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STLEE2021

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26th August 2021

PROCEEDINGS OF SYMPOSIUM ON TEACHING AND LEARNING PRACTICES IN ELECTRICAL ENGINEERING 2021

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STLEE2021

Symposium on Teaching & Learning Practices in Electrical Engineering
Universiti Teknologi Malaysia, Johor Bahru, Malaysia
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PREFACE

Welcome to the 1st Symposium on Teaching and Learning Practices in Electrical Engineering (STLEE) 2021. The symposium aims to inspire participants to share innovations in their teaching and learning journey towards best practices of the 21st century education, focusing on the electrical engineering field.

The volume contains the papers presented at the STLEE 2021, held on the 26th of August 2021 virtually. The symposium is organized by the School of Electrical Engineering and the Future Ready Educators (FREE) Committee of Universiti Teknologi Malaysia, as an effort in supporting the UTM FREE aspiration which is an initiative to support future ready curriculum for the millennials, by developing community of practice in teaching and learning. Each submission was reviewed carefully and meticulously by dedicated reviewers in the engineering education field.

With the theme "Empowering 21st Century Educators for Electrical Engineering Practices", the symposium serves as a platform for electrical engineering educators and practitioners to share innovations in teaching and learning practices towards a scholarly manner - to obtain feedback on teaching and learning practices, to identify common challenges and discuss solution for best practices, to support and strengthen the community of practice as well as to acknowledge the efforts in enhancing teaching and learning practices.

It is our hope that STLEE 2021 has provided a meaningful, productive, and enjoyable experience to all participants through interactions and rich discussions in developing scholarly practitioners among electrical engineering educators. We gratefully acknowledge everyone who has provided support, assistance and guidance during the planning, preparation and other phases of the symposium.

Thank you.

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TABLE OF CONTENTS

SUB THEME 1: TEACHING & LEARNING INNOVATION

SUB-THEME 2: TEACHING & LEARNING COVID-19 PANDEMIC

SUB THEME 3: TEACHING & LEARNING TECHNOLOGY

SUB THEME 1

TEACHING & LEARNING INNOVATION

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EXPERIENTIAL LEARNING FOR ENTREPRENEURSHIP

Thoo Ai Chin*, Zuraidah Sulaiman Adaviah Mas'od and Farrah Merlinda Muharam
Azman Hashim International Business School, Universiti Teknologi Malaysia, Johor, MALAYSIA.
(*acthoo@utm.my, zuraidahs@utm.my, adaviah@utm.my, merlinda@utm.my)

ABSTRACT

Experiential learning is a powerful tool for students' learning. The experiential learning allows students to experience the process of first-hand so that they have a clearer and impactful understanding of course concepts. Most of experience learning practices includes action learning, service learning, adventure education, problem-based learning, as well as simulation and gaming. Universiti Teknologi Malaysia has designed a curriculum to give students a varied way of experiential learning. Introduction to Entrepreneurship is one of the compulsory university courses for engineering students and it is about experiential learning for entrepreneurship. With action and experience as a major learning method of the course, students work in a team to learn about customers and markets, create business ideas and execute the business in real life. The experiential learning and project based enable students to deep dive into business needs, meet top management and develop practical solutions to industrial issues. By working on real business projects, students develop critical skills including teamwork, creativity, communication, and critical thinking. As a result, graduates who are holistic could stand out among their peers when entering the workplace.

Key words: Experiential learning, entrepreneurship, problem solving

INTRODUCTION

Experiential learning is one of the active and engaged learning methods whereby students "learn by doing" and then reflect their experience. Slavich and Zimbardo [1] found that experiential learning allows students to experience the process of first-hand so that they have a clearer and impactful understanding of course concepts. Further, students will know how the real world operates. They involve in problem solving skills such as critical reflection, critical analysis and synthesis. Due to its popularity, experience learning practices include action learning, service learning, adventure education, problem-based learning, as well as simulation and gaming [2]. Therefore, many educational institutions provide internship, projects and co- curricular experiential education program for students to have hands-on learning exposure.

Experiential Learning Theory (ELT) is significant to discuss the applications of experiential learning in higher education. ELT is a multi-dimensional model for adult learning. The ELT is underpinned by a learning cycle driven by the experience, transform and grasp which includes concrete experience, abstract conceptualization, active experimentation, and reflective observation [2]. This means ELT can be everywhere at all times. The learning process functions at level of individual, group, organization and society as a whole.

According to [3], a framework is paramount to assist educators to apply ELT. Most successful educators prone to organize their teaching activities in four learning cycle modes – experiencing, reflecting, thinking and acting. A self-assessment instrument called Kolb Educator Role Profile

(KERP) aims to assist educators to understand their teaching practices. The KERP explains four roles of educators around the learning cycle, from facilitator to subject expert, evaluator and coach [2]. The facilitator role includes helping learners to experience personally and reflect on it. The subject expert role is to lead learners to organize and connect their reflections to the subject matter for knowledge increment. The evaluator role is to help learners to master the skills and apply the knowledge for performance measurement. Lastly, the coaching role is to assist learners to apply relevant knowledge for goals attainment. The four different roles evolve from group interactions to one-on-one personal coaching.

Universiti Teknologi Malaysia (UTM) has designed a curriculum to give students a varied ways of experiential learning. In UTM, iLeaGue is an institution responsible for enriching experiential learning through curriculum and co-curriculum as well as student academic development programs as an effort for students readiness for their real-life challenges. The mission of UTM iLeaGue is to provide gainful experiences towards life readiness. There are several clusters of university general courses such as appreciation of philosophy, value and history, generic skills, co-curriculum and service learning, knowledge enhancement, language skills and entrepreneurship.

Introduction to Entrepreneurship is one of the compulsory university courses for engineering students under entrepreneurship cluster with code UBSS1032. This course introduces the fundamental concepts and principles of entrepreneurship and the process of starting a business venture. A three-stage approach is used to achieve the course learning outcome: (a) understanding the individual characteristics of an entrepreneur, (b) analysing business opportunities and forming an entrepreneurial venture, and (c) developing a business model for the new venture idea. During the first stage, students will be exposed to the concepts and principles of entrepreneurship and individual characteristics and the required skills to manage business ventures successfully. Then, they are introduced to techniques and tools to analyse and assess business ideas and the procedures to set up business ventures in Malaysia. Finally, they are guided through every stage of business model development using their business ideas. In addition to guided teaching and learning, students are exposed to real life entrepreneurial activities through entrepreneurship carnivals containing several activities such as talks by successful entrepreneurs and entrepreneurial workshops.

EXPERIENTIAL ENTREPRENEURIAL LEARNING

Using ELT, lecturer of the course plays a facilitator role to help students to experience personally and reflect on it. In this experiential learning project, students in a group are required to plan and organize business activities for at least one day. They are encouraged to run their business activities either during university events or business carnival. The assessment is composed of 50%. With action and experience as a major learning method of the course, students work in a team to learn about customers and markets, create business ideas and execute the business in real life. They learn about managing resources, marketing, operations and financial planning. Importantly, students have to engage in the hands-on learning process through discussions and problem-solving. This group of students work together to create knowledge and achieve business goals. This approach requires students with different backgrounds, race, or upbringing to work together. Hence, students are worked in groups of two or more members to solve problems, complete tasks or learn new concepts.

Reflection is essential of a successful implementation of an experiential learning project in order for students to reflect what they have learnt throughout the process. In this course, a two-stage process proposed by Moon [4] is used to train students in reflection. The first stage involves “presenting reflection.” In this stage, students are required to provide individual feedback in a report. This is important to enable opportunities and practice for feedback by setting up a platform in which students

can share their ideas. Thus far, positive feedbacks were received from the students such as this course explores their mind in finding opportunity and doing business.

The second stage of reflection aims to expand the students' understanding of reflection. Besides providing feedback in a written format, students are introduced with an exercise that involves 'standing back from oneself'. In this context, a peer evaluation form is used to allow students to assess each other's performance in a collaborative project. Peer evaluation or assessment is imperative to help students for a structured learning process. This process enables them to critique and provide feedback pertaining to the group work. Essentially, lifelong skills will be developed when students evaluate and provide feedback to each other. Peer assessment will enhance the skills of self- assessment, problem identification, problem-solving solution, diversity acknowledgment which could lead to work improvement and self-directed learning.

CONCLUSION

Experiential learning is a powerful tool for students' learning. By incorporating experiential learning into education, students could be empowered with the competency they need to thrive when pursuing their career. The experiential learning and project based enable students to deep dive into business needs, meet top management and develop practical solutions to industrial issues. By working on real business projects, students develop critical skills including teamwork, creativity, communication and critical thinking. As a result, graduates who are holistic could stand out among their peers when entering the workplace.

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ROLE-PLAYING EXERCISES IN OCCUPATIONAL, SAFETY AND HEALTH MANAGEMENT SUBJECT

Siti Suraya Abd Razak[*] and Teh Zaharah Yaacob
Azman Hashim International Business School, Universiti Teknologi Malaysia, Skudai, Johor, MALAYSIA
([*]sitisuraya@utm.my, tehzaharah@utm.my)

ABSTRACT

Scenario-based learning approach through role-play enable learners to experience the real-situation and improve their problem-solving skills. Occupational Safety and Health Management (OSHM) is one of the subjects which requires student to explore the relevant law relating to occupational, safety and health management at the workplace. However, the effectiveness of role-play exercise in OSHM subject for electrical engineering student is yet to be explored. The aim of this research is to examine the suitability of role-play exercises in OSHM subject and to examine the application of role-play exercise in order to achieve the programme learning outcome. Electrical engineering student is expected to know the relevant law for OSHM and the solving issues relating OSHM when occurred at the workplace. In this approach, students work in a group to perform a role-play exercises to deal with a scenario given. It is found that this learning approach provide a more interactive way of learning and enhance student engagement. It is recommended that future research should be done to examine the effectiveness of role-play exercise in the OSHM subject on electrical engineering students.

Keywords: Role-Play, OSHM, Scenario-Based Learning, Problem-Solving

INTRODUCTION

Legal studies refer to the study of rules and regulations in one or more legal system and the application of the law in order to solve legal issues. The absence of experiential learning in law subjects has limited the understanding of case law and problem-solving skills among students. Legal studies offer an ideal environment for the use of deep learning as the subject itself constantly fed with practical problems and material from 'real world' [4]. Scenario-based learning (SBL) presented as a possible method to be implemented in studying law subjects. SBL affords learners a more active role in their learning and to develop their real-life skills to be future ready graduates. Students are presented with hypothetical situations derived from actual practice and asked to immerse themselves in the situation and solve the issues [2]. One of the method under SBL is known as role-play. Role-play is effective to teach problem solving skills and to explore issues arising in a specific context [1]. Errington [1] stated that a stimulated scenario must be given in a role-play exercise. There are three elements of role-play: role taking, role making and role negotiation. The first element is students will be taking the characters to play in the role-play, the second element is students will build up the character of the role-play given.

Lastly is related to role negotiation that depending on how other members within the interaction view the role. However, the effectiveness of role-play exercise in OSHM subject for electrical engineering student is yet to be explored. The aim of this research is to examine the suitability of role-play

exercises in OSHM subject and to examine the application of role-play exercise in order to achieve the programme learning outcome.

COURSE DESIGN AND IMPLEMENTATION

Occupational, Safety and Health Management is one of the subjects for electrical engineering students. This subject introduces the concept of occupational safety, health and environment which is considered as crucial components of organisational competitiveness. It started by highlighting the safety and health movement then and now followed by the legal requirements stipulated under the Occupational Safety and Health 1994, the Factories and Machineries Act 1967 and Environment Quality Act 1974. Other topics covered include safety promotion, hazard analysis, accident investigation and emergency preparedness programme. One of the programme learning outcome of this subject is to analyse organisational safety, health and environmental issues by conducting the relevant search, investigation or inspection across a wide range of contexts. Therefore, role-play can be used to reach the outcome of this programme.

Problem-solving model is suitable to be employed in this role-play. Lecturer will prepare a scenario, where student is given set of facts, followed by the instruction, 'advise the officer/ party'. From the scenario given, students have to read and manage the facts, identify the characters and sift out the issues of the case. Students have to solve these issues with legal justification such as statutory provisions and case law. Next, students must divide the roles among themselves and prepare scripts for the role-play. The role-play is presented through face-to-face presentation in class or it can be recorded. A specific time is given to each group and at the end of the role-play presentation lecturer will give comments on the said presentation. Marks will be given according to the solution provided from students in the role-play. Marks for the acting or role-play should be given however it should not outweigh the solution and facts understanding performed in the role-play. The presentation is a as a part of students coursework assessment for OSHM subject.

For instance, a set of facts can be given as follows: -

"Farheen is a worker from Bangladesh who works at Syarikat Garupa Sdn. Bhd. in Seri Alam. His work involves the cutting of timber to be processed into furniture. Farheen could not read and does not understand English. A large notice was posted on the wall of the factory instructing all workers to wear gloves and goggles to protect their hands and eyes respectively. Andy, the employer, provides the gloves and goggles but never bothers to show Farheen how to use them and where they could be found. Farheen was injured while on duty because he did not wear the goggles. Is Andy in breach of his common law duty to ensure Farheen's safety at work? Advise Andy.''

Students have to identify the issues related to the situation given and the law applicable. From the facts, students will have to divide the role of Farheen and Andy in the role-play. Then they will be given 20 minutes to act in front of the lecturer. At the end of the presentation, the lecturer will advise on the recommended solution. Online presentation is possible to be done as students can record their role-play and edit it into video for presentation. This method is convenient and practical to be done in face to face classes and even during COVID-19 pandemic where online learning is implemented.

IMPACTS ON STUDENT'S LEARNING

In order to reach of the objective this study, a survey was conducted by distributing Google Form to students which consists of open and close ended questions. The form was distributed to 85 students in OSHM class. These are some of the responses extracted out of the survey:

" This method is fun and interesting and I can interact more with my friends.''

" From this task I can understand the case better''
" I learned a lot through the case given''
" It is related with real situation of the current OSHM issues''
" This tasks provides insights on the task of OSHM officer and how to deal with various situations''
" It makes me reflects on the real situation and how I should act in these situations''

Results of this study shows that the role-play study exercise is positively accepted by students learning OSHM subject as the method increase the interactions between students during the task preparation and with subject lecturer during the presentation session. It is found to be a suitable approach that can increase student's knowledge and understanding of the subject.

CONCLUSION

Role play in the form of problem-solving does offer the advantage of being fun, interesting and increase the engagement between students and lecturer. Nonetheless, the fact that simulations are time- and resource-greedy cannot be overlooked; this has to be factored into the pedagogic decision to use them and the careful planning that is required. Role-play exercise can be seen as one of the ways to reach the common goal of improving the quality of student learning and achievement. In the context of this study, role-play exercises will improve student's learning on OSHM subject.

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REFLECTIONS ON PROJECT BASED LEARNING IMPLEMENTATION IN SYSTEM MODELING AND ANALYSIS COURSE

Fatimah Sham Ismail*, Nurul Adilla Mohd Subha, Zaharuddin Mohamed, Fazilah Hassan, Norhaliza Ab Wahab, Herman Wahid
Department of Control and Mechatronic,
School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia.
(*fatimahs@utm.my, nuruladilla@utm.my, zahar@utm.my, fazilah.hassan@utm.my, norhaliza@utm.my, herman@utm.my)

ABSTRACT

This paper presents the findings of a study of student reflections from Project-based Learning (ProjBL) conducted in System Modeling and Analysis course. ProjBL is one of the most effective methods for incorporating students-centered activities into the learning process in order to improve students' ability, performance, attention and creativity. In order to determine the success rate of the conducted project, getting reflection from the students is important as they indicate potential improvements that can be included by the lecturer in the future plan. In this paper, only the final reflection is discussed including the rating and short answer questions. A total of 100 respondents from three different Electrical Engineering majors are being analyzed. Overall, the results show that more than 80% of students strongly agree of using project-based learning to support their learning process.

Key words: Project-based learning, Active learning, Student centered learning.

INTRODUCTION

Project-based learning (ProjBL) is one of the learning processes based on constructive problems, self-directed, collaborative and contextual insights, which focuses not only on the outcome of study, but also the application of gained knowledge into practice with real applications [1, 2]. Therefore, the proposed project-based learning used to be more complex, realistic, open-ended, and less structured [3, 4].

This ProjBL has been implemented in System Modeling and Simulation course during semester 2, 2020/2021 for three groups of undergraduate program: Bachelor of Engineering (Electrical) Program (SKEE Program), Bachelor of Engineering (Electrical-Mechatronics) Program (SKEM Program) and Bachelor of Engineering (Electrical-Electronics) Program (SKEL Program), at School of Electrical Engineering (SKE). Students' reflection and feedback from 100 selected respondents have been collected and analyzed.

LITERATURE REVIEW

Generally, ProjBL has been discussed in the literature as a student-centered learning activity [4, 5]. The ProjBL is designed for gantry crane control system has 5 tasks that covering the entire four course learning outcome (CLO) that relate to the course chapters as shown in Figure 1. In order to determine the success rate of the conducted project, getting reflections from the students are very important as

they indicate potential improvements that can be included by the educators or lecturers in the future plan.

Since the ProjBL is conducted in a group of 3 to 4 members, participating in the ProjBL can also help students to develop generic skills including teamwork, communication skills and presentation skills [6], which each of them is assigned to every team members of the group. Each member is responsible to determine the best solution to their task by finding appropriate resources such as lecture slides, related reference books, or scholar articles. Following that, all students are required to explain to their group members while being observed by the lecturer. All these active learning activities involved throughout the semester and try to ensure all students actively participate in their roles. Furthermore, several individual and group assessments are performed such as peer evaluation, progress report, presentation and final report.

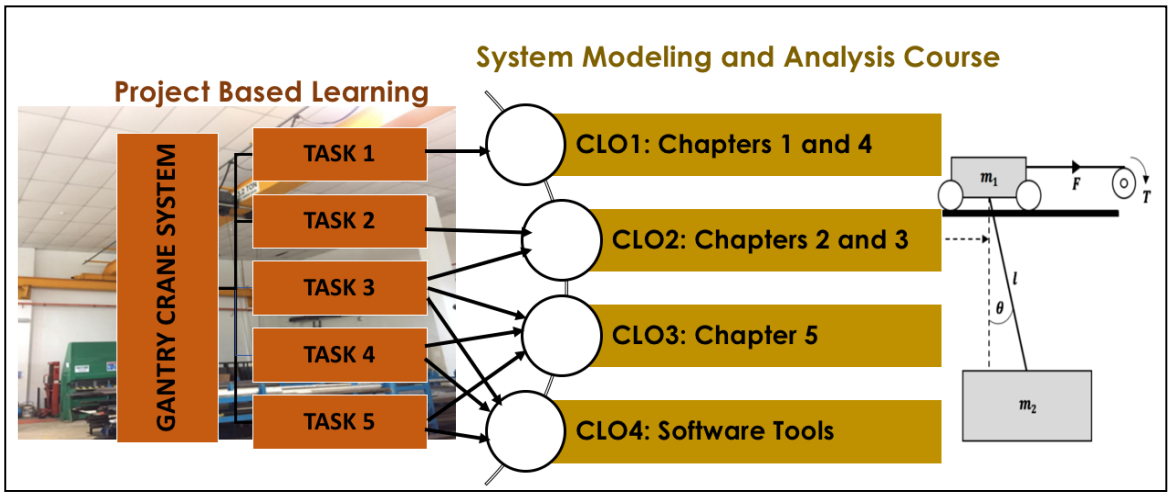

Figure 1. ProjBL Mapping to Course Contents.

APPLICATION DESIGN

In designing the ProjBL, reflection should also be designed to be ongoing and throughout the project. The reflections allow students to evaluate their work while also allowing ProjBL designer or educator to looks back at how they have contributed to the ProjBL and what can be improved in the future ProjBL plans. For the developed ProjBL, three types of reflections have been designed for students to respond to at the beginning, middle, and end of the project period. The first reflection is focusing on their planning and expectation on ProjBL. The second reflection focuses on the progress and the problems of handling ProjBL. However, the final reflection provided a comprehensive overview of the students' views and perspectives on how beneficial the ProjBL is in assisting them in their learning process.

In this paper, only the final reflection is presented, which consists of a set 'rating' questions and two short answer questions asking students to share their feedbacks. A rating question is important and useful to compare different questions or items using a common scale, where '0' means 'Strongly Disagree' and '5' means 'Strongly Agree'. On the contrary, the short answer question is intended to allow the student to construct their response using their own words to a specific question. Both types of questions were created in the e-learning platform as shown in Table 1. A total of 100 respondents from three different electrical engineering majors as mentioned earlier has been collected.

