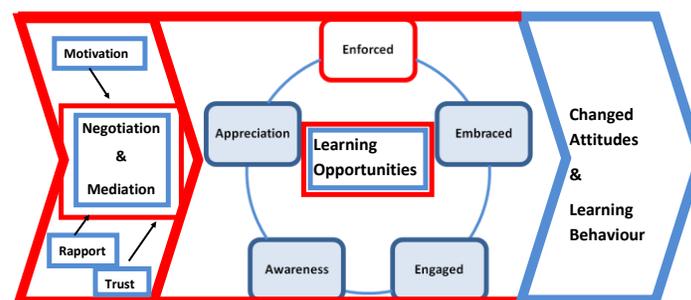


Figure 3. Model of the Change Process

**Entry Phase** – rapport and trust of the lecturer were elements that students identified as important and they believed these can affect their motivation. In this entry phase, two keywords, ‘negotiation’ and ‘mediation’ describes a significant process in engaging students’ interest in changing. The lecturer’s domain of influence (red box) is in providing learning opportunities to support and enhance students’ learning as well as a means of intervention to help them develop better thinking skills. The blue box signifies students’ domain of influence in that they can choose to take action upon the lecturers’ actions. Thus, ‘rapport’, ‘trust’ and ‘motivation’ are in blue boxes. The students have to decide to give their trust and reciprocate any overtures by the lecturers to establish a connection with them.

**Activity Phase** – where students engage in the class tasks and activities but in various stages of participation. The stages are represented as cyclic but they are not sequential as students move from one stage to the next based on their responsiveness, perceptiveness and understanding. There was a cycle of (i) doing the tasks and activities because they had to, (ii) deciding to participate, (iii) getting involved in the tasks and activities, (iv) increasing their awareness and finally (v) increasing their understanding and appreciation of their own powers. The students move from one stage to the other at their own choice and in their own time. The five stages are encapsulated as a non-directional cyclic process and labeled as the stages of (i) **Enforced** activity, (ii) **Embracing** the tasks and activities, (iii) **Engaging** with the tasks and activities, (iv) Increasing their **Awareness**, and lastly, (v) **Appreciating** their own abilities. The lecturer provides designs and executes the teaching strategies. She has more influence in the enforcement stage but other than this, the students then decide the level of participation and engagement with the tasks and activities.

**Adoption Phase** – some criteria were used to indicate that students have gained some appreciation of the importance of being aware of their own thinking powers, to be more articulate in their mathematical communication as well as appreciating the importance of team work. The first criterion is that they show support for these values in their reflections about working on the mathematics. Secondly, they can communicate their mathematics either verbally or in writing to the lecturer and to their peers. Thirdly, they have a better group work ethic and finally, they show an appreciation of the importance of independent learning.

### Significance of the study

We used the framework analytically to develop strategies to support changing engineering students’ attitudes towards mathematics and as a design framework for teaching strategies to invoke students’ use of their own mathematical thinking powers. Changes in the teaching practice were made to the presentation of mathematical content, class tasks and activities, as well as the teaching and learning environment by encouraging active participation of the students in inquiry, thinking, problem solving and communicating the mathematics learnt. The strategies not only addressed the cognitive development but also deal with some affective factors related to reducing mathematical anxiety and confidence in mathematical skills.

Responses from the students have contributed a greater understanding of the domains of influence wielded by the lecturer and the importance of knowing the stage at which students are participating. The results from the study have also indicated that the strategies used were successful in promoting positive changes in our attitude as well as well as our students.

### Acknowledgement

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33.

### A PROBLEM-BASED LABORATORY (PBLab) MODEL FOR AN ELECTRICAL ENGINEERING PROGRAM

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#### Introduction

Problem-based learning (PBL) is one of the student-centered educational approach that highlights the importance of the shift from instructor centered to student-centered as an approach to encourage active learning among students (Tan, 2004). Researches from several laboratory models implemented in engineering degree programs (Cline, 1997; Jianbiao, 2008; Macias-Guarasa, 2005; Moore, 1997) have shown that applying PBL in laboratory courses have greatly enhanced students learning. In addition, the PBL approach has been acknowledged as a teaching and learning (T&L) method that develops further the students' interpersonal, problem solving, critical thinking and communication skills which are in line with the demand from industries (Gani Hamzah, 2009).

The Problem-based Laboratory model, known as PBLab was established to replace the 4<sup>th</sup> Year Electrical Engineering Laboratory which was previously a conventional instructional based laboratory in as one of the core courses for the SEE program.