Table 1. Reflection Design Items

ITEMS	Strongly Disagree ⟷ Strongly Agree
The project improves my understanding on the course SKEE3133 System Modeling and Analysis, which can relate the theory with real system	0 1 2 3 4 5
The contents of the assignment which are divided into Task 1 to 5 are appropriate to cover the syllabus according to the chapters	0 1 2 3 4 5
The project enhances the students understanding on the importance of computer aided control system design (such as MATLAB) in modelling, analysis and controller design	0 1 2 3 4 5
The project encourages problem solving skills among the students to achieve the best design	0 1 2 3 4 5
What are the advantages of doing this project case study in this subject?	Text answer
Give your suggestion/opinion on how to improve the project case study in the future	Text answer

FINDINGS AND DISCUSSION

The reflection of four criteria from 100 respondents as shown in Figure 2, which scores are measured as Strongly Disagree (0) to Strongly Agree (5). On average, all criteria achieve a score of more than 4.7 score (between 'Agree' and 'Strongly Agree') indicating that all students agree that the ProjBL can effectively assist them in understanding the course content and improving their critical thinking skills in solving a real complex engineering problem. It can be noted that more than 80% of students have strongly agree with the implementation of the ProjBL.

Responses with positive feedbacks on ProjBL are tabulated in Table 2. In response to the first question, majority of students agree that the ProjBL exposed them to dealing with a practical problem by relating the theoretical concept learned in the lecture to the actual real-world problem. In addition, to accomplish the task, they not only need to develop their understanding about the project, but also need to develop their interactions with the members, distribute the task, and consequently, improve their generic skills. In response to the second question, the ProjBL designer and educator may find these suggestions useful for the future plan. Referring to Table 1, one interesting suggestion that the designer could consider in the future is to create a prototype as part of the ProjBL, where students can transform their knowledge into a tangible form. However, not all suggestions are appropriate, the ProjBL should be designed based on the course learning outcomes that have been established earlier.

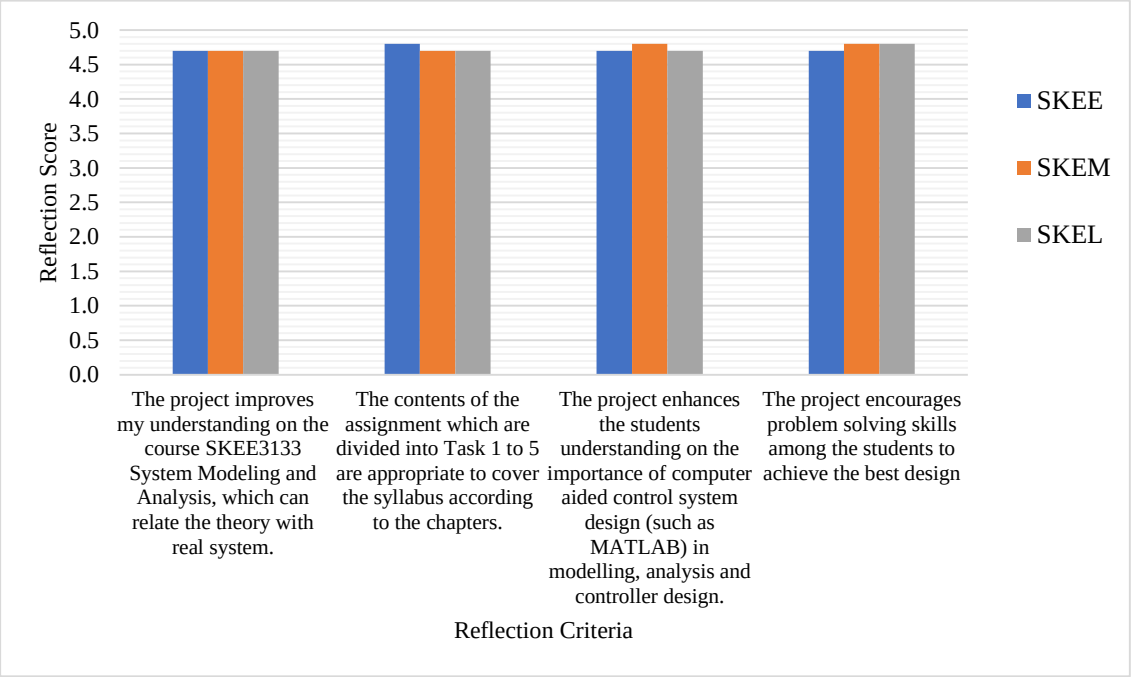

Figure 2. Reflection Score.

Table 2. Students Feedback on Project-based Learning

Items	Samples of Students feedback	
What are the advantages of doing this project case study in this subject?	Strong understanding about application of system modelling towards industries.	Dealing with practical problem is a huge advantage as it prepares in industrial work
	Learn new things, enhance knowledge, enhance teamworking skills, enhance communication skills	It helps me to understand how the modelling to control system actually works in real life.
	learn more about control system and using simulation software like MATLAB and Simulink function	Able to experience with real practical on how to design control system from basic.
Give your suggestion/opinion on how to improve the project case study in the future	Relate the industrial concerns such as cost and material in case study.	I hope that we can build a small crane that can simulate what we program into real world.
	Give at least 2 different projects (individual & group) where the pattern of the task almost same. When they work in group, they can give the best idea because have experience for individual task.	Student need to experience on how to handle the MATLAB earlier in the Basic Control lab, thus, student can explore more on the project case study. Since, there are students enter the Basic Control lab late.
	It would be more interesting if we can combine with other course for more complex system.	It would help a lot if this case study requires the student to make a prototype.

CONCLUSION

This paper has discussed a final reflection of the ProjBL. The final reflection included rating and short answer questions. The responses of students from three different Electrical Engineering majors have been analyzed. According to the findings, the majority of students agree that implementing ProjBL could significantly enhance their understanding of the System and Modelling course. Moreover, many useful suggestions and comments from the feedbacks can be applied for future ProjBL improvement and enhancement.

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ACTIVE LEARNING IN SYNCHRONOUS CLASS FOR DIGITAL SYSTEMS COURSE

Norlina Paraman and Ismahani Ismail*
School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia.
(pnorlina@utm.my, *ismahani@utm.my)

ABSTRACT

Online learning is implemented as a delivery method to give the lecture to the students during pandemic breakdown. However, the student's level of understanding is unsatisfactory compared to the face to face learning. This paper describes the implementation of active learning for synchronous class in order to improve the student's level of understanding. The activity of think pair share is implemented in the active learning which is conducted through online tool i.e Webex. Students will be given the instructions of class activity during the synchronous class guided by the lecturer. Padlet is used as the platform for task submission and discussion of the given tasks. From the students' feedback, it shows that students were agreed with the activity of active learning in synchronous class that can improve their understanding of this course.

Key words: active learning, synchronous learning, think pair share

INTRODUCTION

Nowadays, most of the learning are moved to the online learning during the pandemic breakdown. Students have to attend class by using virtual platform such as Webex, Google Meet or Zoom if the class is conducted by synchronous learning. Synchronous learning is supported by video conferencing and has the potential to support students in the development of learning communities [1]. On the other hand, synchronous learning is conducted in real-times. More challenges will be faced by the students including the understanding of the lecture contents during the synchronous learning [2]. Students become more passive and only memorize without having a conceptual understanding. The class environment is not the same as face to face learning environment. In fact, students will feel bored attending online synchronous learning. Therefore, active learning is implemented to assist student learning and overcome the drawback of online learning. Active learning is an approach to actively engage students with the course materials through discussions, problem solving and other methods [3]. This study is done for the second year student that taking the subject of digital systems. Students have to involve in the class activity such that create two ways of communication between students and the lecturer. The objective of this paper is to study the implementation of active learning in synchronous class for digital systems course. This course is designed based on constructive alignment, which is based on the constructivist theory [4]. One of the course learning outcome is to analyze and design complex digital systems within defined specifications. In order to achieve the course learning outcome, the activity class such as active learning is implemented to improve the understanding of lecture to students.

LITERATURE REVIEW

Active learning is implemented in the class activity in order to improve the teaching and learning process and making students participate in the class. In [5], they implemented project-based learning as active learning for digital systems course. They done this activity during face to face learning environment. The students need to do milestones project using complex programmable logic devices (CPLD). From the students' feedback, the content of the course will be easier and enjoyable by doing class activities and milestones. In [6], active learning is implemented for digital electronics. They used tools for simulating creativity, including games of visual exercises to identify student's creative abilities and encouraging contributions. Another study presented the flipped mode approach as active learning to develop the design skills of the student [7]. The proposed approach was aimed on hands-on design skills and improved the students' ability for independent learning making them more confident.

APPLICATION DESIGN

Before implementing this activity, students have learned the related topic in the previous synchronous class. The online learning includes the activity of think pair share and focused listing. Each task must be completed in the given times by following the steps shown in Figure 1. An example of a task is 'design the finite state machine for 2-bits counter'. Figure 1 shows the class activity for two hours that consists of several tasks. Each student actively involved by thinking, creating and solving the task given rather than passively listen to lecturers.

Firstly, students have to write the answer individually after obtaining the task. This step ensures that students need to solve the question itself without discussing it with friends. The individual student activities are important to develop self-learning for each student. Next, students have to share the solution with the group members that contains of three students per group. They will discuss among them to get the best answer. From this observation, it shows that each student will increase their understanding from the discussion [8]. They will give the ideas or opinions in order to get the correct answer among them. At this stage, students are able to develop skills such as problem-solving and working in groups. They also learned how to analyze and synthesis the problems.

Finally, the finalized answer is uploaded to Padlet by each group. The lecturer will give the reflections once all submissions are accepted at Padlet. Any questions from students are allowed during the reflection session. At this stage, students are provided with a solid conclusion from this activity.

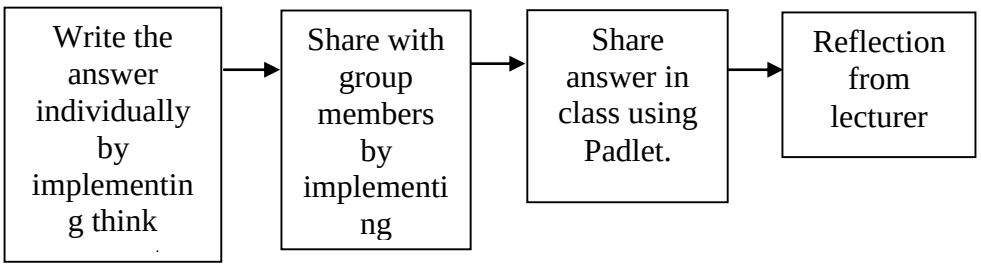

Figure 1. Active learning activity in synchronous class

FINDINGS AND DISCUSSION

Figure 2 shows the sample of uploaded solutions for each task in Padlet. Students are able to see other answers from other groups and do comparisons among themselves. In fact, the lecturer can check the submission from the students easily. The selected group will be required to present and share their solutions with the class. All students were agreed that this active learning can improve the level of their understanding compared to the traditional teaching method. They feel not lonely and less stress during the online class because they have discussion between group members during active learning activity.

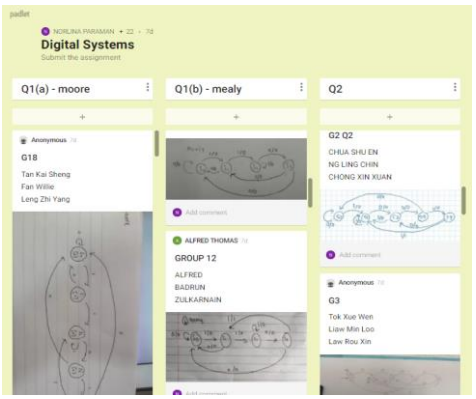

Figure 2. Sample of students' answer at Padlet

Table 1. Student's feedback for active learning activity

2. Write your opinion to this active learning class activity.
It is really good
good
very good
This activity let us practice,after that lecturer will discuss the question,this method is the best method for me if during synchronous class
It is nice as this activity improve my understanding on the FSM
good as i learn from my mistake when answering question
Today lesson is good as we can do a revision based on the previous chapter that we have learned and we also learned about how to solve the question given.
We get to know how the study applied in the questions
Very interactive and effective
I learn a lot of new things because I make a lot mistake
Informative
have better understanding on FSM with step by step solution explained
The class activity is useful for our revision.
Understand more thru exercise
It is good that to discuss with friends, so that not feel lonely and less stress during the online class. Dr. can also access our understanding and enhance our understanding. Learn through Q&A is suitable for me, just sometimes I will lost connection or internet not stable at my place.
Good and Clear
Still manageable. Just that sometimes the explanation is a little fast.
The activity is quite good as we can have more exercises and discuss with our friends. Lecturer also provides the solution and explaination to student which is really good as student can know the mistakes we made.
exercise improved our understanding on the topic
Maybe can carry more as revision for test and final
It is a good way to test and confirm student's understanding by doing question.

Table 1 shows the opinion of the students about the implementation of active learning in the synchronous class by obtaining the students' feedback. It has been done at the end of class to 25 students. Most of the students satisfied that this activity can improve their understanding of the concept of state diagram counter. Students are given the exercise regarding the topic and need to be solved in the specific time. By having the reflection session at the end of the activity, they will learn from the mistakes done before the discussion. However, there is a feedback about the limitation of times to handle this activity and unstable internet connection.

CONCLUSION

In this paper, the implementation of active learning in synchronous class for digital systems course has been studied. From the students' feedback, it shows that all of the students were satisfied with the active learning activity implementation. This activity is useful since it helps students not to feel alone looking for a solution because they can discuss with their team member. Students also can gain skills for synthesizing and analysing information during active learning activity. Further improvement is needed to address internet connection such that students will follow the learning smoothly. For future work, the feedback in terms of percentage for level understanding before and after implementation of active learning should be included in the students' feedback.

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ACADEMIC SERVICE-LEARNING IMPLEMENTATION TO PROMOTE STEM INTEREST AMONG SECONDARY SCHOOL STUDENTS

Shahrin Md Ayob*, Tan Chee Wei and Mohd Zaki Daud
School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia.
(*shahrin@fke.utm.my, cheewei@utm.my, mdzaki@utm.my)

ABSTRACT

This paper describes the implementation of academic service-learning (ASL) implementation that has been conducted for two consecutive semesters in secondary schools within the Skudai area, Johor Darul Takzim. Service-learning is a teaching method that can enhance student comprehension on the course syllabus while simultaneously promoting interest for the secondary schools' students to pursue study in science, technology, engineering, and mathematics fields for their tertiary education. This is in line with the vision of the ministry to increase the percentage of Malaysian students, especially Malay involvement in this area.

Keywords: academic service-learning, engineering education, photovoltaic, secondary school

INTRODUCTION

Academic service-learning in electrical engineering is considered a new tool in engineering pedagogy. It leverages service-learning principles to help create a bridge between academics and real-world work. Those involved can see it to deepen students' engagement with the material and orient them in the professional world. Service-learning aims to teach lessons and make a difference in people's lives, whether students or nonstudents.

Service-learning can take many forms in an electric power engineering course. It depends on the course objective and the allocated budget. This paper describes the service-learning implementation activities that have been conducted through course SKEE4653: Photovoltaic and Wind Energy. The activities were done for two consecutive semesters involving secondary schools in the Skudai area. The activities are targeting students of forms two and three who have recently taken the PT3 examination. The secondary school students were exposed to the science behind the photovoltaic energy system. Feedbacks received from the school students are overwhelming, with over 80% of the students will pursue education in STEM.

LITERATURE REVIEW

It was reported that the number of students that pursue their study in science, technology, engineering, and mathematics (STEM) is decreasing by 6,000 students annually [1]. Based on the Science and Technology Human Capital Report and Science Outlook 2015 by Akademi Sains Malaysia, the country needs at least 270,000 science students sitting the Sijil Pelajaran Malaysia examination annually. However, there are only about 90,000 now [2]. The number is quite worrying, and

educationist has urged the government to increase the effort in promoting STEM interest among the students so that the ratio of 60:40 between STEM and non-STEM students can be achieved [3].

In line with the effort, the School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, in 2017 has introduced academic service-learning (ASL) elements in several courses in the school. The introduction of ASL is concurrent with the vision of UTM to strengthen public-university ties [4]. In these courses, the students are required to conduct knowledge transfer activities to the public. Apart from that, service-learning features several benefits to the students, namely personality growth, civic learning, and academic enhancement [5,6]. The relationship between the content of service learning and the goal is illustrated in Figure 1.

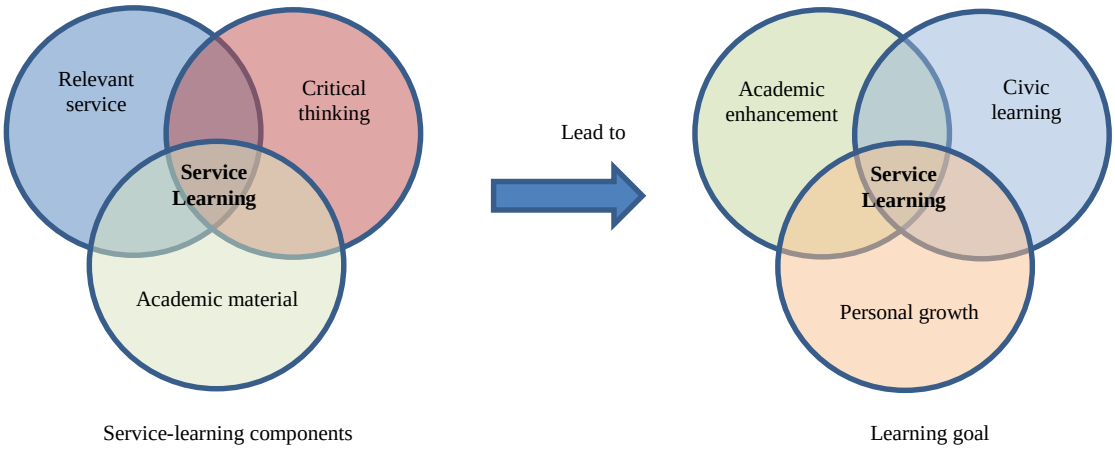

Figure 1. Conceptual framework of service-learning

The course SKEE 4653 (Photovoltaic and Wind) has been selected to implement the academic service-learning for the first time. The course is an elective course and is opened to all final year students in the electrical power engineering degree program. The main topic of this course is to introduce the student to photovoltaic and wind energy technologies. However, for the services-learning, the activities will concentrate on the photovoltaic only. Before the service-learning activity design for the course, literature was carried out. There were limited resources on the implementation of the service-learning in Malaysia. Hence, the author has some difficulties in delivering the service-learning for the course, especially on the implementation process and assessments.

APPLICATION DESIGN

In this first cycle, a total of 57 students has been grouped into five groups containing around ten to eleven members. The group first needs to approach a secondary school and communicate directly with the school principal or counselors. One group will conduct the activity for only one school. For this cycle, five secondary schools were approached, and they are:

a. SMK Taman Impian Emas
b. SMK Bandar Baru Uda
c. SMK Bandar Selesa Jaya
d. SMK Taman Pulai Perdana
e. SMK Taman Universiti 2

The groups need to have two compulsory components in their activity. The first should be the 1-hour

academic talk about photovoltaic and the second component is the 2-hour interactive activities. The groups have come out with their proposal, and it was discussed with the lecturer. For the activities, the student is compulsory to conduct a demonstration of the PV system. For this, a set of PV education kits was built for the demonstration, as shown in Figure 1. The PV education kit comprises of:

1. Solar panel Monocrystalline 20 Watt
2. PV meter and Load meter
3. Solar charge controller (PWM based)
4. 50-Watt Inverter
5. 240Vrms socket plug to connect ac load
6. Lead-acid battery

The proposal will be assessed based on the content of the talk and activities. All the activities development tool cost is limited to only RM200.00 per group. At the end of the ASL, each group will write a report on the activities that have been conducted. The mark of ASL activity will be 30% from their final mark. The breakdown of the marks is planning (5%), execution (20%), and Peer Review (5%).

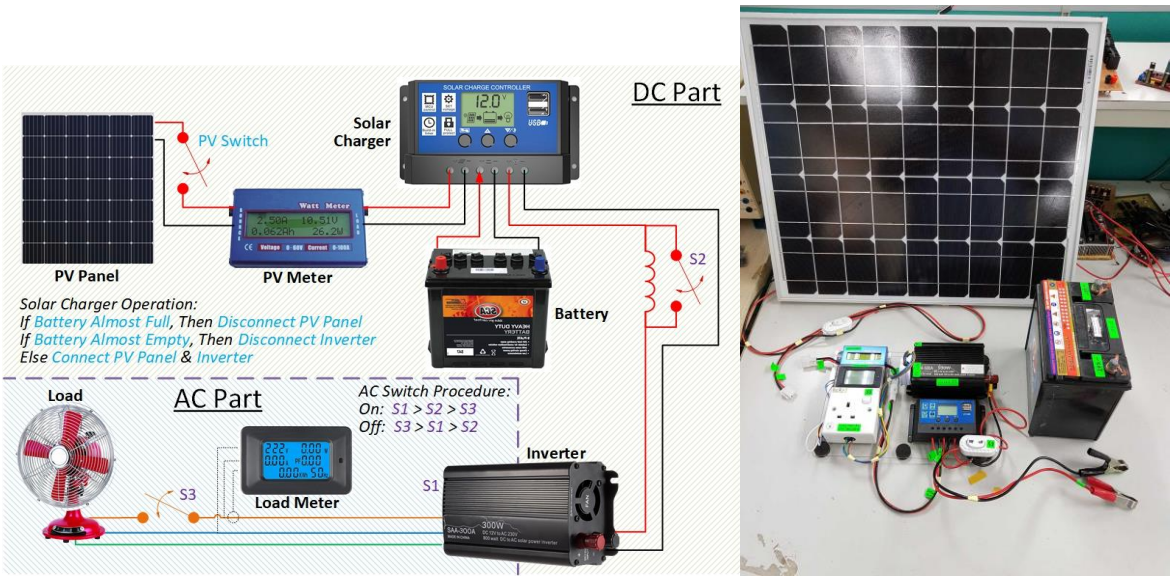

Figure 2. (a): Schematic diagram of the PV education kit (b) Actual PV education kit

FINDINGS & DISCUSSION

More than 200 feedback responses from school students were taken to evaluate the effectiveness of the activities in promoting STEM interest among the school students. Figure 3 is the chart that shows the percentage of students who have been exposed to photovoltaic technology. It was shown that more than 70% of the students had been exposed to PV energy technology. The remaining student stated that they have not yet been exposed to the knowledge. However, as from Figure 4, out of it, only 14% of students have zero knowledge about photovoltaic technology.