The previous laboratory courses were conducted using traditional methods where students were provided with specific instructions and followed a step by step procedure to complete their laboratory tasks. Although students were assigned to work in group, the extent of team-working skill acquired by students is equivocal. This is due to the normal practice where students divide the works according to the experiments on rotational basis rather than based on group consensus. Besides that, submitted reports were found to be similar to the format given in the laboratory sheets without any creativity of innovation from the students.

The main factor to introduce PBLab was that it complied with the requirements set by the Engineering Accreditation Council (EAC) appointed by the Board of Engineers

Malaysia (BEM) to primarily set policies, provide approvals and accreditation evaluations of engineering degree program offered in Malaysia (Council, 2007). Another motivating factor that promotes PBLab to be offered in the program is the fact that the students are in their final year and will soon be entering the job market in the field of electrical engineering.

#### PBLab Description

The PBLab is conducted during the first semester of the final year, based on the 4-year Bachelor of Engineering (Electrical) program (SEE) curriculum. PBLab was offered in three laboratory courses: Advanced Power, Power Electronics and High Voltage. Generally, the PBLab incorporates the Problem Based Learning (PBL) process as illustrated in Figure 1.

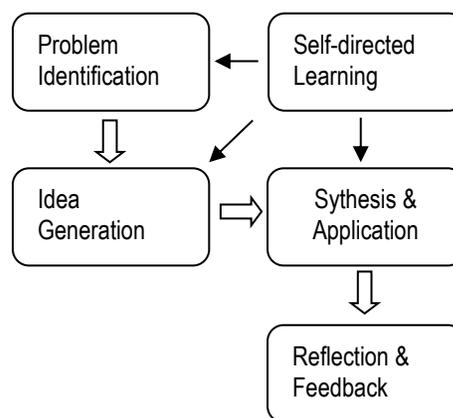


Figure 1. The Problem Based Learning (PBL) process

In the PBLab, real-world or industry related electrical engineering problems are presented to students in groups of 4 or 5 members. Each group of students is required to solve three problems or complete projects by conducting experiments with each one to be completed within 4 weeks. The experiments conducted can be software based, hardware based or both depending on the laboratory requirements.

Students basically spend 3 hours per week in the respective laboratories with facilitations from lecturers (in lab sessions). In addition, they also need to meet at least 2 hours per week out of the laboratory to further discuss the problem or project with team members (out-lab sessions).

#### Facilitation & Laboratory Activities

Based on the given problem or project, the typical activities carried out throughout the four weeks are listed as in Table 1 (Appendix). Each problem or project comes with a Student Pack and a Facilitator Pack which consists of relevant materials to assist the group and the facilitators when solving problems or conducting projects. The packs are also designed to ensure proper conduct of the tasks related to the assignments by providing documentation that aligns between the problem or projects and the outcomes of the PBLab. The course outcomes (CO) of the PBLab are designed to be aligned with the program outcomes (PO), T&

L approaches as well as the assessments. This is in accordance with the constructive alignment developed by Biggs (2003). Measurement of the COs achievement for the PBLab directly reflects the achievement of the SEE POs. More importantly, the measurement of students' generic skills acquisitions are mainly obtained from PBLab as many of the courses in program curriculum do not focus on these aspects.

### Evaluation

Table 2 lists the PBLab evaluation criteria which allows not only the facilitators to assess the students' performance as a group, but also the students themselves to evaluate their group members in terms of participation in handling the problem or project given. Based on the evaluation rubrics filled by the PBLab facilitators, the Key Performance Index (KPI) of each CO achievement is calculated by averaging the marks obtained by all students in a particular assessed item and dividing it with the number of students.

Table 2. PBLab evaluation criteria

	Criterion	%
1	Individual in-lab activities (4 x) Include one-to-one interview sessions	20
2	Peer review (1 x)	10
3	Group log book (3 x)	30
4	Group presentation (1 x)	20
5	Group Report (1 x)	20

### Research Impact

The graph in Figure 2 shows that all of the POs related to the generic skills exceeded the 0.6 limit which was set by the faculty as the achievement of a particular PO for all programs. The lifelong learning skills represented as PO8 have the highest KPI value of all SEE program. Based on the graph, most SEE students lack communication skills (PO6) which are assessed through their presentation and report writing. The KPI achievement for PO7 which represents the student's team working skills is higher than that of the communication skills. The team-working skills is mostly contributed by the marks obtained from the Peer and Self evaluation forms which in general were rated highly by students. A similar situation has also occurred in a report by Vaughan, Jr. (2001) and suggested that peer review form to be given and collected immediately after the laboratory session ends. Although the average students' performance was found to be between 76% - 85% across all sections, this is not an indication on the generic skills acquisition. The marks obtained by the students based on the individual in-lab activities and log book supported the students' comment which in general showed that there were no major issues working in a group and students agreed that the problem given was interesting, related to real-world application and rather challenging. However, there is still room for improvement in the laboratory conditions although had generally been accepted.