Figure 3. Chart showing the percentage of the student with PV knowledge exposure.

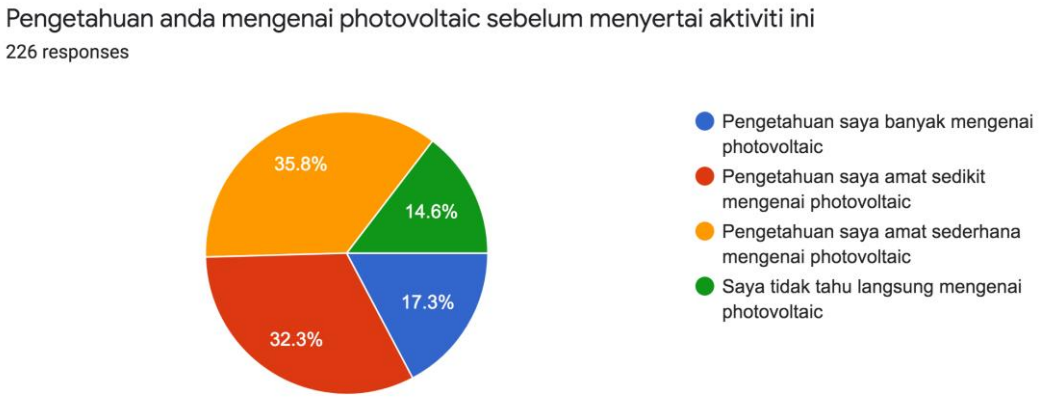

Figure 4. Chart showing the percentage of the knowledge level of the student with PV knowledge.

Figure 5 shows the percentage of students who have gained knowledge of PV technology after the activity. Most of them agreed that the ASL activities had boosted their knowledge of PV technology. Only 1.8% of them (4 respondents) stated that they have not benefited from the activity.

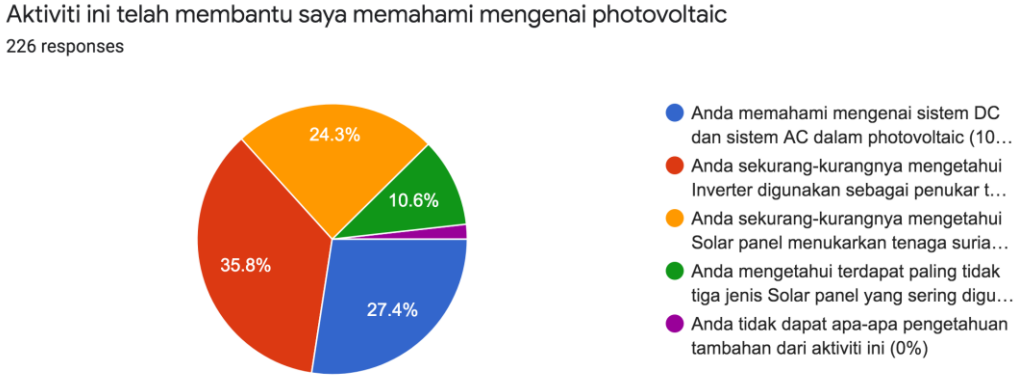

Figure 5. Chart showing the percentage of the knowledge level of the student with PV knowledge.

As previously stated, the activity's objectives are to promote the school student's interest in pursuing STEM fields. Figure 6 shows the result of the outcome. From the result, it is clearly shown that more than 87.6% of the students have an interest increment to pursue STEM. However, there 12.4% were not interested. Most of the answer is that they agreed that they enjoy science and engineering but are worried about their ability. There was also feedback that their family is not allowing them to take paths in the STEM stream due to several unknown reasons.

Figure 6. Chart showing the percentage of students who will pursue in STEM stream

CONCLUSION

The paper presents the implementation of academic service-learning (ASL) for secondary schools in Skudai, Johor. The students were exposed to photovoltaic energy technology through several activities such as technical talks, actual system demonstrations, and interactive activities. The outcome of the service-learning activity to the students is positive, where most of them are enjoying the activities while at the same time increasing their interest in STEM.

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ACTIVE LEARNING ACTIVITY IN ELECTRONIC CIRCUIT AND SYSTEM COURSE

Zaharah Johari[1*], Camallil Omar[1], Mastura Shafinaz Zainal Abidin[1], M. Fairus M. Yusoff[1], Norhafizah Ramli[1], Johari Kasim[1], M. Arif Abd. Rahim[1], Siti Zaleha Abdul Hamid and Fatin Aliah Phang[2]
[1]School of Electrical Engineering, Faculty of Engineering
[2]Centre for Engineering Education & School of Education, Faculty Social Sciences and Humanities, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia.
(*zaharahj@utm.my)

ABSTRACT

An effective teaching and learning strategy based on student-centred learning must prepare students with 21st-century learning skills. Therefore, the instructor must be creative and innovative to create a meaningful learning environment. This paper describes active learning named stick it activity to learn bipolar junction transistor (BJT) AC analysis for small signal amplification in electronic circuit and system (ECS) course. The collaborative learning approach implemented is designed based on constructive alignment. In this activity, the learner is given a set of question involving the BJT AC analysis, where they need to apply some technique and method of analysis to solve the problem. This activity requires the learner to work with each other in a team to solve the problem. The learner will need to stick and join the laminated electronic components to form a complete BJT AC circuit. This electronic component sticking kit is provided by the instructor consist of a resistor, capacitor, wires, voltage, and current source. During this activity, the instructor will facilitate the learner, including discussion and exchanging ideas. Active engagement between the learners in a group is observed where everyone tries to explain to each other, making sure everyone understands. The learner is given a quiz at the end of the activity to evaluate their understanding of the topic. Student reflection from a survey after the activity is used to see their improvement in the content of knowledge and learning motivation. The results show a positives impact on student content of knowledge and learning motivation. Through instructor observation, the learner becomes more engaged and shows good teamwork in solving the question. In summary, an active learning approach presented here provides an enjoyable environment that could help learners enhance their understanding of the topic and effective learning process.

Keywords: learning motivation, electronic circuit, electronic system, active learning

INTRODUCTION

Electronic circuit and system course involve much technical content and the use of a technological tool. This course covers a wide range of topics such as transistor AC analysis for amplification application, filters, operational amplifier, oscillator, and voltage regulator at varying level of complexity. The varying level of complexity has sometimes faced difficulties with understanding some concept, particularly related to a circuit. To improve the conceptual understanding, Mazzolini et al. [1] have attempted to use interactive lecture demonstration (ILD) to improve conceptual understanding about resonance in electronics course where they show that active engagement of the learner in ILD is from those who had least beneficial in the traditional

classroom. In another course, such as digital electronics, Wang [2] has shown that new pedagogy created an active learning environment between the instructor and the learner. Arias et al. [3] shifted to student-centred learning to teach power electronics by changing the classroom into a laboratory where it enables the learner to learn by doing and have shown to improve their marks significantly. Therefore, it is proven that a meaningful learning and teaching environment can be achieved through active learning.

Transforming from teacher-centred learning into student-centred learning allows the learner to become more engaged, increase knowledge retention, the content of knowledge, and learning motivations [4]. Therefore, the course design must constructively align with the learning outcome. Suitable assessment needs to be aligned with learning and teaching activities that can be adopted to achieve the intended learning outcome. Smith.K [5] has introduced an approach named book-ends division to implement active learning effectively. The class is divided into three segments using bookends division: advance organizing, intermittent discussion, and closure-focused discussion. This teaching strategy has been implemented in several electrical engineering courses, which have positively impacted learner engagement [6]. This work aims to explore the learner response after implementing simple active learning activities to learn about BJT AC analysis, including the frequency response. It involves a 50 third-year student taking this course at the faculty of engineering. The instructor can plan for further improvement in the implementation for best practice in designing active learning activities, particularly for electronics-related courses.

COURSE DESIGN

One of the reasons for implementing these activities is for the learner to practice drawing the BJT AC equivalent circuit before performing the analysis to find the input/output impedance and the voltage gain. The AC equivalent circuit required modification considering the effect of the capacitors when doing the frequency response analysis. The instructor has discussed the approach of doing this kind of analysis; thus, this activity aims to strengthen their knowledge and help those still unclear by having their peer teach them. Throughout the activity, the instructor will visit each group to facilitate the group discussion in finding the solution for the problem given. For this activity, the instructor has prepared a laminated component to consist of some resistor, capacitor and other parts required to draw the equivalent circuit. The task that needs to be solved by each group is taken from previous exam questions. Once all group have completed, they will attempt others group question to experience different types of BJT circuit for drawing the AC equivalent circuit. In this activity, the learner will stick the laminated component on the whiteboard according to the circuit assigned for each group. Figure 1 shows the sample of the laminated component and what have the learner done during the activity.

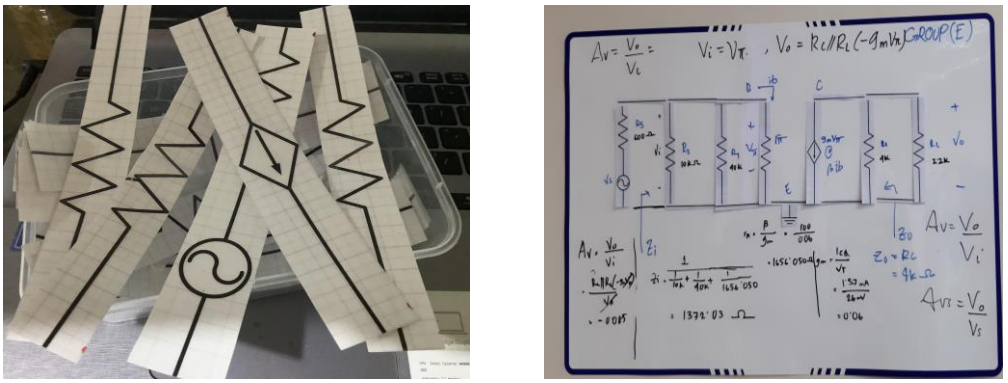

Figure 1. Sample of laminated components and how it is implemented during the activity

For the learner to value the activity, the instructor provides a quiz to answer to assess their understanding of the topic. Then they write a reflection on them through about this activity.

RESULTS AND DISCUSSION

Through instructor observation, the learner shows active participation in this activity. They help explaining to each other can enjoy the activity.

The thematic analysis was done from the reflections collected, and the result is listed in Table 1 to Table 3, which are their response related to teamwork, learning motivation and content of knowledge.

Table 1. Sample of Reflection Excerpts for Team Working

Item	Sample of Reflection Excerpts
S1	"I really like the activity because it make us work as team and help each other"
S3	"We discuss together and get confuse for certain part so help each other to solve it"
S4	“Explanation from friends really help me to understand”
S5	"Firstly I was a bit confused by the capacitors and when do we short it and open it, however with discussing it with my group mates they explain it to me”
S6	“I and my group could share the knowledge to each other. Helped me a lot to raise my understanding”
S7	“It is a good brain storming session together with my team member"

Table 2. Sample of Reflection Excerpts for Learning Motivation

Item	Sample of Reflection Excerpts
S2	“The activity just now was fun. I support it as sometime I felt quite shy to ask question during the class, so with this activity, I can ask my team on any question that I don’t understand”
S7	“I enjoy the activity session since it feel very refresh rather than we just sit for the whole class”
S8	“Very good exercise, I learnt a lot."
S14	“The activity is very fun and learned a lot 100%”
S18	“Makes me remember more about the drawing very interesting and effective”
S29	“Active learning is a good activity that should be include frequently”

Table 3. Sample of Reflection Excerpts for Content of Knowledge

Item	Sample of Reflection Excerpts
S17	“Active learning is a good activity that should be include frequently”
S24	“The activity is helpful to understand at least how to draw the circuit”
S27	“We had better understanding, more clear”
S48	“This activity really boost my understanding especially to differentiate AC circuit between the bands.”

Generally, the learner found this activity motivating to interact with their team members and help each other design the AC equivalent circuit for mid, low, and high frequency. By participating in this activity, the learner can improve their understanding and clarify any doubt they have. From the instructor's point of view, the implementation of active learning in the electronic circuit and system course can be improved by applying informal cooperative learning such as the jigsaw technique.

CONCLUSION

In summary, this work demonstrates a simple active learning activity that can be used in electronic circuit and system work. From student response through reflections at the end of the activity, it indicates that employing simple active learning activity in the classroom for learnt BJT AC analysis increases their learning motivation and content of knowledge. Good engagement between the learner allowing them to show team working skills. This work provides another evidence that active learning is necessary for more effective learning and teaching.

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KPI ACHIEVEMENT IMPROVEMENT FOR COMPLEX ENGINEERING CLOs IN SEMICONDUCTOR DEVICE ENGINEERING COURSE THROUGH ACTIVE LEARNING STRATEGIES IN CLASSROOM

Nurul Ezaila Alias* and Usman Ullah Sheikh
School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia.
(*ezaila@fke.utm.my, usman@utm.my)

ABSTRACT

The COVID-19 pandemic has disrupted education worldwide from primary school to university level. In this situation, the conventional teaching and learning of the face-to-face method have been temporarily stopped due to complying with the new norm of social distancing. One of the most significant challenges moving to online classes is to effectively deliver to students and to promote effective discussion and peer-teaching among students. In this study, the author has adopted the multiple active learning activities in the Bookend model classroom. Interactive lecture followed by active learning activities such as peer-teaching through effective discussion and also hands-on technology through a simulation activity. The implementations greatly improved the KPI of the 3 complex engineering CLOs and successfully promoted peer-teaching among students through effective discussion.

Keywords: collaborative learning, peer-teaching, active learning, hands-on technology, bookend model

INTRODUCTION

In the final year of the Electrical and Electronic Engineering program, a student majoring in microelectronics will take the Semiconductor Devices Engineering course, and it can be said it is one of the favourite courses taken by the students. Therefore, in this study, this course is chosen because, in this course, the students will be provided with the physical principles of underlying semiconductor device operation and the application of these principles to specific devices. This course has 5-course learning outcomes (CLOs), and in this study, only 3 CLOs (CLO2, CLO3 and CLO4) will be focused on which are related to complex engineering. In the previous semester, the key-performance index (KPI) of these 3 CLOs are below 0.65, and the KPI achievements and comparison of all CLOs are compared in the finding and discussion section. The study involved two groups of final year students of the Bachelor of Engineering (Electrical-Electronics) program from the School of Electrical Engineering, UTM, who registered in the Semiconductor Devices Engineering course in 2018/2019-1, 2019/2020-1 and 2020/2021-1 academic session. All groups of students (2018/2019-1, 2019/2020-1 and 2020/2021-1) were allocated with similar 5 CLOs with different cultures and styles of teaching and learning strategies. The comparison was made between these two groups of students corresponds to their KPI achievements for group activity according to the introduction of various active learning strategies applied in the later academic session.

OBJECTIVES

The objective of this study is to improve the KPI of 3 complex engineering CLOs and explore students' perception of the course design activities with various active learning strategies in the classroom.

1. To improve the KPI of 3 CLOs (complex engineering) by implementing multiple active learning strategies in the classroom from interactive lecture, peer-teaching to hands-on technology through the Bookend Model.
2. To promote peer teaching among students through effective discussion using the Discord platform and hands-on technology application in the classroom.

For the first objective, the data collected were based on the KPI achievements of the 3 CLOs, where the KPI should be 0.65. Whereas, for the second objective, the data collected were based on the students' feedback on the understanding of the topic discussion and their perception of the hands-on technology. Both findings are discussed in the following section.

LITERATURE REVIEW

The term "learner-centred" refers to environments that students or learners are paying attention to the knowledge, skills, attitudes, and beliefs that learners bring to the educational setting. The concept of learner-centred includes a sensitivity to the cultural practices of students and the effect of those practices on classroom learning [1]. The teacher who applies the learner-centred must carefully observe the students' behaviour (their understanding through their response and body language). This is because it is going to be the further steps for the learning process [1]. In science or engineering classrooms, students who actively discussed or argued in the classroom show their level of understanding of specific topics. This statement proves that peer-teaching amongst students will help them in better understanding a certain topic given by the teacher in the classroom.
Normally in the classroom, students are encouraged to participate actively and engage. For example, some groups of students rely on learning by observation and listening and then becoming involved in ongoing activities [1].

Cooperative learning is one active learning technique that has been proven to be effective in helping students to learn and helps students to obtain feedback about their current performance and provide chances for them to improve themselves [2]. Active learning activity in the classroom means students engage with provided lecture materials, hands-on technology, equipment, participate in class's activity and peer-teaching among themselves. In electrical engineering subjects, students are challenged with complex engineering problems. Most of the time, students work in teams to understand the concept and propose solutions to solve the problems. Engaging students with hands-on technology, for example, engineering software, will support Malaysia Industrial Revolution (IR) 4.0 outline in education. Malaysia IR 4.0 is an opportunity to pro-actively design the blueprint for converging the digital and physical worlds to overcome social challenges, improve productivity and create new markets [3].

In science and engineering, students were given a problem where they must analyze the problem, identify the methodology to solve the problem and generate ideas for possible solutions [4]. Therefore, various active learning strategies in the classroom are suitable to be applied in engineering courses. Students learn more when they participate in in-class activities. They apply, practice and do hands-on to what they have learned in class [5].

APPLICATION DESIGN

In designing synchronous online class with various active learning strategies applied in the classroom, it needs to be driven by pedagogical practice. Learning is a collaborative process, and knowledge develops from individual interactions to a group of discussions. Hence, engagement of students during the synchronous online class is very important, which results in peer-teaching among them. In the previous academic session 2018/2019-1 and 2019/2020-1, conventional teaching and learning were implemented, usual lecture by the lecturer without any active learning activity was done. Figure 1 shows the CLOs that needs to be improved with the proposed implementations in the academic session of 2020/2021-1. There are three complex engineering CLOs involved in this study which is the main objective. Figure 2 shows the active learning activities that have been implemented in the 2 hours class lesson. The general concept is based on the Bookend Model, where the flow is as follows; course content, recaps, and active-learning activities are sandwiched between pre-class and post-class summary bookends.

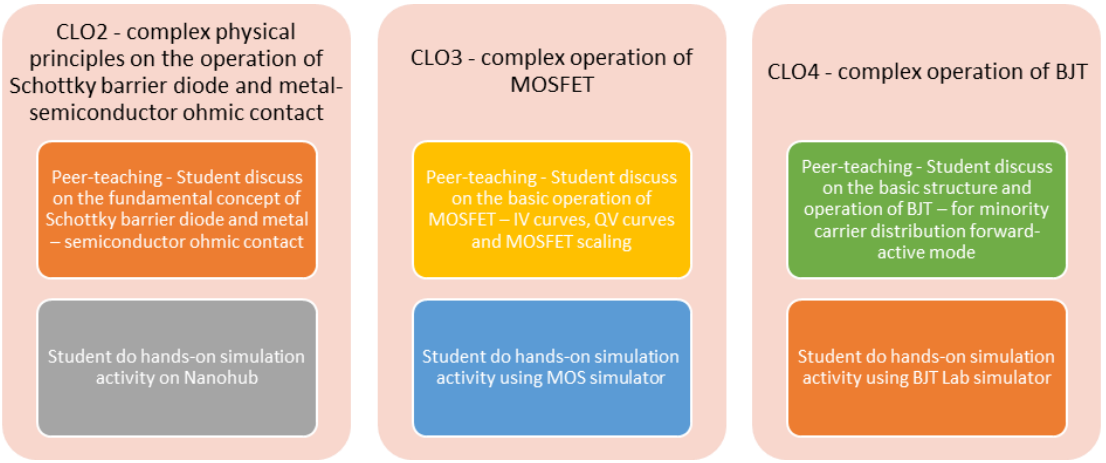

Figure 1. Course learning outcome with its proposed active learning strategies.

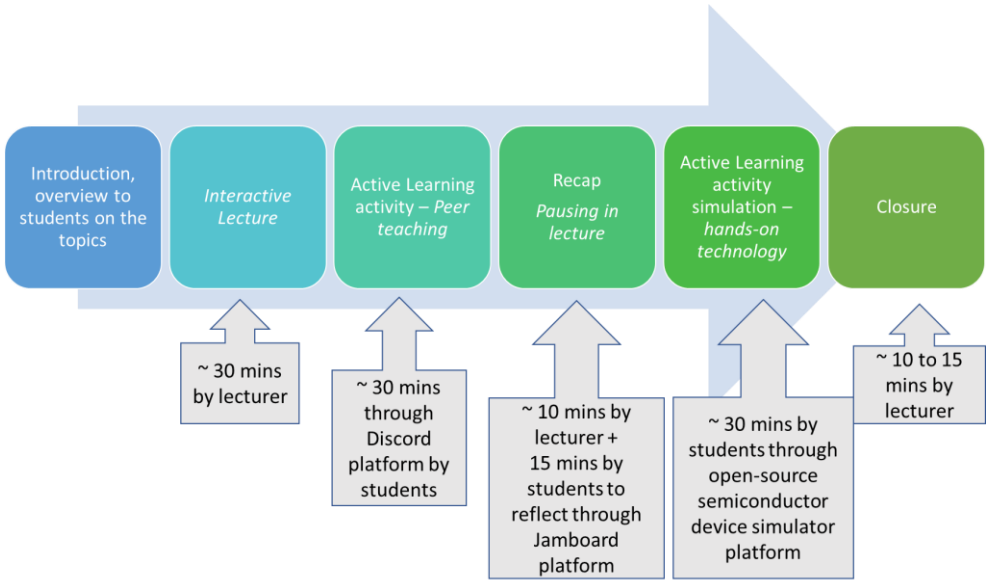

Figure 2. Active learning implementation in 2 hours class lesson.

FINDINGS & DISCUSSION

The data collection of this study is based on students who have given their feedback on the overall implementation of synchronous class via hands-on technology used in the classroom. The flow of the data collection is from the students' feedback, peer assessment, lecturer's observation and finally, CLO achievements. They rated their experiences into several categories, which are; (1) Satisfied: This includes the feeling of excitement of the session, overall understanding, session organization and flow, and finally, the smoothness of the whole session, (2) Neutral: No comment by the students and (3) Unsatisfied.

Figures 3 and 4 summarized the feedback and comments given by the students towards the overall implementation of synchronous class with the use of hands-on technology and students' feedback on the understanding of the topic discussion. All students have been assigned a task that must be completed in a group. Every group must discuss the topic given through the Discord platform and summarize it in Jamboard so that everyone, including the lecturer, can look at it and can monitor their progress. From the lecturer's observation, all groups have done an excellent job in delivering their understanding, and it shows that they have clearly understood what has been taught, with 95% majority of them agreed as shown in Figure 3. Not only that, but they also did hands-on technology by doing the simulation of what they have learned to further enhance their understanding. The majority of students, about 90% as depicted in Figure 4, think that the adoption of hands-on technology (simulator) in the classroom is really helpful and interesting where they felt enjoyable and helpful in understanding some fundamental topics which previously needs their imagination, but now they get to see the real situation by doing the simulation.

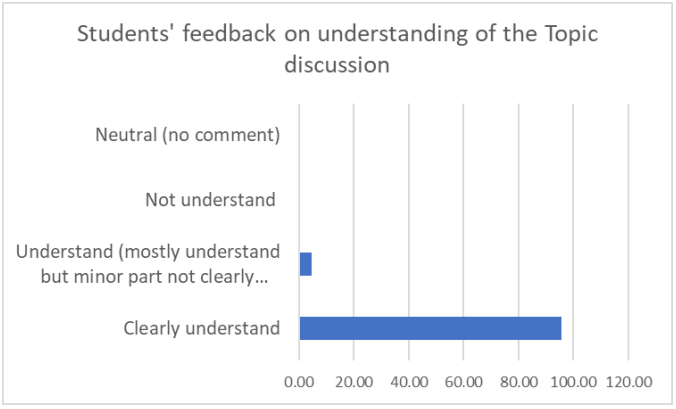

Figure 3. Students' feedback on the understanding of the topic discussion.

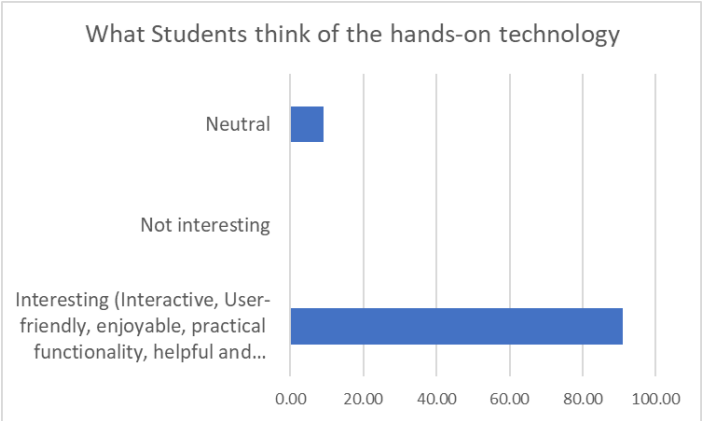

Figure 4. Students' feedback on their perception of the hands-on technology.

Figure 5 indicates the average score for all 3 CLOs achievement between 20182019-1, 20192020-1 and 20202021-1 students. All tasks involved in this proposed implementation in the academic session of 20202021-1 have been designed to be done in groups that are aimed to develop the students' ability to peer-teaching. Three times of active learning activities were conducted throughout the 2 hours class session for every 3 CLO topics. For 20182019-1 and 20192020-1 students, the standard practice, which consisted of the normal lecture, has been done in the classroom. Instead, for 20202021-1, multiple active learning activities had been adopted, consisting of group discussion through the Discord platform, summarizing understanding through Jamboard and one hands-on activity, which is simulation. The implementation of multiple active learning activities in grouping seems to be very good in promoting peer-teaching among them. They will have a better opportunity in learning space such as learning from peers, observation from the virtual experiment conducted through a hands-on simulation. It is proven by the CLOs scores shown in Figure 5. All targeted CLOs show great improvement as compared to the previous academic sessions.

Term	CLO1	CLO2	CLO3	CLO4	CLO5
20202021-1	0.85	0.90	0.82	0.76	0.90
20192020-1	0.70	0.59	0.63	0.37	0.87
20182019-1	-	0.53	0.52	0.50	-

Figure 5. Comparison of the average score for all 3 CLOs achievement from 20182019-1 to 20202021-1 students.

CONCLUSION

The implementation of multiple active learning strategies in the Bookend model classroom significantly improved the KPI of the three complex engineering CLOs and successfully promoted peer-teaching among students through effective discussion. Furthermore, adopting hands-on technology or simulation tasks during students' discussions also enhanced student's understanding of certain topics, especially on fundamental topics related to complex engineering. From the majority feedback on the students' experience throughout the designated class, it was evident that the proposed implementation promotes effective communication and peer-teaching. It also makes the learning environment more interesting.

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STUDENT PERCEPTION OF INTEGRATED PROJECT FOR MULTIPLE-COURSE ASSESSMENT

Eileen Su Lee Ming*, Mitra Mohd. Addi, Yeong Che Fai and Zaharah Johari
School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia.
(*eileensu@utm.my, mitra@utm.my, cfyeong@utm.my, zaharahj@utm.my)

ABSTRACT

The paper presents the student perception on the implementation of an integrated design project for two medical electronic courses taken by the undergraduate students from Universiti Teknologi Malaysia. This single design project would be assessed by the two courses, which were the Medical Instrumentation course and the Physiology & Medicine course, using separate assessment rubrics. As such, the project was designed to incorporate requirements of both courses: students must work on medical-related device or software and then, relate its application to the human physiological system. Overall, most students responded positively to the integrated project and enjoyed working as a team. They also found the integrated project to be time-saving and challenged them to combine different knowledge fields. Nevertheless, the students highlighted some difficulties in delivering hardware-based projects while undergoing online classes.

Key words: Integrated Design Project, Medical Instrumentation, Physiology and Medicine

INTRODUCTION

Curriculum integration is one of the methods in teaching and learning that purposefully links together knowledge, perspectives, and skills from various disciplines to build a more prevailing understanding of a topic [1]. The advocates of curriculum integration claimed that the best way to teach and learn should be comprehensive and non-fragmented. Unfortunately, the current structure of study programs in many institutions of higher learning, the traditional teaching approaches and the trend towards individualism have resulted in fragmented delivery of knowledge with repetition of themes in courses, double effort required from students to fulfill course assignments and lack of opportunities for students to integrate diverse subject knowledge to solve a given problem. Establishing links between knowledge from different disciplines or subjects can potentially provide students a wider range of experiences, create a less fragmented learning approach, and create better connections to the real world.

Additionally, more modern approaches to teaching and learning advocate that students interact and participate earnestly in a class with the aim to understand and retain a topic better. Hands-on projects, group work, brainstorming and presentations are planned through jigsaw method, think-pair-share, gallery walk, discussion forums and design projects to increase the active interaction and participation from the students [2]-[4]. To encourage student's engagement in these activities, some classes will apportion marks for them. Students will need to participate and do well in these activities, in addition to excel in their written examination, to achieve a good grade for the course.

While the objective of engaging a student through learning activities is commendable, when students are inundated with too many activities from multiple courses within the same semester, there might be a risk of being fatigued-out by the deadlines, out-of-class discussions and project demands.
In this paper, we introduce an integrated project that involved two different courses, the Physiology & Medicine course and the Medical Instrumentation course at the School of Electrical Engineering, Universiti Teknologi Malaysia. Students only needed to complete one project encompassing the requirements of both courses. The aim was to get the students to link up the information from two different courses, make the students consider a wider perspective when delivering a project and reduce the amount of overall assignments required of a student within the semester.

APPLICATION DESIGN

An excerpt of the project scope is presented in Figure 1. The students were required to propose an improvement to a current medical-related system, enhancing either a product or a service in the healthcare domain. They would have to link the working principle of their system to the human physiology. The proposal should meet the needs of society in line with the United Nations Sustainable Development Goals. With that, we also hope to promote global citizenship, where students use their knowledge to contribute back to society.

> ...This year, the organizing committee has decided to allow the teams to choose their own field of interest to encourage variety of ideas for innovations that support the UN Sustainable Development Goals, specifically on Goal 3: Good Health & Well Being, Goal 9: Industry, Innovation & Infrastructure and Goal 11: Sustainable Cities & Communities.
>
> Each member will be assigned to a team and you are required to propose a bioelectronics or biomedical instrument or system that is designed to help meet the needs of society in the chosen field of interest. The design is not limited to only new ideas but also include innovations and improvements of existing technology or systems.
>
> All teams are required to identify the essential issues related to the field of interest, study the relevant, available and required technologies, propose a functional design concept of the solution, and analyze the market potential for the proposed solution. All teams are also required to develop a prototype of the proposed design...

Figure 1. An excerpt of the project scope presented to the students.

Table 1 shows the timeline of project deliverables. The project timeline was scheduled such that there would be certain deliverables weekly to ensure that the students did not procrastinate, leaving the bulk of work till the end of the semester. Progressive assessment and feedback were provided along with the deliverables.

Table 1. Timeline of project deliverables

TASKS / DELIVERABLES	WEEK												
	3	4	5	6	7	8	9	10	11	12	13	14	15
Project Briefing							BREAK						
Team Formation													
Proposal Draft													
Proposal submission & presentation													
Individual progress report													
Final Presentation & Demonstration													
Final Report Submission													
Minutes of Meeting													
Peer Assessment & Self Reflection													

This year, the courses had students from both 3rd and 4th year, and the project implementation had to be carried out fully online. For group assignment, the students did not get to choose their own team members. The group members were assigned with diversity in mind, with four members per group that included a mix of 3rd and 4th year students, high and low scorers, different gender, race or nationality. The rationale for diversity in a team was to help the students look at things from different perspective, widen their knowledge, increase their creativity and narrow achievement gaps [5].

Towards the end of the project, prior to their presentation, students were asked to provide some feedback to gauge their perception of the integrated project concept, and their opinions regarding the project implementation. Their feedback was anonymous and voluntary. A total of 25 respondents out of 32 students in the class submitted their feedbacks to the questions. Questions asked were as follow:

Question 1: What is your feedback about the concept of integrated project?
Question 2: What do you like best about the project?
Question 3: What do you think can be improved about the integrated project?
Question 4: Do you prefer to work on a project on your own or as a group? Why so?

RESULTS & DISCUSSION

For Question 1 on the concept of integrated project, majority provide positive feedback while listing challenges they faced. A total of 64% respondents recorded that integrated project was good, citing time saving, combination of knowledge and good learning process as supporting reasons. An additional 28% respondents also gave positive feedback for the integration but found it a bit challenging due to online classes and more considerations required to meet project requirements. Only one student responded that the integrated project was a bit difficult.

For Question 2 regarding their favorite part of the project, 44% of students replied that it was the team: the team members, the sharing of knowledge, communication, and unity among the members. Due to the online classes, students lacked the opportunity to mingle and discuss with their classmates; this group project gave them an opportunity to interact more. A total of 24% indicated that the learning of new knowledge was the best part while 16% respondents liked that they could apply their knowledge in the medical field and make something useful. The other 16% of students liked the implementation of the project the most, where they were free to work on any title and could dive deep into a specific case.

When asking respondents to suggest improvements for the project in Question 3, the answers varied. There are 20% who replied that everything was good, while 20% others wanted only software

projects due to the online learning condition. Sixteen percent indicated that completing the project during face-to-face learning might be more ideal. Another 16% respondents commented on the timeline – some wanted fixed while others asked for flexibility and more reminders. Twenty percent wanted changes on project requirements, asking for simpler and clearer specifications, more guidelines and improved peer review system. Only one student asked to choose own team members and another one student commented that the project was difficult.

When asked in Question 4, if the students prefer to work in a group or individually, a majority of 72% respondents preferred to work as a group while only 20% wanted to work individually due to lack of commitment from team members. Two of the respondents (8%) indicated no preference as both options were advantageous in their opinion.

In our implementation, we focused on diverse group members to improve creativity and to train communication [5]. However, a team that is too diverse could lead to communication issues when skill gap among the members is too wide. With the current group, we put a high scorer with two average scorers and one low scorer in the same group to flatten out the differences. Generally, most students were happy with their group and only a minority highlighted lack of commitment from their team. Knowledge or skill gap did not seem to be an issue, with cooperative members able to help each other out.

Springer et al. [6] studied the effect of incorporating small, medium and large amounts of group work and found that the highest benefit was associated with medium time in groups. Other researchers noted a small negative effect associated with both self-paced and self-directed learning when seven out of ten cases of students in problem-based learning (PBL) programs scored lower than students in traditional programs on tests of basic science [7]-[9]. In contrast, recent studies suggested that PBL may help in developing positive student attitudes, foster a deeper approach to learning and help students retain knowledge longer than traditional instruction [10]. Therefore, implementation of group project as class assignment has to be well-thought out so that it would not be too burdensome to the students, at the same time, should be challenging enough for learning to take place. Students should be given time to study independently and as a group.

For this year, the implementation of integrated project was conducted fully online and this learning condition has to be taken into account because during online classes, students would have challenges completing the project with the lack of physical interaction and lack of communication among team members. As indicated in the student responses, it was difficult to discuss and get some of the team members to contribute their fair share. The teams that worked with hardware saw the bulk of responsibility fell heavily on specific team members who are in possession of the hardware components. Additionally, the weekly progress reports and reflections could be simplified and designed to help students towards completing their work, rather than adding on to their chores.

While it is worthwhile to consider allowing students to work on integrated projects that can be graded across several courses, the implementation has to be carefully thought out to suit the learning condition the students were in. Future implementation can consider fully software-based projects during online learning while keeping the hardware-based projects for face-to-face learning. An optimal amount of activities has to be planned for a class, not too little that it lacks engagement and yet not too much, that it causes student to shun learning.

CONCLUSION

An integrated project was introduced to the students for the Physiology & Medicine and Medical Instrumentation courses, where students work in a group to complete a single project that will be assessed by both courses. The objective of this implementation is to save time for the students on

projects, at the same time, train the students in making decisions about complex problems that involve several areas of knowledge. Students undertaking this integrated project were asked to provide their perspective regarding the implementation and most students gave positive feedback despite the challenges faced during online learning. Many students cited teamwork as their favorite portion of the implementation and indicated approval for the concept of integrated project because it was time-saving and required different knowledge fields. Implementation of the project integration has to be carefully designed by considering the students' knowledge level and could be steered towards software related work if the group project has to be completed online.

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INSPIRING STUDENTS INTEREST AND MOTIVATION THROUGH IN-CLASS FORUM WITH INDUSTRIAL SPEAKER

Mastura Shafinaz Zainal Abidin[*] and Zaharah Johari
School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia.
([*]m-shafinaz@utm.my)

ABSTRACT

Due to the worldwide Covid pandemic outbreak that began in 2019, there are a lot of changes occurred in all businesses including the education sector. Schools and higher learning institutions are closed and being replaced with online platforms to perform classes. Educators are forced to raise up new ideas and strategies of teaching to ensure that the students obtain the knowledge they deserve and always keep motivated. However, this might be much tougher especially for new intake students as they never meet their lecturer and friends physically. They also never be in campus and the higher institution learning environment itself would be a very new thing for them. In this study, the aim is to observe the students' response towards in-class forum activity by inviting a speaker from industry. This study involves 40 first year undergraduate students from Universiti Teknologi Malaysia (UTM) who took Electronic Devices and Circuits course. Students feedback on this activity was collected using Google Form. Besides, the students' response during question-and-answer session in forum also been observed. The data shows that the majority were satisfied with this forum activity. Hence, we believe that in-class forum with industrial speaker is considered as an efficient way of inspiring students' interest and motivation towards this course.

Key words: forum, motivation, interest, industry

INTRODUCTION

The way global education is delivered had dramatically reformed due to Covid-19. Millions of learners were affected by educational institution closures due to the pandemic, which resulted in the largest online movement in the history of education. It forced the instructors and the learners to adopt with new paradigm of classroom. A meaningful learning experience should be created with the use of many online platform and various apps and tools. However, the most important criteria is how the instructors get preparing themselves with this new classroom norms [1]. Moreover, understanding of the newer generations can help instructors better meet current students' educational needs [2].

Electronic Devices and Circuits is a core course, taken by all students in School of Electrical Engineering. This course provides introduction to the basic operating principles and applications of discrete electronic devices and circuits. The course content starts with the fundamental solid-state principles and continues the discussions with the constructions, characteristics, and applications of electronic devices such as diode, Bipolar Junction Transistor (BJT), Enhancement Metal Oxide Semiconductor Field Effect Transistor (E-MOSFET and operational amplifier (op-amp).

It is quite challenging to identify the students' interest into this course as the came from various backgrounds, besides never have chance to learn physically in campus due to pandemic. Moreover, it is important to develop a clear picture in students' mind about the real world of electric-electronics engineering. The different high school background may influence the way they think, character and preparations [3]. Consequently, some of them might lack in interest and performance while

undergoing their study life. Besides design the learning activities to be aligned with intended outcome [4]-[6], it is also important to create a learning experience that able to enhance the students' interests in related field.

In this study, an in-class forum has been implemented by inviting a speaker from industry. The purpose of having this session mainly to boost the students' interest and motivation towards this course, also to open-up the students' understanding about the electrical and electronic engineer job, besides encourage more interactions amongst the participants.

LITERATURE REVIEW

As we know, there are number of ways to deliver knowledge to the students for electrical and electronics engineering course. For example, [7] reported that a blended learning approach that have been applied to electrical engineering courses shows a positive impact to the student. Besides that, [8] shows the used of e–learning platform for blended leaning in power electronics course can benefit student in terms of knowledge retention and achievement. Most of the students see electrical and electronics engineering course as a technical course, which does not provide an in-depth understanding of the discipline of electrical engineering. Thus, idea of design integration of the examples coming from various fields of practice in the industry quite useful to increase students' interest in the course [9].

In 2015, the World Economic Forum (WEF) developed a twenty-first Century Skills framework that identified foundational literacies, competencies, and character qualities required for a successful career as we transition into the 4^{th} industrial revolution [10]. Literature also has emerged analyzing how different pedagogical practices like service-learning, work-integrated learning, and project-based learning support the development of these WEF twenty-first Century Skills [11]-[13]. Furthermore, there are several factors that affecting high education engineering students [14]-[16].

Due to limitation of physical activities in this new norm online class, a forum has been implemented by inviting a speaker from industry. In wondering how this activity affect the student interest and self-concept about this Electronic Devices and Circuits course, observation on student's interaction during question-and-answer session and analysis on their feedback after the class has been done.

APPLICATION DESIGN

The Electronic Devices and Circuits course is taken by students during their second semester of year 1. Due to current situation of pandemic, this group of students basically never came into campus physically. Thus, the never met each other and the lecturers too. Some of students seem not sure about their field of study. Probably, this caused by lack of interest, motivation, no guidance, or other reasons.