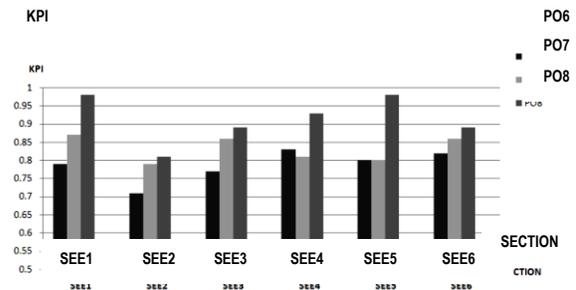


Figure 2. KPI of generic skills achievements of students in the SEE program.

### Conclusion

The analysis on the performance of students who undergone the PBLab showed that the PBLab has the potential to become an effective approach in enhancing generic skill acquisition among the electrical engineering students.

The implementation of PBLab had managed to make students apply active learning strategies that improved their soft skills, despite their feedbacks that it was difficult. The positive and negative feedbacks from students with regards to group members, laboratory conditions and the problems/projects given are indicators of the acceptable level of them towards the overall implementation of the PBLab model.

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Table 1. Four week of PBLab activities

Week	In-Lab Session (3 hours)	Out-Lab Session (2 hours)
Week 1 (Each group assigned a problem)	<ol style="list-style-type: none"> <li>1. Understanding the problem with guide from facilitator</li> <li>2. Brainstorming, giving ideas to solve problem</li> <li>3. Identifying available resources and tools</li> <li>4. Identifying what you know and what you need to know in solving the problems</li> <li>5. Facilitator marks individual in-lab activities</li> </ol>	<ol style="list-style-type: none"> <li>1. Get more resources to help understand the problem</li> <li>2. Divide work among group members</li> <li>3. Report findings to group</li> <li>4. Agree on solution</li> </ol>
Week 2	<ol style="list-style-type: none"> <li>1. Present solution to facilitator</li> <li>2. Facilitator comments on solution, making sure the group is on the right track</li> <li>3. Group begins to develop the experiments</li> <li>4. Group confirms the experiment layout</li> <li>5. Facilitator monitors and marks individual in-lab activities and group log book</li> </ol>	<ol style="list-style-type: none"> <li>1. Group conducts some simulation work to reconfirm design</li> <li>2. Group verifies availability of equipment and tools to conduct experiment</li> <li>3. Group prepares schematic or connection diagrams for experiment</li> </ol>
Week 3	<ol style="list-style-type: none"> <li>1. Group begins to conduct experiment</li> <li>2. Facilitator monitors and marks individual in-lab activities and group log book</li> <li>3. Group gets results from experimental work</li> </ol>	<ol style="list-style-type: none"> <li>1. Group prepared slides for presentation of completed work</li> <li>2. Group starts preparing report</li> </ol>
Week 4	<ol style="list-style-type: none"> <li>1. Group presentation and demo</li> <li>2. Report writing (Facilitator monitors and marks individual in-lab activities and group log book. Facilitators also evaluates all group presentations)</li> </ol>	<ol style="list-style-type: none"> <li>1. Continuation of report writing and submission to exactly one week later to the Lab Technician to be recorded and given to the facilitator</li> </ol>

34.

**THE MEDICAL STUDENT STRESSOR QUESTIONNAIRE: A VALID SCREENING TOOL TO DISCOVER SOURCES OF STRESS OF MEDICAL STUDENTS**

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**Problems faced in teaching & learning in higher education that called for the innovation**

Studies have revealed that the prevalence of stress, anxiety and depression among medical students during medical training is higher than that of the general population (Yusoff & Arifin, 2015; Yusoff, Abdul Rahim, et al., 2013a, 2013b; Yusoff, Pa, & Rahim, 2013). This concurs that the learning environment during medical training is at suboptimal level, and thus not really psychological-friendly to the students. Therefore, early detection and identification of potential sources of stress of medical students will enable medical educators to take appropriate preventive measures to remedy these matters.

**Theories underlying the innovation**



Figure 1. Potential sources of stress based on the five stress theories

The person-environment fit model identified two factors that determine stress; environmental demands and the person's ability either real or perceived. Stress occurs when there is a mismatch between the environmental demands and the person's ability (Edwards, Caplan, & Van Harrison, 1998; Edwards & Cooper, 1990; Van Harrison, 1978). Potential sources of stress are devised when are gaps between academic demand and the student's ability to meet the demand. For examples, tests and examinations, time pressure and getting behind in work as well as conflicting demands, not getting work done within time planned and heavy workload. Such mismatch may result in learning dissatisfaction and may lead to unfavourable consequences on their academic performance. This stressor is related to academic stressors.