A guest speaker from industry was invited for 60 minutes forum session via GoogleMeet platform. This activity gave a chance for students to get some insights from an engineer related to semiconductor field and preparation before graduating. The first 30 minutes were allocated for the speaker to present the content using Microsoft Power Point. Then, it is followed with 30 minutes question-and-answer session. After the activity completed, students sent their feedback on this activity through Google Form anonymously.

The student's response, interaction during the forum and question-and-answer session has been done. Their feedback was analyzed to see their satisfaction about the forum implementation.

FINDINGS & DISCUSSION

Figure 1 displays the students' satisfaction on this forum activity. The activity involved 40 students, however only 35 students filled up the Google Form. In general, majority had agreed well with this forum implementation.

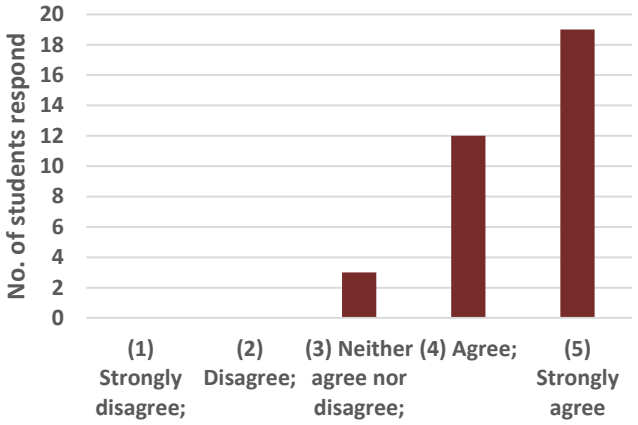

Figure 1. Students' opinion on in-class forum implementation.

Table 1 shows sample of reflection excerpts from students. Based on that, elements of enjoyment, interest and learning motivations had been expressed by students. There were lots of questions received during question-and-answer session. Interestingly, there were also technical questions been asked besides the speaker's experience and needed attribute for employment interview. Samples of questions asked by students were listed in Table 2.

Table 1: Sample of reflection excerpts

interesting and quite useful
Guest inviting activity is really good.
Those activities can make myself learn more about this course
Interesting and greatly informative
The activities are quite new for me especially the Intel speaker, i learnt new things. I am satisfied.
i love the guest speaker activity, make me wanna do more
These activities has giving extra knowledge to us
The Guest Speaker from INTEL is quite good and interesting, we can get to know how is the interview and how the work at the INTEL for us to prepare ourselves before graduate. Thanks for invite the guest speaker from INTEL, hope to have more guest speaker from the company in future.
Very informative and helps a lot in my studies.
Quite good especially the talk from Intel. I have learned more extra knowledges throughout the talk.
Love the activity which guest speaker from INTEL. Love what the speaker share her experiences in INTEL.

In general, the students had chance the get some viewpoints from industrial engineer besides their own lecturer only. This will benefit them to have a bigger picture in understanding the engineer's role, relationship between electronics and semiconductor field, and preparation needed before they graduate soon. From the instructor's point of view, their interest and self-concept on this course and field also would be enhanced, as evidenced by their feedback and questions raised during forum.

Table 2: Sample of questions asked by students to the guest speaker.

Experience	Graduate attributes	Technical
• How was your engineering journey before coming into a big company like intel? Is is directly employed into intel or any related experience needed before applying? • Good evening Miss, how is your working experience in Intel. How Intel make employees work-life balance? • what is the biggest challenger you met in this job? • Good evening miss, during your working experience in Intel, does the company provides chances to visit the headquarter at Silicon Valley or talks given by the CEO something like that? • hello miss, may i ask do u feel pressure (tekanan) in working such a big company (Intel)? • How is the competition as a woman engineer? How do you persuade people into believing in your ability? Since we all know men usually dominate the engineering field.. • if one is quite professional in this filed and having a good horizon of knowledge but have a little bit sosial phobia, is he/she will be accepeted as an engineer? • hello miss, are you really satisfied with your life as engineer now? Does Intel satisfy your desires, fantasies about work?	• Hello miss, when we are applying the sponsorship from intel, do we only can take the specific elective as their ask? for example, we are required to take software engineering as our 4th year study electives by intel or we can take on our interest? • Good afternoon, may I ask on how does the process of the interview session in intel looks like? Can you share any more tips on how to pass the intel interview session? • Salam sejahtera, Miss. Is the big company like Intel, Huawei hire an engineer/worker will more focus on their academic achievement or personal soft skills? • May I know about what job usually will be given to fresh graduated student once he/she passed the interview successfully? • During interview, will they ask to operate practically? • Hello miss, may i know the basic sallary of intel of fresh graduate? • If someone has deeper working experiences in this field, but the academic result is below moderate, is there a bigger chance to be employed? • How much of the minimum cgpa needed to interview intel?	• Good afternoon Miss, there is news about Intel processor is releasing new 10nm technology to achieve a higher processor speed, I heard Intel had struggled at it from few years ago. What is the biggest challenge in the process of achieving this achievement? • Good afternoon miss, how does IC chip(like i7, i9) related to the programming to ensure the system performance to be perform well? • Hello miss may i ask why intel still using the 10nm processed cpu in 2021? Is it enough to compete with AMD 7nm cpu? • Hello, can I know why the intel chips always expensive than amd chips since their performance is quite similar. Is that any secret recipe in it? • How often do Intel release new products (new generations of CPUs) ? Does Intel release them every year? • Hello miss, may I ask which programming language(s) are being used the most in industries nowadays? As far as i know it may differ for different industries like for intel, gaming industry and more. • What is the differences between intel chip compared to the others chip (like AMD)

CONCLUSION

In conclusion, this study provides some insight on the implementation of in-class forum towards students' interest and motivation. Periodical activity such this forum might be useful to inspire students' interest towards this course and engineering field.

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INCORPORATING HISTORY OF ELECTRICITY AND MAGNETISM INTO ACTIVITIES FOR NON-ENGINEERING STUDENTS

Mohd Zaki Daud[*] and Shahrin Md Ayob
School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia.
([*]mdzaki@utm.my, e-shahrin@utm.my)

ABSTRACT

The extensive technical difficulties dealing with mathematical contents of electrical technology course may allow nonelectrical engineering students loose interest in the course. If history of electricity and magnetism is incorporated into activities for group assignment, this may motivate them and give them an opportunity to explore the course from non-technical perspective, which is the objective of this paper. Three video episodes of documentaries were assigned for three groups of students to watch and produce either a mind map, devise a simple demonstration kit or write a reflection note. The activities will explore and apply all three learning domains, namely – cognitive, psychomotor and affective. The results of the group activities showed that students were creative in summarizing the contents of the documentaries in many ways encompassing all three learning domains. These findings will help the same application design to be targeted for engineering students and pre-university students as well.

Key words: cognitive, psychomotor, affective, history of electricity and magnetism, Bloom's taxonomy

INTRODUCTION

Curricula in Bachelor of Technology with Education (Electric & Electronic) include credits philosophy of education, psychology of education, fundamental of pedagogy, teaching methods, microteaching, measurement and evaluation in education, research methods in education, electrical and electronic courses. Graduates of the programme are expected to work as : a) teachers in government or private schools, and matriculation centres. b) teaching assistants, tutors or research assistants in higher learning institutions. Such expansive nature of the curricula contents, not to mention deep mathematical contents may not appeal to a student's personal interest and increasing their motivation to learn. In addition, many of those graduated end up working in engineering sector with job title of assistant engineer or technician. Moreover, connection between engineering and other subjects is not always clear and sometimes no attempt is made to connect them. The connection between history of electricity and magnetism and engineering has not been readily taught and in some cases not even explored. A paper on integrating history into engineering curriculum has been published based on civil engineering. [1]

In this a paper, a history of electricity and magnetism is incorporated into activities for group assignment for electrical technology course, hoping that this may motivate the students and give them an opportunity to explore the course from non-technical perspective and looking the course into three learning domains – cognitive, psychomotor, and affective. It has been shown that the interdisciplinary approach of integrating elements of history into technical engineering courses has potential to result in improved student learning and engagement. [2]

APPLICATION DESIGN

The course Electrical Technology (code - SKEU 3053) was taught to sixteen part-time undergraduate students based on the programme structure in School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia. Students were based in Kuala Lumpur course centre. The course was conducted online due to movement control order during Semester II, Session 2020/2021. Based on course information, a 10% marks was allocated for group assignment.

History of electricity and magnetism has been incorporated in the activities in terms of documentaries - Shock and Awe: The Story of Electricity. This was a British television series outlining aspects of the history of electricity. The series was a co-production between the Open University and the BBC. The programs were presented by Jim Al-Khalili, a professor of theoretical physics and chair in the public engagement in science at the University of Surrey. He is a regular broadcaster and presenter of science programmes on BBC radio and television, and a frequent commentator about science in other British media.

There were three episodes in total, with English subtitles, each lasting about 60 minutes. The first episode entitled "Spark" detailing how pioneers unlocked electricity's mysteries and built strange instruments to create it. The second episode entitled "The Age of Invention" shown how harnessing the link between magnetism and electricity transformed the world. The final episode – "Revelations and Revolutions" described how after centuries of experimentation, we finally came to understand electromagnetism.

Each group is required to produce either a mind map, devise a simple demonstration kit or write a reflection note.

FINDINGS AND DISCUSSION

Figure 1 showed a mind map produced by a student, developed in Jamboard – an online collaborative digital whiteboard, based on a 12 minute part from first episode. As such, there were 6 mind maps developed by students for the whole first episode. As students command of English is quite weak, the subtitles helped the students understand the documentaries better and each student was assigned to watch only a portion of the video.

Figure 2 showed a demonstration kit produced by one group of students inspired by Faraday's law of electromagnetic induction in one of the episodes. This kind of activities gave students opportunities to apply the law by applying psychomotor learning domain.

Figure 3 showed a reflection note in Malay language expressing students opinion on introducing this kind of activities to school children. They wrote in the notes that students in secondary schools may find it hard to understand the contents of the video due to many factors, such as too many names of scientists to remember and some difficult concepts of electricity and magnetism involved.

In general, the activities was a success in terms of its output – either in terms of technical or non-technical aspect. Students were given the opportunity to utilized collaborative tools, and also develop affective learning domain which was not emphasized before.

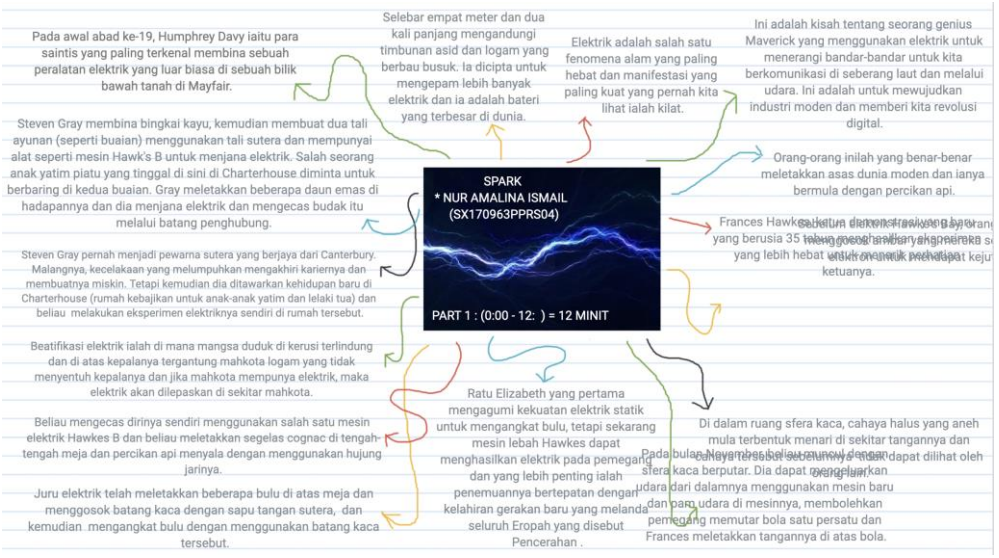

Figure 1. Mind map produced by student, using Jamboard, an online digital collaborative whiteboard.

Figure 2. Demo kit to illustrate the application of electromagnetism

KESESUAIAN VIDEO KEPADA PELAJAR

Video amat sesuai untuk pelajar bagi memahami dengan mendalam akan ilmu elektrik. Video sesuai untuk pelajar yang berumur 18 tahun ke atas. Bagi pelajar yang berumur bawah 15 tahun atau yang berada di sekolah menengah atas, video agak berat kerana:

1. Video terlalu banyak penerangan yang berkaitan satu sejarah perjalanan saintis elektrik
2. Bagaimana elektrik dan magnet itu berkaitan. Sekiranya di sekolah menengah, ujian amali telah menerangkan cara magnet bekerja. Ilmu asas semasa amali ini , akan membantu pelajar di Universiti, Politeknik, IKBN atau seumpanya untuk mengetahui lebih mendalam bagaimana, wujudnya magnet dan elektrik atau lebih tepat penerangan di dalam video ini.
3. Video memerlukan penerangan daripada tenaga pengajar, kerana mempunyai penerangan mengenai hukum yang digunakan seperti faraday, tesla dan sebagainya.
4. Selain daripada pengiraan Maxwell juga amat berat untuk difahami bagi pelajar menengah rendah.
5. Di sekolah menengah, pelajar telah didedahkan dengan nama-nama berikut, namun diperingkat lebih tinggi, video ini sesuai ditayangkan kerana menambahkan ilmu dan berkenalan dengan ilmuan tersebut.

Figure 3. Reflection notes

CONCLUSION

In conclusion, all three learning domains – cognitive, psychomotor and affective have been explored and applied in the students' activities from incorporating history of electricity and magnetism into students' activities. Students have utilized different collaboration platforms to produce mind map, design a working demonstration kit to illustrate the application of electromagnetism and being able to include affective aspect in the reflection notes after watching the documentaries. These findings will help further investigation how such a similar application design can be adopted for engineering students and pre-university students as well.

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IMPLEMENTATION OF CASE STUDY ACTIVITY FOR FORCE VECTOR APPLICATION IN ENGINEERING MECHANICS SUBJECT

Mohamad Amir Shamsudin*, Fazilah Hassan , Zaharuddin Mohamed, Jibrin Muazu Musa and Mohd Saiful Azimi Mahmud
School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia.
(*amirshamsudin@utm.my, fazilah.hassan@utm.my, zahar@utm.my, mmjibrin@utm.my, azimi@utm.my)

ABSTRACT

A case study activity is implemented in SEEM113 subject and aims to embed students with competency in understanding and analyzing the engineering mechanics problems found in a practical application. This activity is also implemented to achieve one of the course learning outcomes. Lies under the collaborative learning approach, the activity encourages students to actively involve in the learning process. Student's reports and presentations were analyzed to determine the attainment of the intended course learning outcome. A rubric was also used to ease the instructor to evaluate the performance of the students. The implemented learning activity could be further enhanced to improve students' knowledge and skill in analyzing given problems.

Key words: case study, collaborative learning, practical application.

INTRODUCTION

The SEEM1113 Engineering Mechanics course is a field core subject taken by the first-year mechatronics students at the School of Electrical Engineering (SKE), Faculty of Engineering, Universiti Teknologi Malaysia. In the last two semesters, this subject was taken by 147 students in session 201920202 and 109 students in session 202020212. This subject covers the static and dynamics of a particle in six different topics. This course introduces students to the basic principles of engineering mechanics with emphasis on the analysis and application to practical static and dynamic engineering problems. The static is covered in three topics. The fundamental knowledge in vectors and the concept of force, mass, and weight are covered in Topic 1. The force system and equilibrium of particles are covered consecutively in Topic 2. And Finally, Force resultant system is covered in Topic 3. Meanwhile, the dynamic part is covered in three remaining topics. The Kinematics and kinetics of particles with their governing physical laws are also introduced and analyzed such that the students will gain the ability to apply these basic principles to solve mechanic problems.

CASE STUDY

This course has implemented a collaborative learning strategy known as a case study activity on a specific topic. Collaborative learning generally refers to 2. small group learning where the group members actively support the learning processes of one another. Learning within groups that have been formed for the specific purpose of achieving set educational goals (1). Research indicates that collaborative learning is one such student-centered method, which changes the attitude of the

students and ensures their active participation. In this strategy, students with different learning levels are put together in a small group of 4-5 members to achieve the defined outcome (2).

In the case study activity, students are given predefined data, specifications, or applications. The students will search for a range of possible applications and requires them to gather additional information to understand the valid application. The main advantage of learning with case studies is that the learners are actively engaged in the learning process and develop their skills in problem-solving, analytical tools, quantitative and/or qualitative, depending on the case (3).

OUTCOME-BASED EDUCATION

In line with this requirement, the subject offered would be outcome-based education (OBE). Under this framework, three course learning outcomes (CLO) have to be spelled out. The CLOs are a) CLO1: Apply the physical laws and principles related to static and dynamic of particles, b) CLO2: Investigate and solve critically problems related to statics of particles, and c) CLO3: Investigate and solve critically problems related to dynamic of particles. Among the important criteria of an OBE is to be able to measure how well the outcomes are achieved. Thus some Learning and teaching practices have been implemented including lectures, class activity, formative assessments such as exercises and quizzes, and summative assessments such as assignments, tests and final exam.

Based on OBE, the activity was initiated to fulfill the 2nd CLO which investigates and solves critically problems related to the static of particles. By running the activity, students implement the concept of force vector learn in class and solve the force vector problem for new and particle applications.

APPLICATION DESIGN

This course has employed a collaborative learning strategy known as case study activity (4) in learning the force vector. The force vector is a vital topic in static engineering problems. It is a basis for half of the learned material in engineering mechanics. moreover, by applying the rule and concept of force vector applications in a practical situation, students work together in a group to achieve the defined outcome namely CLO2.

This activity focuses on force vector application and consists of three parts that run in the first three weeks of the semester. The activity was conducted to achieve the CLO2. In the activity, students were divided into several groups and the groups need to present their results to the class. In part 1, each group needs to list five practical applications of the force vector and label all forces and weight. Then they are required to submit a short group report which lists the found five applications of force vectors. In part 2, each group needs to select one of the force vector applications with at least or more than 3 acting forces involve in the system and find the resultant force. Then they are required to submit a short group report which shows the selected force vectors application. While completing the first two tasks, students can discuss with their group members and get feedback or information from the instructor. Lastly, in part 3, students present their work and result for the task in week 2. I this part, students are required to prepare a poster and 4-6 minutes' presentation video. After all students view the poster and watch the video, then they have an opportunity to comment/discuss their peer's work (from the other two groups). Table 1 highlights the activity run in three weeks.

Table 1. Highlight of case study activity for the force vector applications

Week	Objective	Activity
1	List five practical applications of the force vector and label all forces and weight	-find five practical force vector applications around them -take a photo for each application and label all forces and weights. -Prepare and submit a report for the activity in week 1 in google classroom
2	Select one of the applications with more than 3 acting forces involved in the system and find the resultant force	- choose one application from week 1 that has at least three forces acting on the system. -draw the force vector diagram in a 2 or 3-dimensional plan. - state the directional angle and magnitude of the involved forces. -find the resultant force and its direction. -Prepare and submit a report for the activity in week 12in google classroom
3	Share and discuss their finding on a force vector application to the class	-Using the given template, prepare a presentation poster that includes and explains the selected force vector application. -Share the poster in Jamboard - prepare a 4-6 minutes' presentation video which presents their works and finding. -post and share their video on YouTube. -Within one week after the presentation session, other assigned groups need to discuss or comment on their friend's work in Forum activity in E-Learning.

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Using a rubric attached in the appendix, the submitted student's reports and presentations were analyzed to determine the learning performance of the students. The rubric was developed to evaluate the works done by students in three different weeks. In the designed rubric, the criteria that directly contribute to the attainment of CLO2 would have a higher weight. The related criteria for part 1 are content and reflection, for part 2 are calculation and drawing, and for part 3 are clarity and content. The others criteria will contribute lesser weight to the activity.

FINDINGS

Some reported force vector applications are shown in Figure 1. In general, students are able to identified force vector applications in practical applications around them.

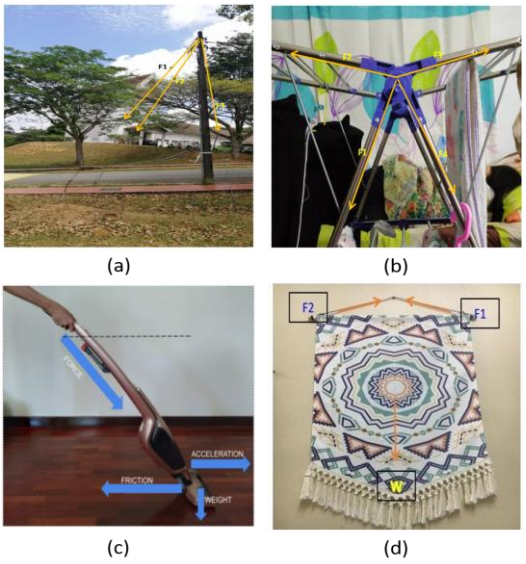

Figure 1. Practical example found for Force vector application. (a) a pole that support by three cables, (b) cloth rack with support, (c) vacuum cleaner and (d) decorative fabric hang with a rope.