The demand-support-constraint model identified three factors that determine stress; psychological demands,

constraint and support. This model postulates stress occurs when there is a lack of support and a high level of constraint in high demand conditions (Payne & Fletcher, 1983). Obviously, doing extra works with the same or insufficient support and resources is likely to causing distress, for examples, poor motivation to learn, conflict with other students, teachers and personnel, and poor social relationships. It is worth to mention that individuals who feel unsupported are vulnerable to burnout (Brissie, Hoover-Dempsey, & Bassler, 1988). These stressors are related to social stressors and group activity stressors.

The stress-appraisal-coping model concurs that stress occurs when demands are appraised as taxing or exceeding a person's resources and endangering wellbeing. Therefore, when a person appraise their teaching and learning environment as challenges, stress can motivate them, thus augment ability to get works done. But, when teaching and learning environment are appraised as a threat, stress can inhibit their motivation thus diminish ability to get works done. This stressor is related to teaching and learning stressors.

The job-strain model emphasized that two factors determine stress; job autonomy and psychological demands (Karasek, et al., 1998; Karasek & Theorell, 1990). Job autonomy is the amount of control that a person has over his/her works (Karasek, et al., 1998; Karasek & Theorell, 1990). This indicates, stress during learning is less likely to bother persons who have a sense of control over their learning (Karasek, et al., 1998; Karasek & Theorell, 1990). Based on this model, wrong career choice and unwilling to study medicine will be one of the sources of stress of medical students [1, 26], and thus this stressor is related to motivation of the students to learn medicine - drive/desire stressors.

The effort-reward model described that stress occur as a result of a discrepancy between the amount of effort spent to complete works and the rewards gained for the works done (Siegrist, 1996). In this context, the potential source of stress is devised if recognition obtained by medical students are mismatched with their learning efforts, for examples, poor examination results, poor feedback and unjustified grades. Psychological burnout was less common among person who are satisfied with their rewards (Brissie, et al., 1988). This stressor can be related to academic stressors, interpersonal stressors, teaching and learning stressors and social stressors.

### **Description of the innovation and how it solves the problems in teaching & learning mentioned initially**

The Medical Student Stressor Questionnaire (MSSQ) was developed with the purpose of identifying sources of stress in medical students, such as academic stressors, interpersonal stressors, teaching and learning stressors, social stressors, drive/desire stressors, and group activity stressors (Yusoff & Rahim, 2010; Yusoff, Rahim, & Yaacob, 2010a). The MSSQ is a self-report, self-scoring instrument with 40 and 20 items that require students to rate the intensity of stress caused by each item on a scale of 0-4 (causing no stress to causing extreme stress) (Yusoff, 2011a, 2013; Yusoff, et al., 2010a). Validation studies

indicate that the items have a high level of internal consistency (Cronbach's alpha 0.7), and thus are reliable (Yusoff, 2011b; Yusoff, et al., 2010a). Factor analysis indicated that all items had construct validity and should be included in the survey (Yusoff, 2011b; Yusoff, et al., 2010a). Confirmatory Factor Analysis also yielded positive results with Cronbach's alpha consistently over 0.9 (M. S. B. Yusoff, 2011a). Its strengths are that it has been used with constant results with all stages of medical students (entering to graduating) (Yusoff, 2011a, 2011b, 2013; & Esa, 2015; Yusoff, et al., 2011; Yusoff & Rahim, 2010; Yusoff, et al., 2010a; Yusoff, Rahim, & Yaacob, 2010b; Yusoff, Yaacob, Naing, & Esa, 2015) and that it has the potential to be a great tool to design wellness programs in medical schools as well as individual interventions for students (Salazar, 2015). Further research with non-Malaysian medical students is necessary to support its psychometric credential in other medical schools.

### **The impact of the innovation towards teaching & learning**

Since 2010, the MSSQ has been used by more than 100 users from various backgrounds (i.e., undergraduates, postgraduates, educators, specialists and researchers) and countries (i.e., US, UK, UAE, Saudi Arabia, India, Indonesia, Pakistan, Sri Lanka, Norway, many more) for training, research and evaluation. It was critically appraised by Salazar in 2015 and the report was published in MedEdPORTAL that is freely accessible to all levels of users (Salazar, 2015). This has encouraged medical educators around the globe to evaluate the potential sources of stress among their students, and thus early interventions could be planned to alleviate the stressors. In addition, the MSSQ is indexed in the PsycTESTS database published by the American Psychologist Association (doi:10.1037/t15334-000).

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