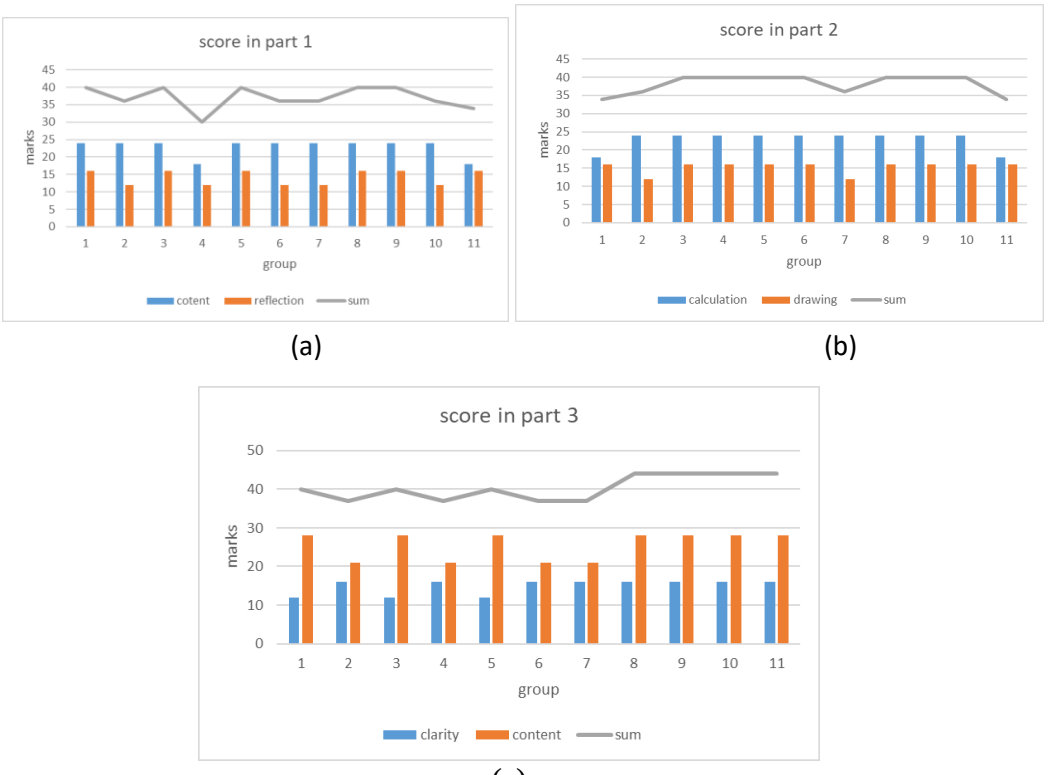

Figure 2. Score marks for reports and presentation

Figure 2(a) shows most of the groups (9 groups) had able to list 5 application of force vector and 6 groups able to label the forces and list all the force vectors application correctly. Figure 2(b) shows most of the groups (9 groups) had able to calculate all forces correctly and draw and label all the forces correctly. Lastly, Figure 2(c) shows most of the groups (8 groups) had able to show clear and well-organized information, and 7 groups were able to show relevant and structured points with clear examples/applications.

Results indicate the implemented learning and teaching activity enable students to apply the learning material in some practical application. The instruction and the rubric given, help students to progress in this case study activity. Using the rubric, the instructor was also able to evaluate the performance of the students.

CONCLUSION

The Case study is an instructional method that can embed students with the skill to observe, analyze, record, implement, conclude, summarize, or recommend. The implemented case study activity is able to embed students with competency in understanding and analyzing the engineering mechanics problems s in a practical application. This activity is also increased the attainment of CLO2 for this course.

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APPENDIX (optional)

Rubric for student's report in week 1

Table 1: Assesment rubric for part 1

Ranking: On a scale from 1 (lowest performance) to 4 (highest performance), assign points to each dimension based on the criteria below.

Evaluate the **group** as a unit with this section of the evaluation tool

		Poor (1 point)	Fair (2)	Good (3 points)	Excellent (4 points)			
No.	**criteria**	**Does Not Meet Expectations**	**partially meet the expectation**	**neerly meet the expectation**	**Exceeds Expectations**	**score**	**weight**	**marks**
1	**submission**	more than a week late	up to a week late	up to 2 days late	on time		2	
2	**Content**	List less than 3 applications of force vector	List 3 applications of force vector	List 4 applications of force vector	List all 5 applications of force vector		6	
3	**refelection**	Label all the figures/photos wrongly	Label only 2 figures/photos correctly.	Label only 3 figures/photos correctly.	Label all the forces and list all the force vectors application correctly		4	
	Total 5%	Part 1						

Rubric for student's report in week 2

Table 2: Assesment rubric for part 2

Ranking: On a scale from 1 (lowest performance) to 4 (highest performance), assign points to each dimension based on the criteria below.

Evaluate the **group** as a unit with this section of the evaluation tool

No.	criteria	Poor (1 point) Does Not Meet Expectations	Fair (2) partially meet the expectation	Good (3 points) neerly meet the expectation	Excellent (4 points) Exceeds Expectations	score	weight	marks
1	submission	more than a week late	up to a week late	up to 2 days late	on time		2	
2	calculation	Use wrong solution to calculate resultant force	Calculate two forces wrongly	Calculate one force wrongly	Calculate all forces correctly		6	
3	drawing	Not submitting any skecth/drawing	Draw and label only one forces correctly	Draw and label 2 forces correctly	Draw and label all the forces correctly		4	
	Total 5%	Part 2						

Rubric for student's presentation in week 3

Table 3: presentatio assessment

Ranking: On a scale from 1 (lowest performance) to 4 (highest performance), assign points to each dimension based on the criteria below.

Evaluate the **group** as a unit with this section of the evaluation tool

No.	criteria	Poor (1 point) Does Not Meet Expectations	Fair (2) partially meet the expectation	Good (3 points) neerly meet the expectation	Excellent (4 points) Exceeds Expectations	score	weight	marks
1	clarity	No apparent logical order of presentation	Content is loosely connected. Transition lack of clarity	Sequence of information is well organized but lack of clarity	Development and transition are clear		4	
2	content	Unclear and information randomly chosen	Supporting information is disconnected	Many relevant point but they are somewhat unstructured	Relevant and structured points with clear examples		7	
3	presentation lenght	Greatly exceeding or falling short the allotted time	Exceeding or falling short the allotted time	Remain close to the allotted time	Presented within the allotted tim		2	
	delivery	Monotone and unisterested	Little eye contact, fast speaking, little expression and mumbling.	Clear articulation of ideas but lack of confidence in materials	Confidence with good eye contact and enthusiasm.		2	
	Total 5%	Part 3						

INCULCATING INNOVATIVE THINKING AMONG SCHOOL TEACHERS THROUGH KNOWLEDGE TRANSFER OF INTERNET-OF-THINGS TECHNOLOGY

Nurul Ashikin Abdul-Kadir*, Rubita Sudirman, Mohd Azhar Abd Razak, Mitra Mohd Addi, Zaharah Johari, Mohd Afzan Othman, Nasrul Humaimi Mahmood, Norhafizah Ramli, Nor Aini Zakaria, Suhana Mohamed Sultan, Fauzan Khairi Che Harun* and Fatin Afiqa Mansor

School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81300 UTM Johor Bahru, Johor, MALAYSIA.

(*ashikin.kadir@utm.my, rubita@utm.my, azhar@utm.my, mitra@utm.my, zaharah@utm.my, afzan@utm.my, nasrulhumaimi@utm.my, e-hafizah@utm.my, norainiz@utm.my, suhana@utm.my, *fauzan@utm.my and fafiqa3@graduate.utm.my)

ABSTRACT

A major component of Industrial Revolution (IR) 4.0 is encouraging academic communities to participate in 3 key focus areas; "Research and Innovation," "Education and Training" and "Infrastructure Modernization". This study aims to transfer knowledge of electronic and Internet-of-thing related technology from higher education to school community, so that they can learn and appreciate the importance of electronics and engineering skills. To accomplish this goal, a group of electronics experts shared their knowledge with 27 schools from Sabah, Sarawak and Peninsular of Malaysia during Minggu Sains Negara 2021 (MSN2021). In thence event, participants were taught on how to assemble and program an automatic temperature detector (iSUHU) and QR-code automatic attendance using mobile application, namely JomHadir. The participated schools were equipped with iSUHU devices. After online session of troubleshooting, programming and setting up of the device, each school needs to teach at least 2 of their students in either programming and installation of iSUHU device. The iSUHU device is specially designed to take the body temperature of each individual and the microcontroller that embedded in the system would transfer the data to JomHadir mobile app which paired via Bluetooth technology. Then, JomHadir records the attendance automatically into JomHadir server using Wi-Fi technology. Therefore, this knowledge transfer program helped the schools management to record the data efficiently and ease them to give reports of attendance especially during pandemic COVID-19.

Key words: Electronic, Internet of Things, Automatic Temperature Detector, Automatic Attendance System

INTRODUCTION

According to literature review [1], several strategies could be considered to improve knowledge transfer process by the knowledge of researchers to practitioners. The knowledge must be easier to be adapted and used by practitioners. Hence the effectiveness could be contributed by several factors; the attributes, the process and transfer mechanism. Meanwhile, as part of the 2050 National Transformation (TN50) roadmap, Malaysia is seeking to rank among the world's top 20 nations by 2050 in terms of economic development, citizen welfare, and science and technology advances [2]. A

key objective of TN50 is to build Malaysia's future with the young generation; therefore, to deal with Industry Revolution (IR) 4.0, young people are being encouraged to take part in technology-based courses, particularly in engineering and robotics, to assist in building industries through automation [2]. Yet, knowledge transfer activities are a crucial process for letting them to practice and adapt the transfer activities and be benefit for the mankind [1].

In addition, the ability to solve complex problems, to think critically and to be creative is three of the most important skills to learn. The required skills must be taught in institutions [3]. The purpose is to prepare students and adolescents for successful careers in manufacturing or in any other branches, with an emphasis on 'learning to learn' combined with the acquisition of new skills, so they would be able to occupy jobs that do not yet exist [3]. To support and achieve TN50, and to ensure the institutions able to provide the students with such desired skills, the teachers or lecturers must help in the learning process. One of the ways is through knowledge transfer activities.

At the present time, the pandemic COVID-19 virus has forced us to practice new norms in various situations. As we go on any premises either schools, mosques, offices, supermarkets or hotels, one of the Standard Operating Procedures (SOP) stated by the government is that every individual has to check their body temperature using thermometer, and the premises have to record both personal information and temperatures data at all of their entrance time. The pandemic situation gave credence to this method and this has become the norm for both premises and individuals. Therefore, COVID-19 can be seen as a stepping stone as major industries have implemented IR 4.0 as one of the solutions to overcome this problem.

Therefore, the objective of this study is to describe the design and implementation of automatic temperature device detector (namely, iSUHU) program to support TN50 through knowledge transfer from academic experts to the school community. In this program, the authors managed to develop a temperature device that automatically measures individual body temperature regardless of ambient temperature [4] and transfer the knowledge related to electronics and Internet-of-thing to the school teachers.

APPLICATION DESIGN

Based on the literature [1], we focused our application design on six main steps for two communications between researchers (authors as electronic engineering experts) and users (school community), namely dyadic knowledge transfer process. The three earlier steps are acquired by the researchers and next three steps are utilized by users. In this study, the users are the school community, i.e., the school teachers, staffs and students.

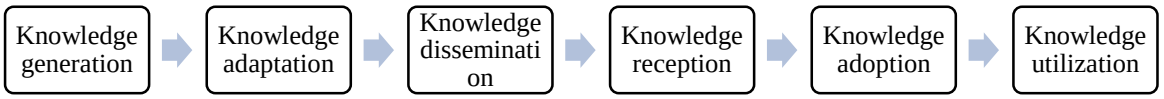

Figure 1. Six steps of a dyadic knowledge transfer process [1]

Firstly, is knowledge generation as concern to IR4.0 and TN50, thus we decided to used IoT and electronics related knowledge for this study. In addition to current situation of pandemic COVID-19, we applied the related knowledge into the application that is known as automatic temperature device detector (namely, iSUHU).

In order to let the knowledge adaptation by the users, we developed the device by integrating the widely available temperature device (K3 temperature sensor) with a microcontroller (ESP32). The microcontroller unit has a Bluetooth sensor to enable data (individual's temperature) transfer from K3 to mobile application (app). For this purpose, a mobile app is developed (namely JomHadir). The app would read the temperature data and identity of the user, then transferred and saved it to the server, or cloud storage. Later, this data could be used by the administrative management of each premise for tracking attendance record. However, the data will be erased after two weeks' time. Figure 2 shows the modified K3 temperature sensor which integrated with an ESP32 and the uniquely generated QR codes of the users in a premise. JomHadir mobile app is shown in Figure 3

Figure 2. K3 temperature sensor integrated with ESP32 and the QR codes for each user

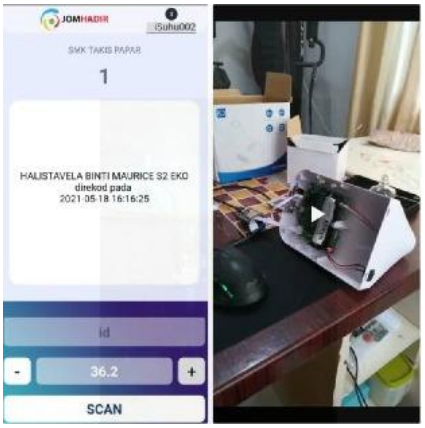

Figure 3. JomHadir mobile app interface is connected with modified K3 temperature sensor

We believed that this invention of iSUHU and JomHadir is useful for current situation in tracking the individual attendance at each premise. Indeed, the device could help for data management and storage, as well as tracking system. The transfer process of the results to communities is done by several stages. The promotion video as well as usage demonstration are shared through social media platform: Facebook (*https://www.facebook.com/jomhadirqr*) and website (*https://jomhadir.com/daftar/*) to attract community interest and participation. Furthermore, the source code and printed circuit board (PCB) layout design for integrating the ESP32 to K3 are shared freely through github.com. Through this sharing platform, users could try and design the iSUHU on their own pace or could contact us for further inquiries.

Next is knowledge dissemination of public information, where we took part in Minggu Sains Negara 2021 (MSN2021), a program organized by Ministry of Education of Malaysia (MoE), Ministry of Science, Technology and Innovation of Malaysia (MOSTI) and Pusat STEM Negara (PSTEMN), and co-organized by Institute of Electrical and Electronics Engineers (IEEE) and Universiti Teknologi Malaysia (UTM). The program is known as Integrating IoT in Electronic Design for a limited number of participants from Sabah, Sarawak and Peninsular of Malaysia. Figure 4 shows the activity pamphlet. In total of 20 schools (a school represented by two teachers) were selected of which most of the school's community are from Sabah and Sarawak. Each school was provided with two sets of K3 and ESP32 electronic kit. In addition to the program, we included another seven schools by using Faculty of Engineering grant of which each of them received a set of K3 and ESP32 electronic kit. The knowledge transfer process was done virtually to the school teachers using telegram, Google Meet and Google Classroom.

Figure 4. Pamphlet of the program during MSN2021

There is 1-day Google Meet training where the participants were guided earlier through Telegram and googleclassroom. This interprets the knowledge reception by the participants as a first step in knowledge transfer process by the users. They were provided with a manual and video tutorial through Google Classroom for iSUHU and JomHadir set-up. As the first step, they (the users) were asked to register the JomHadir account for their school. Each school would receive a unique identity (username) and password for data protection and security. From here, they learnt to generate QR code for their students and school staff. Next is to program their iSUHU, to test and to troubleshoot the device with JomHadir mobile app. The Telegram group is where they discussed and asked their problems and progress. During Google Meet session, they could reconfigure and troubleshoot their device and mobile app together with the appointed facilitators. The Google Meet training was break-out into 2-to-1 session to assist the participants; 2 schools and 1 facilitator. This could increase their self-confidence in electronics and IoT.

Then, knowledge adoption was acquired as part of the transfer knowledge process where the teachers are required to teach their students to assemble, test and troubleshoot iSUHU. Here, they were required to record the knowledge transfer process to their students and shared the video to authors. One of the adoption factors includes the motivation of the receiver (the teachers) to use or not use the new knowledge. Thus, through recorded videos, we could ensure that the teachers use the new knowledge and transfer it to their students.

Lastly, is knowledge utilization, where there are three forms of major utilization: 1) instrumental utilization, 2) conceptual utilization, and 3) symbolic utilization. For current study, instrumental utilization has taken placed where the results are used to solve problems, i.e. checking individual temperature and record their attendance automatically using iSUHU temperature device and JomHadir mobile app.

FINDINGS & DISCUSSION

The three knowledge transfer processes by researchers and users are well-developed and interpreted in this study. To ensure sustainability of the knowledge by the researchers, the content of the construction of automatic temperature devices is provided in Github and Moodle eLearning. Anyone able to access to circuit design, programming code, and PCB design to build their own automatic temperature devices. Next, the users (school community) would have the ability to repair the

temperature device in the event of damage later. Also, their students (through knowledge utilization process) could expand the knowledge for further innovation or other innovations.

At the end of the study, out of 27 schools, 100 % teachers have successfully participated until four steps and 33 % have successfully (sixth steps) transferred the knowledge to their students and utilized iSUHU and JomHadir at their schools. Through telegram conversation, the most difficult part is to program the microcontroller ESP32 and to communicate (or pair) the mobile app and iSUHU.

CONCLUSION

Through this program, the teachers were exposed and taught by the authors related to electronic engineering and IoT with the application of automatic temperature detector (iSuhu) and automatic attendance system (JomHadir) through online training. Educational kits based on electronic and IoT have also been provided to them. Then, they shared and transferred the knowledge to their students and recorded them. Every participant was able to complete their temperature detector which function automatically and properly with the respective automatic attendance system. By the end of the program, they are able to assemble, program and troubleshoot the device and system on their own if they need to use it later.

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COOPERATIVE LEARNING ACTIVITY IN SEMICONDUCTOR DEVICE PHYSICS COURSE

Shaharin Fadzli Abd Rahman
School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, Johor Bahru, MALAYSIA
(shaharinfadzli@utm.my)

ABSTRACT

Cooperative learning activity, namely jigsaw classroom, was designed and implemented for learning of bipolar junction transistor (BJT) structure and operation. The activity aimed to promote student's engagement and critical thinking in learning device theory and concept. The students were divided into several home groups. The set end goal of the home group was to propose and justify appropriate BJT device parameters. Each home group member was assigned a different subtopic related to the BJT device parameters. The learning of the assigned subtopic was done in the expert group through discussion among the member and with the guidance of the lecturer. Then, the student returned to the home group to discuss and present the proposal of the device parameter. The jigsaw classroom was ended with a summarization by the lecturer. The jigsaw method seemed to be an effective strategy to ensure the active participation of all the students. In the future, the effectiveness of the activity should be analyzed for further improvement.

Keywords: Cooperative learning, Active learning, Semiconductor device physics

INTRODUCTION

This paper presents our first attempt to implement cooperative learning activity in "SKEL4623: Solid State Electronic Devices" course. The course is an elective course designed for the fourth-year student of Bachelor of Engineering (Electrical-Electronics) with microelectronics specialization. This is a continuation of "Semiconductor Material Engineering" course. Before taking this course, students are expected to have a basic understanding of semiconductor material and device physics.

According to the previous years' Course Assessment Report, student understanding of device physics and theory (i.e. Course Learning Outcome no. 2 (CLO2)) has always been an issue that needs to be improved. In the examination, students tend to memorize the related theories and concepts. Some of them failed to demonstrate the ability to analyze and examine the device's operation. Students might have low motivation to acquire a better and deep understanding of the related theory and concepts. A lecturer-style classroom also does not provide many opportunities for the student to critically analyze the topic.

Cooperative learning activity was considered to address the aforementioned issues. Cooperative learning is an active learning activity that can encourage the student to involve in the learning and can enhance their understanding through interaction among them [1-3]. The type of cooperative learning strategy used was jigsaw classroom.

LITERATURE REVIEW

Cooperative learning is a learning strategy that requires students to work together in a group to complete common goals or objectives [4]. The implementation of cooperative learning leads to high motivation to do academic work and acquisition of critical thinking skills [5]. The accomplishment of the group's goals is directly dependent on the effort of each group member. Thus, the student shall become more responsible to complete the assigned individual task. Through the individual task, students are expected to develop understanding on their own before explaining it to other members. When other members have different opinions and viewpoints, their understanding can be questioned and need further clarification. The interaction between team members stimulates greater understanding and promotes elaborative thinking [4].

The jigsaw method is a strategy that emphasizes cooperative learning [6]. In a conventional lecture-style classroom. The teacher is seen as an expert that delivers the content to all of the students. In the jigsaw classroom setting, each of the students is the resource of knowledge. To accomplish the assigned task, students need to work together and interact actively among themselves. The assigned task may come from one selected topic that can be broken down into several sub-topics. In general, the jig-saw classroom is implemented through the following flow [7]. First, students are divided into several so-called "home" groups. Each of the group members is assigned different subtopics. They are expected to become an expert of that sub-topic by gathering relevant information. To facilitate the learning process, students with common sub-topic will form a temporary group called expert group. The knowledge on the specific sub-topic will be further clarified through discussion in the expert group. After the discussion in the expert group finished, the students return to the original home group to finish the main task of the home group. Every group member plays an important role as they are the expert of the assigned sub- topics. The members of "home group" are responsible to learn all the content of the sub-topics from one another.

APPLICATION DESIGN

The jigsaw method was employed in the learning of basic theory and device operation of bipolar junction transistor (BJT) (Chapter 2). Parameters, namely thickness and doping concentration of the silicon thin film layers in the BJT device structure, are important parameters that are decided based on the required BJT's current gain and cut-off frequency. The selection of the parameter values should also consider effects such as early voltage, current crowding, and bandgap narrowing. As shown in Figure 1, the factors that determine the selection of device structure parameters are set to be the sub-topics in the jigsaw classroom activity. At the end of the activity, the student should be able to propose appropriate device parameter values and justify the selection.

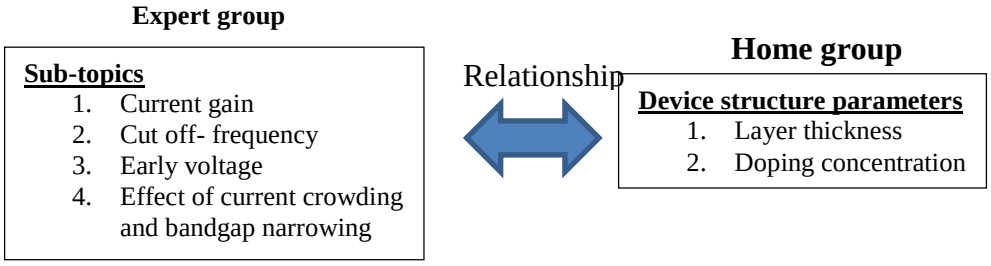

Figure 1. Summary of the targeted content

Table 1 summarizes the flow of the jigsaw classroom. Before the session, the lecturer prepared the instructional material and related resources. Related articles and excerpts from the reference book were printed for the usage of the expert group. For group assignment, the grouping was randomly done. Three home groups consist of four members were formed. One member of the group was assigned to a different subtopic. The jigsaw classroom started with the explanation from the lecturer on the overview of the topic and the details of the jigsaw activity. Then, students formed the expert group and discussed the assigned sun-topics. To guide and assist the discussion, the scope of the learning was limited to several key points; (1) Definition, (2) Significance to the BJT operation, and (3) How they affect the BJT operation. The session was monitored so that the student will construct correct and relevant knowledge. The expert groups were asked to write a summary of what they understood on the given subtopic. In Bloom's taxonomy, the activity in the expert group was at the "comprehension" level.

Table 1. Implementation of Jigsaw classroom

Phase	**Activity**
Pre-implementation	-Lecture prepared instructional material and related supplementary documents. - Lecturer assigned group
Implementation	Step 1: Lecturer did briefing on the details of the activity and overview of content.
	Step 2: -Student discussion of the sub-topic in expert group. -Lecturer monitored the discussion
	Step 3: -Student discussion of the main task in home group. -Lecturer monitored the discussion
	Step 4: Group presentation
Post-implementation	Summarization of the content

After the discussion in the expert group ended, the students moved to the home group. Each home group was required to propose suitable BJT layer width and doping concentration to realize a high current gain, high-speed BJT. The proposal should be based on the constructed knowledge in the sub-group. Each member was expected to provide the proposal from a different point of view. The activity required the analysis of device operations which can be categorized in the "application" level of Bloom's taxonomy. After the discussion ended, the group representative presented and justified their proposal. At the end of the class, instructor commented on the student's proposal and summarized the topics.

FINDINGS & DISCUSSION

It was observed that all the students actively engaged with the activities and played their roles. Each of the students was responsible to learn the assigned sub-topic and deliver the knowledge to other members in the home group. The students seemed to enjoy the activity. In the end-of-course survey, students suggested more group activities to be done. Figure 3 shows an excerpt of one sample of summary written by the "cut-off frequency" expert group. In general, the written summary covered the basic knowledge of the sub-topic. However, some expected point was not covered. It seemed that the student required more time and resources to understand the assigned sub-topics. The lack of understanding of certain subtopics could be noticed in the final presentation by the home group.

Some of the students had difficulty relating certain subtopics to justify the proposed device design and performance.

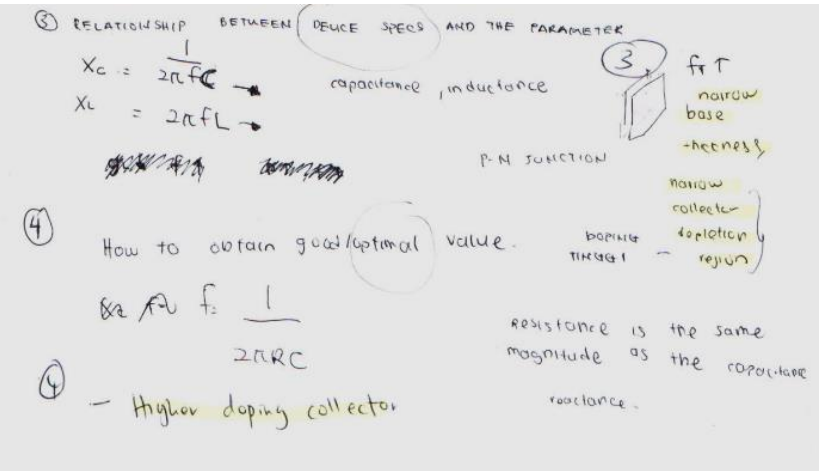

Figure 3. One of the written summaries by the expert group

The design and implementation of the activity need to be improved. The activity can be conducted for more than one class period. This shall provide more time for the student to interact with each other and to achieve better understanding. In terms of the lecturer's role during the activity, ample time is required to test the understanding of every student. Assignment of the group may also have a significant effect on the outcome of the activity. The expert group should be made of students with different academic levels. Excellent students can help other members to understand the content. At the moment, systematic analysis on the effectiveness of the activity was not done. In the future, a more well-designed assessment method needs to be done to provide valuable data.

CONCLUSION

The cooperative learning activity, namely, the jigsaw classroom, was designed and implemented in learning the device structure and operation of BJT. As the activity encouraged the active participation of all the students, the jigsaw classroom seemed to be a suitable method for teaching the theory and concept. Nevertheless, many improvements are still required. The activity can be improved by adding an assessment to gauge the efficiency of this group activity.

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SUB THEME 2

TEACHING & LEARNING COVID-19 PANDEMIC

THE EFFECTIVENESS OF USING VIDEO FOR ONLINE LABORATORY DURING PANDEMIC

Norlina Paraman and Ismahani Ismail*
School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, Johor Bahru, MALAYSIA.
(pnorlina@utm.my, *ismahani@utm.my)

ABSTRACT

Students will attend a few series of laboratory subjects along their study duration in University. During normal semesters, students will attend lab in physical lab room and lab session will be conducted face to face by lab supervisors. However during the pandemic breakdown, there is no eye contact allowed including for the laboratories. Students have to attend the lab session with the guidance of lab supervisor using online platform i.e Webex. This study is done to 2nd year lab and 3rd year lab for students from School of Electrical Engineering UTM to find the effectiveness of using video to replace face to face method during in-lab activities. A few things are focused such as how the recording of video can benefit the students and can help the lab supervisors in assessing the students' works. Students' feedbacks shows that the use of video is effective for them as a prove of detailed description on design efforts and at same time supervisor can fair enough to assess the students' works.

Key words: online laboratory, video recording, pandemic breakdown

INTRODUCTION

The world is moving toward online learning as the consequence of Covid-19 pandemic. Students are unable to access physical laboratory due to closure of university and the requirement of social distancing [1]. This study involves students from School of Electrical Engineering UTM, which are from second year laboratories (6 groups) and third year laboratories (24 groups). During normal semesters, students will attend three hours lab per week in physical lab room and lab session will be conducted face to face by lab supervisors. However during the pandemic breakdown, students have to attend the lab session with the guidance of lab supervisor using online platform i.e Webex. Both parties will be at different places. Therefore, some issues can arise i.e how reliable the lab session can be implemented in long distance? How this online lab session can affect the assessment process? One way to solve the issues is by providing evident of working scenes i.e video during the lab hours [2].

LITERATURE REVIEW

The effect of COVID-19 pandemic has left the option to implement teaching and learning activities virtually via online platforms. However, this poses a challenge for subjects that require the physical hardware which normally are only available in the laboratory. Work by [1] has overcome the issue by deploying a remote laboratory system in replacing the traditional physical laboratory sessions for hardware programming related subjects. The system consists of a few software modules that mimic the real hardware utilized in the physical lab. They observed that the students are able to gain similar experience as when they are conducting the experiments in the physical lab. Work by [2] has described that real-time video can deliver high quality education in anywhere with modern Internet

tools using video conferencing-TelePresence, Cisco Webex or Google Hangouts. They argued that online content provides several multimedia and interactive parts which make the learning process of students much more effective and make it easy to understand topics, rather than using black and white textbooks.

Motivated by the previous works, the objective of this study is to find the effectiveness of using video to replace face to face method during the in-lab activities. The findings from this study is to search how effective the video can help the students to present their works during the lab hours and facilitate the lab supervisor in assessing the students' work. This is done by collecting the students' feedbacks after they have finished all the laboratory sessions.

APPLICATION DESIGN

Basically, the experiments involve software simulation tools to assist design tasks process and certain hardware to implement the design. Students need to record the working scenes from their computer i.e using OBS System during lab hours as shown in Figure 1.

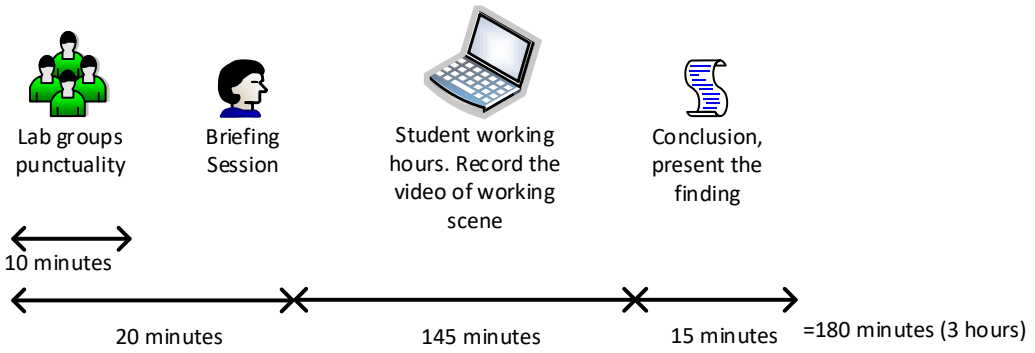

Figure 1. Learning design environment for in-lab activities

The lab is assessed mainly based on 3 parts which are prelab, in-lab and reports. The criteria that be assessed for in-lab activity are punctuality (presence of students in lab on time), disciplines, performance with equipment and device (ability to use equipment), planning (understanding of experiment) and experimentation (efficiency in taking data). All of these criteria will be assessed based on how efficient the students can finish the works within the time since the recording video will show the date and time duration of their working hours. The bonus is given to the clear, managed and comprehensive contents and creative of video presentation. Figure 2 shows some samples of screenshots of recorded video that made by students during the in-lab hours. The video shows the activities i.e circuit designing, simulating and physical implementation. Final video can be submitted one day after lab. Students are given the time to manage again the recorded video of working scenes during the lab hours. They can use their own creativity to compile and produce an interesting video by inserting features such as text, speech or sound. Then the video is uploaded to Youtube or drive and only the video's link is submitted to the lab supervisor for each week after finishing the lab.

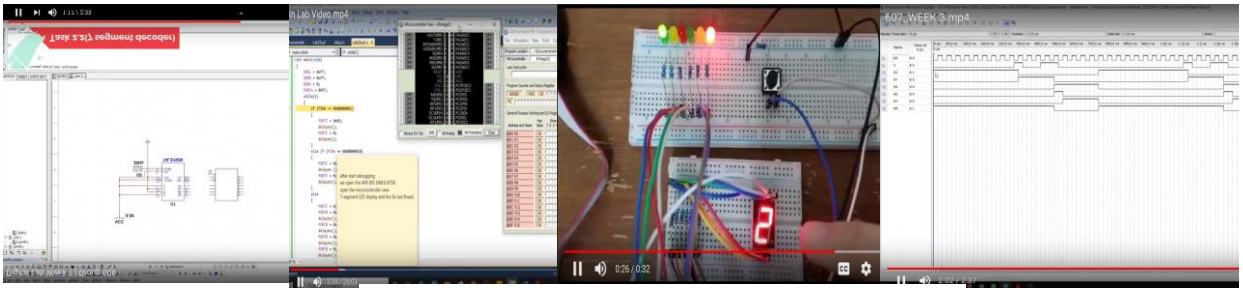

Figure 2. Recorded video during in-lab activities

Once they have finished all the sessions, the students need to give feedbacks regarding of their online laboratory process. The feedback aims is to peel the effectiveness of using the video for students to show their works during the lab hours. There are few focuses highlighted in this study. Firstly, how the recording of video for showing in-lab activities can benefit the students. Second, how the video can help the lab supervisors in assessing the students works.

FINDINGS & DISCUSSION

Table 1 presents the students' reflection regarding the use of video during online laboratory.

Table 1. Student's feedback

Q1: How the effectiveness of the video during the in-lab activities can help you to show your works?
During in-lab activities, we just complete the task and show the simulation results to the lecturer. By making the video, the lecturer can get know how we design and draw the schematic diagram, compile the files and getting simulation output waveform, program CPLD and so on. Making the videos is the way to show how we complete our tasks.
can show and let us explain how we design our circuit and get our simulation
Making video for in-lab activities may help us to show the process of designing in simplest way.
Rating 7 / 10
a direct way to prove our team's work
The video absolutely helps us to show our work effectively with every step has been recorded
Very effective as it will be one of the evident
I can show both process and result in one video, also can put timeline inside the video to ease lecturer to check different part
It's very effective since the video shows the whole process of the work.
Video can: -prove our efforts and understandings to the design criteria made by our instructors. -Showcase the hands-on experience like bread boarding. -Improve on detailed description on design and at same time increase our video editing skills.
It is very easier to show my results through video instead of explaining through words

Q2: How the making of video can make you to be more responsible and creative to complete the tasks during the lab hours?

Making videos increase our engagement which we will take our responsibility in completing our task during the lab hours, so that we can just making the videos after lab activities. During in-lab activities, we need to make sure that all of us are understanding the task requirements, so that we can just complete our task successfully. So, we can directly make the videos after in-lab activities.
we need to make sure everything is correct and we understand it
Making video will help us to reflect on the knowledge we gained since most probably we will not record only one time. Throughout the process, we will be clearer about what we have learnt and done. Sometimes, we will also be more creative by finding some possible solutions for designing process.
video helps me to present what I want to show
Will concern what is need to be recorded.
While editing the video, we need to think about how to show the result effectively in a short video, with every step being shown follow by the results.
It provide a better picture to understand more and more responsible to complete the task.
Can help me to more understand what lecturer want us to show and improve on that way
Video editing skills is needed in making the video to make it seems more interesting. Thus, it helps us to be more creative.
It becomes an urge for us to complete and understand the tasks in a given period
It makes me unable to skip important steps to complete the task

Q3: How is your view that the video can cause the lecturer to assess you fairly?

Making the videos can show our efforts in completing tasks for each in-lab activities and it is easy for lecturer to evaluate our works effectively. Besides, if we unable to show our works or we make some mistake during the in-lab activities, we can show our completing and final works by making the videos and the lecturer can evaluate us through the videos.
yes lecture can know what we have done throughout the process and not just showing the result
Since it is a group work, it is not easy to assess us individually and fairly through the video based on my limited understanding.
With the aid of demo video lecturer may look at the result correctly because some times when showing through online there is some lag
I think this method is fair as every member need to record their part, if not, they can just copy from others result.
To prevent plagiarism
Reflect the teamwork and work distribution of one group
The video shows the approach we use to finish the work and it's an evidence that we complete our work. Thus, it'll be easier to access our work through video.
Since we have showcased our real presentation during the in-lab session and get recognized by instructor the steps we get to the results, video can be another plus point for us.
Video can become the evidence for the efforts
I agree with it

Based on the students' feedback, we can conclude the findings as follows:

- How the recording of video for showing in-lab activities can benefit the students?
  The use of video is effective for students to show detailed description on design efforts and showcase the hands-on experience when involving physical implementation i.e bread boarding or testing. They also agree that they have increased their knowledge for video editing skills as well.

- How the video can help the lab supervisors in assessing the students' works?
  The use of video made the lab supervisor easy and be fair in assessing all the criteria for in-lab activities since there is an evidence to show the students' efforts.

CONCLUSION

During the pandemic breakdown nowadays, learning in the classroom is normally not possible. Therefore, the awareness to explore many technologies for assisting academic process has risen sharply. This study is done to find the effectiveness of using video to replace face to face method during in-lab activities. Based on student's reflection that was collected after all lab sessions ended, shows that the use of video is effective for them as a prove of detailed description on design efforts and at the same time increase their knowledge for video editing skills. Moreover, the use of video absolutely can showcase the hands-on experience when involving physical implementation. Besides, they also agree that video can cause the lab supervisor assessing their teamwork efforts fairly. For future work, the online laboratory can be extended for each student to make a short video to demo their task individually. Therefore, this can avoid the issue of take for granted attitude among them and increase the responsibility for teamwork.

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IMPLEMENTATION OF TIMELY, GUIDED FEEDBACK THROUGH ONLINE GOOGLE QUIZ ASSESSMENT TOOL DURING COVID-19 PANDEMIC

Luqman Hakim Satiman [1] and Nadiatulhuda Zulkifli [*2]
[1]Azman Hashim International Business School, Universiti Teknologi Malaysia
[2] School of Electrical Engineering, Universiti Teknologi Malaysia, Johor, MALAYSIA.
(luqmanhakim.satiman@gmail.com, [*]nadiatulhuda@utm.my)

ABSTRACT

Providing timely feedback with useful guidance on the correct solution is very important within the learning process of higher education students. This paper describes an implementation of timely feedback in Communication Principles (SKEE 3533), a 3rd year course that is offered in the electrical engineering undergraduate program during Covid-19 pandemic. Given the substantial depth of this course syllabus, it is important that students receive sufficient feedback on their understandings on current topic before moving to the next. The implementation of this assessment technique is carried out using online quiz assessment through Google quiz platform. Two types of guided explanation are given in the feedback: text explanation for simple, conceptual based questions, and video explanation for design and calculation-based questions. For the latter, YouTube platform is used to perform the video-based explanation. Positive outcomes from a routine university survey revealed the method's potential in improving student satisfactions on the assessment aspect of teaching component.

Key words: Timely Feedback, Online Quiz, Assessment, Communication Principles

INTRODUCTION

The unprecedented Covid-19 pandemic has imposed a dramatic shift on how universities around the world function. Although online learning was not new to the university community, its adoption prior to the outbreak was still low [1]. However, as teaching and learning (T&L) still needs to resume despite the ongoing pandemic, all parties had to quickly adapt with the entirely new online T&L norm.

Given the nature of online education which physically separate students from their peers and lecturers, it is claimed that the importance of feedback in this current higher education environment is even more prevalent [2]. A timely feedback in particular, is very valuable where research has revealed that learnings will be more effective if students are given feedback sooner upon submitting their work [3].

This paper aims to demonstrate the implementation of a timely, guided feedback in the quiz assessment of a third year electrical engineering course, Communication Principles (SKEE 3533). In addition, an analysis was conducted using a routine survey to students on lecturers' T&L performances at the end of semester, focusing on the assessment component.

LITERATURE REVIEW

Timely feedbacks that are equipped with proper guidance or 'model answer' will enable students to amend their mistakes before moving on to the next assessment or topic [4]. However, the importance of feedback is often undermined, especially in the higher education setting [5]. This condition occurred because feedback is sometimes given after course completion. Prior empirical studies attempted to address the problem by using different types of tools such as Evidence-Effect-Change (EEC) [6], class quizzes, discussion board posts [7] and video feedback [8]. However, only few research reported the implementation of a timely, guided feedback practices that used established applications e.g. YouTube and google form, within engineering-based higher educational courses.

APPLICATION DESIGN

This course comprises seven topics where the design of quiz assessments for all the topics is based on the constructive alignment framework, as shown in Table 1. One-hour quiz was dedicated for each topic, with exception to topics 2 and 3 due to time constraints. The quiz combined questions of moderate and high difficulty levels, in the form of either multiple choices or subjective, and either concept-, calculation- or design-based assessment approach.

Table 1. Constructive Alignment Framework

Stage	Outcomes	T&L Activities	Assessment Task
1	Able to demonstrate good understanding on basic component of communication system, and mathematical skills *Topic 1 – Introduction*	Synchronous online lecture on related topics, example of suitable calculation problems or practical experiences. Submission of reflection in online learning platform per individual	Question composition: 2 MM concept 4 MM calculation
2	Able to distinguish noise sources and perform noise calculation *Topic 2 – Noise*	Synchronous online lecture on related topics, example of suitable calculation problems or practical experiences. Independent study using tutorial question sheet Discussion of selected tutorial questions in class through student participation Submission of reflection in online learning platform per individual	Question composition: 1 MM Concept 2 MM Calculation 1 SH Calculation
3	Able to demonstrate important concepts (modulation and multiplexing) with the aid of time-frequency domain analyses and evaluation of communication system performance. *Stage 3, Topic 3: Amplitude Modulation* *Stage 4, Topic 4 : Frequency Modulation* *Stage 5, Topic 5 : Pulse Modulation* *Stage 6, Topic 6 : Radio Digital Modulation* *Stage 7, Topic 7: Multiplexing*		Question composition: 3 MM Concept 1 MM Calculation
4			Question composition: 2 MM Concept 2 SH Design
5			Question composition: 1 MM Concept 4 SM Concept 1 SH Concept 1 SH Calculation
6			Question composition: 3 MM Concept 2 SM Concept 2 SH Calculation
7			Question composition: 3 MM Concept 2 SM Design 1 SH Design

*MM = Multiple choice, moderate, SM = Subjective, moderate, SH = Subjective, high

FINDINGS & DISCUSSION

Google Form Question Design with Integrated Social Media

Prior to the Pandemic Covid19 outbreak, quizzes were normally conducted face-to-face and manually marked. Occasionally, gamification approaches were held to bring excitement into the classroom atmosphere. The former allows more challenging questions to be assessed while the latter typically deals with easier concepts. Even though the former approach is conventional and time-consuming as student solutions need to be prudently studied, it is an important approach that helps greatly with student learning. However, this approach takes much longer time, and any effort toward a timely feedback is often compromised with other responsibilities such as research and administrative tasks.

The face-to-face restriction had led to the adoption of an alternative assessment approach using Google online quiz tool. It was implemented in Semester 1, Session 2020/2021, involving two sections of 54 students. Figures 1 (a) to (d) reveal some excerpts from the online quizzes. Feedback to student answers need to be provided beforehand in the 'Answer key' section as shown in Figure 1 (b). Figure 1 (c) shows the lecturer's automatic responses to both correct and incorrect answers while Figure 1 (d) shows the Youtube video solution as the feedback for a more challenging calculation question.

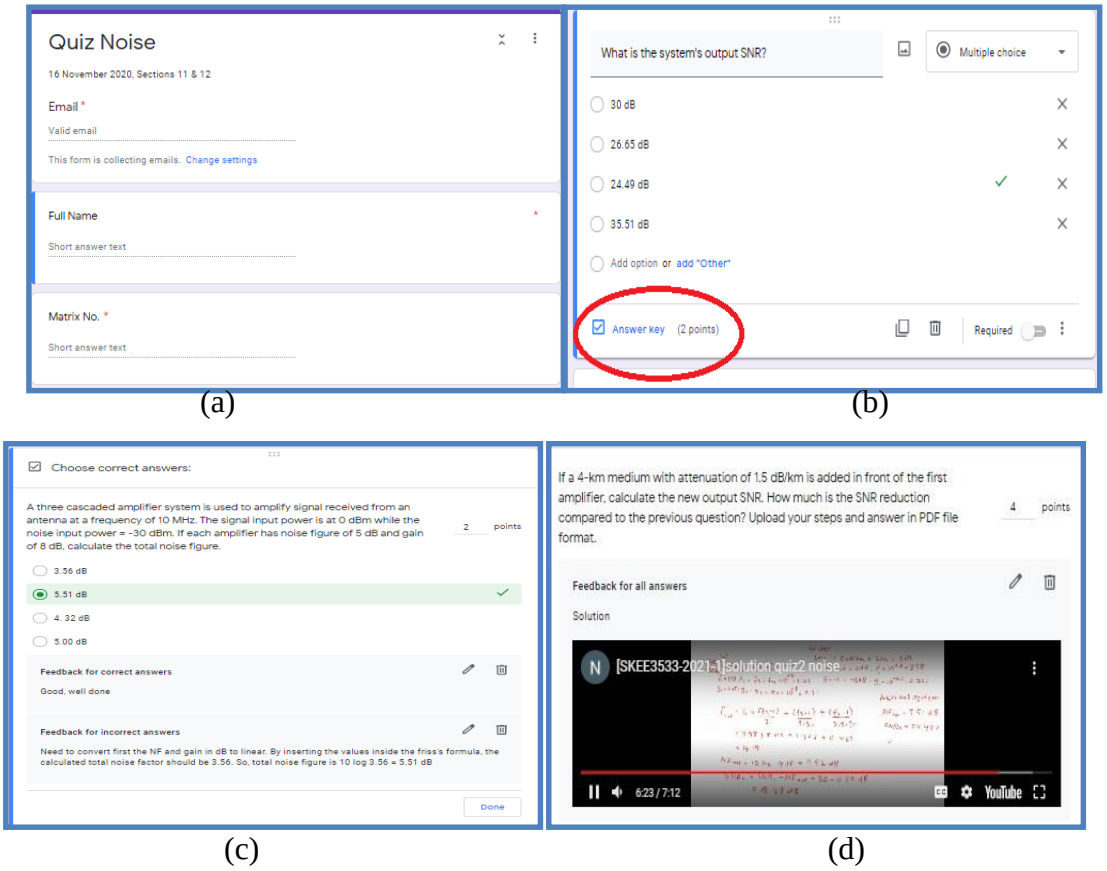

Figure 1. Google Quiz Automatic Feedback Setting

Meanwhile, Figures 2 (a) to (d) reveal some excerpts from a student's view after the quizzes were marked, and results with feedbacks were revealed. The top right of Figure 2 (a) shows the total score

of an individual student's quiz, Figure 2 (b) shows display of a wrongly answered question where the right solution is shown in the feedback area below and Figure 2 (c) shows the response for a rightly answered question. Meanwhile, for a design question as depicted in Figure 2 (d), the student may watch the provided video solution from the feedback area. Individual feedback can also be included for each question here if further comment or guidance is to be given per student basis.

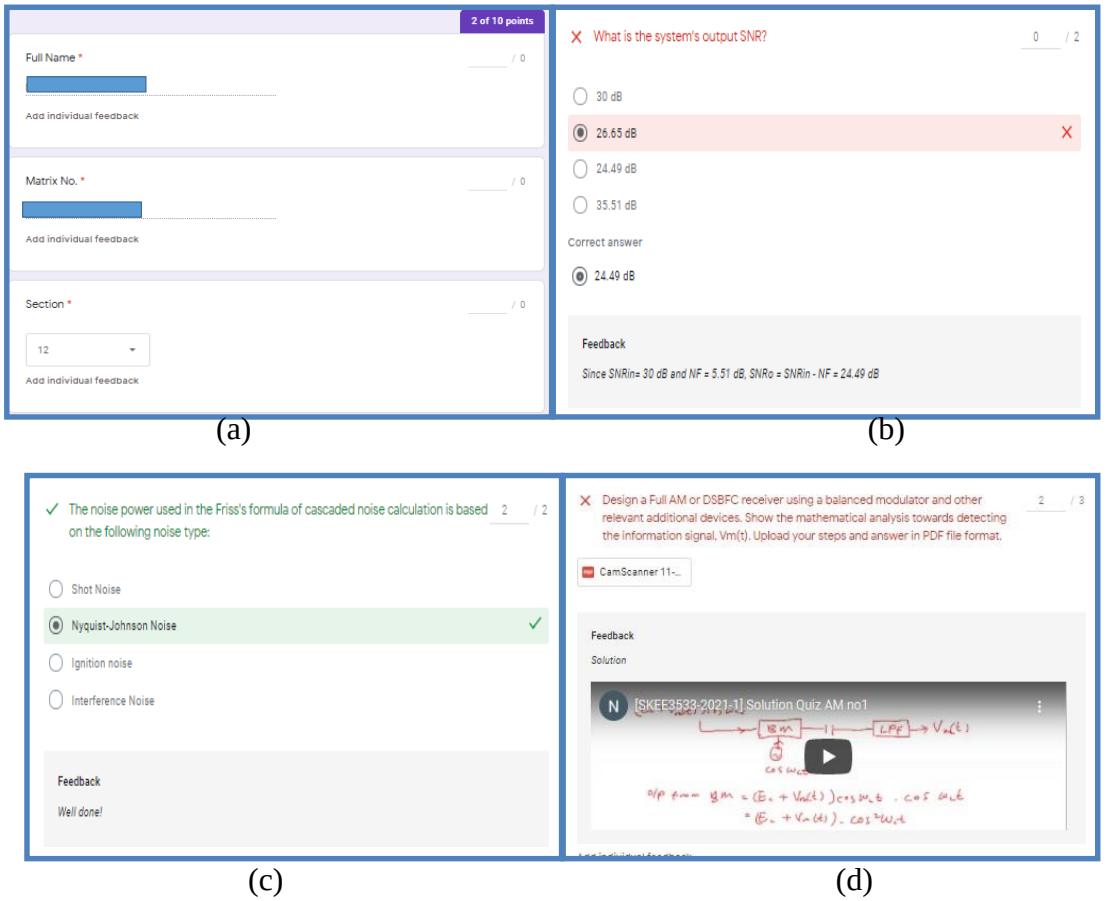

Figure 2. Responses to Student Answers.

Even though Google quiz tool greatly assists in organizing quizzes, some challenges still remain. The most significant challenge was dealing with student's attempt to cheat by using unknown identity and email in order to get the lecturer solution prior to submitting another version using the right student's identity and email. This trick was solved by strictly limiting the access i.e. using student's registered UTM email address and only one submission allowed per email. The other challenge was the assessment of non-automatically marked student answers which was time-consuming. Here, careful reading of student answers was needed, and fast response was made possible by aiming to return the quizzes before a set dateline e.g. before the subsequent topic begins.

Analysis from e-PPP Survey

Results from a routine university survey on lecturer's teaching (e-PPP) at the end of every semester are extracted to acquire student satisfactions on the overall course assessment, inclusive of quizzes. The session 20202021-1's survey outcome is compared with the previous three sessions (20172018-1, 20182019-1 and 20192020-1) that used only conventional quiz assessment method. Out of five, the average scores of e-PPP assessment component are 4.590, 4.645, 4.630 and 4.880 for the four sessions starting from the 20172018-1 session up to the 20202021-1 session, respectively. In all the

previous three sessions, the average scores were nearly equivalent to the average faculty score with differences of only in between 0.01 to 0.03. On the other hand, score in the latest 20202021-1 session is well above the average faculty score with a significant difference of 0.270 point. A more detail insight into scores of all items within the assessment component for the 20202021-1 session is shown in Table 2. The results show that students are very satisfied with all the assessment aspects in overall, where Item 3 on timely assessment return particularly obtains the highest score.

Table 2. Average Scores of Items in the e-PPP's Assessment Component (20202021-1)

Assessment Items	Score
1. Fair assessment (Scope, duration, rationality & prior notice)	4.885
. The ability to use assessment methods to challenge students to develop their individual capacity	4.850
3. Assessment results is returned in a reasonable period of time	4.905
4. Discussion of answers for every assessment	4.870
5. Use of assessment results to improve teaching	4.885

CONCLUSION

This paper reports on the implementation of timely, guided feedback through an online assessment tool that is equipped with different approaches to explanation, in order to suit dissimilar questions' difficulty levels. Though the implementation of such online tool was realized as a direct result of Covid-19 pandemic due to the restriction in face-to-face class setting, it led to a blessed opportunity in improving the lecturer's assessment technique. Comparison made with the previous sessions that used the conventional face-to-face approach and non-systematic feedback mechanism revealed greater student satisfactions with the new method. The findings confirm the usefulness of such an online assessment tool for the benefit of enhancing the overall student learning experiences.

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CASE-STUDY ON ISSUES AND CHALLENGES OF TECHNOLOGY-ENHANCED LEARNING DURING THE COVID-19 ERA

Norlaili Mat Safri* and Usman Ullah Sheikh
Electronic and Computer Engineering Department,
School of Electrical Engineering,
Universiti Teknologi Malaysia
81310 UTM Johor Bahru, MALAYSIA.
(*norlaili@utm.my, usman@utm.my)

ABSTRACT

The recent outbreak of the COVID-19 disease has changed the landscape of teaching and learning (TnL). The conventional TnL approach involving face-to-face classes and activities had to be adapted to the new norm of online TnL. Class instructors now have to explore different methods for online teaching that are both effective and provide a good learning experience for the students. At the Universiti Teknologi Malaysia (UTM), the online TnL came into full effect in March 2020. This paper discusses a case study on online TnL at UTM – one year since online TnL became the new norm. The case study focuses on the challenges experienced by the students and instructors, including network connectivity, learning experience and teaching transferable skills in engineering. The overall mean internet connectivity of the students in this study is found to be more than acceptable for smooth online TnL throughout the country. However, the large standard deviation values show that there were differences in the students' internet experience and accessability. For those students who experienced below the recommended internet connectivity agree that the recorded videos provided by the lectures benefit their TnL experience. It was also found that, teaching transferable engineering skills through online TnL is less effective than face-to-face session due to limited interactivity between the students and the instructors.

Keywords: Technology-Enhanced Learning, Movement Control Order, COVID-19 Pandemic

INTRODUCTION

The world is now facing one of the worst health, economic and political crises it has ever seen in decades. The World Health Organization declared a public health emergency of international concern when a novel coronavirus disease was detected in December 2019, known as COVID-19 [1]. As the virus started to spread throughout the globe since it was first seen in Wuhan, China, Malaysia has also not been spared from the rapid infection. Since the spread of the virus is primarily caused by close human contact, in order to curb the infection, the Malaysian government declared a movement control order (MCO) on 16th March 2020. MCO limits many activities, such as economic and social activities, including teaching and learning (TnL) in higher learning institutions [2].

For Universiti Teknologi Malaysia (UTM), a new norm for TnL was the way forward whereby, since 1st April 2020, TnL was conducted 100% online. During the 1st MCO, students were sent back home, leaving their hostels which are located inside the UTM campus, and they continued their studies remotely from various locations outside the campus. Since the 1st MCO was implemented in March 2020, the TnL for the semester II session 2019/2020 was divided into two parts. The first part was the face-to-face TnL in the classroom before the MCO, and the second part saw the migration to 100% online classes when MCO was enforced. Hence, initially, there were many new TnL approaches

adopted which both students and lecturers themselves had never experienced before, such as using online meeting platform for the online class, virtual-lab, online test, using alternative communication tools such as messaging services (WhatsApp, Telegram) for conveying information to students remotely and quickly. This is a common scenario not only in Malaysia but also in other countries [3].

In this paper, we present some of the issues and challenges of technology-enhanced learning faced by students. We discuss the access constraints, student's reflection on online or e-learning, and teaching transferable skills in engineering. Such a study is important to gauge the effectiveness of online learning experience on different quality of connectivity of the students as well how engineering skills can be effectively transferred to the students with the lack of physical face-to-face sessions. The findings of this research is valuable in understanding the needs of the students both in terms of physical intrastructure as well as designing the method for effective TnL in the context of students of UTM specifically.

LITERATURE REVIEW

An online TnL concept is not something new and has been in place for some time since the internet era although it is more known back then as open and distance learning. It is suggested that the online technologies via the internet can help address issues of accessible educational opportunities. However, the lack of educational and technology infrastructures, lack of trained teachers, negative attitude towards distance learning, and lack of access to adequate learning resources and basic education limit the implementation of online TnL to its full potential [4]. With the world, especially developing nations still facing some of these issues, came the COVID19 pandemic that change the educational landscape, rather abruptly, in many countries.

The transition from face-to-face TnL to completely online TnL has given a toll to both students and lecturers. Such a sudden transition can give effects to the quality of TnL as well as to emotional conditions. Massimo Casacchia et al. [5], conducted a research on determining the effects of distance education on the emotional conditions of lecturers. Lecturers reported difficulties in technical aspects and emotional strain. Another work studied the effects of distance learning on problem-based learning (PBL) tutorial during the COVID-19 pandemic [6]. The aim of the study was to compare the performance of students using distance learning PBL tutorials and conventional face-to-face approach. The study found that students in the distance learning group had a significantly lower scores for five areas of proficiency: participation, communication, preparation, critical thinking and group skills.

APPLICATION DESIGN

This case study was developed based on the data collected from the Biomedical Signal Processing (BSP) course attended by 19 students during the semester I session 2020/2021 at the School of Electrical Engineering, UTM. The students were in their final year, and it was their second semester studying under MCO. During semester 1, 2020/2021 session, the university has allowed final year students to return to the campus – if needed, to complete their final year project. Thus, a fraction of the students (8 out of 19 students, 43.11%) decided to return to the campus and stay in the UTM hostels. One student had previously stayed at a nearby rented room before moving back to UTM hostel. The remaining 11 students (56.89%) were at their hometown, staying with their family where one of them previously stayed at a nearby rented room to UTM before decided to go back home. Two students had to access online classes at public places as they faced constraints in their homes.

TnL for BSP class was conducted online via an online meeting platform using Cisco Webex for synchronous classes and through the UTM e-Learning platform for asynchronous classes. 71.43% of the TnL was done synchronously, while the remaining was done asynchronously. Attendance was taken using an online Google Form, and students were required to key in their internet connectivity details (download and upload speed, ping time and jitter time) each time they joined the online class. Outside online class, two-way communication was established through a WhatsApp group. Meanwhile, quizzes were conducted online via the Socrative platform. At the end of the course, an end-of-course survey via UTM e-Learning platform was conducted to obtain the students' perception and reflection on the TnL for the course. The survey was designed as a open feedback form, where students can submit a text based reflection on their experiences during the online TnL in the 2020/2021 semester 1. This survey is then analyzed to obtain the findings. Other questions in the survey such as student perception on their course learning outcomes attainment and private study hour outside contact hours are not included in this study.

FINDINGS & DISCUSSION

Access Constraints

Table 1 shows the internet connectivity for all the students based on their residing area during semester 1, session 2020/2021. The internet connection quality was based on the Speed Test website provided by Telekom Malaysia Berhad at https://speedtest.tm.com.my. Students are first required to perform the online speed test each time before the class session. The data is then submitted using a Google Form. The connectivity is then measured from the collected data in terms of statistical mean and standard deviation for all the connectivity quality parameters of ping, jitter, download and upload speed.

Table 1. Students' internet connectivity

Access from	**Internet Connectivity**			
	Ping (ms)[#]	Jitter (ms) [#]	Download (Mbps)[^]	Upload (Mbps)[^]
UTM hostel	23.83 ± 35.16	13.90 ± 36.20	30.24 ± 19.97	30.26 ± 23.10
UTM campus (ex. hostel)	11.00 ± 00.00	40.00 ± 00.00	93.40 ± 00.00	94.55± 00.00
Rented room near UTM campus	18.65 ± 14.64	7.00 ± 1.41	11.20 ± 5.80	3.90 ± 2.26
Public area	78.33 ± 97.50	8.33 ± 2.10	24.50 ± 0.50	9.17 ± 6.60
Home	54.90 ± 94.07	23.52 ± 48.28	20.62 ± 29.37	15.33 ± 18.69

. *Note: mean ± std. dev. [#]Lower is better. [^]Higher is better.

Referring to Table 1, the quality of internet connection varies based on location. For good quality of service, ping (latency) should not go over 85 ms [7], while jitter should remain below 30 ms [8]. Based on these requirements for video streaming and VoIP, it was found that the home location had a higher ping (highest was public area) and jitter compared to other locations. As for download and upload speed, it also depends on the type of broadband used. An acceptable download speed for online TnL is having an average of 4.3 Mbps - 5.5Mbps (peak) download bandwidth [9]. From the data collected, download bandwidth is more than acceptable. Overall, based on Table 1, it is evident

that there were access constraints for some students, especially those staying at home as compared to their peers that chose to stay inside UTM. To cater for students with poor internet connection, each online class is recorded and uploaded to UTM's e-learning platform. This allows students to access the TnL material anytime and anywhere to facilitate their learning process.

Students' Reflection on Online Learning Experience

At the end of the course, students were asked to give feedback on their online learning experience. While some students liked everything and have adapted to the new way of learning, there were students with difficulties, as their feedback is listed here:

- Kind of challenging to done *(sic)* the online learning
- Limitation occurs because use data *(sic)* from hotspot.
- Not too convenient due to internet access during the online classes but the recorded video during the classes helps me a lot.
- Challenging because online learning increase student laziness.

Even though some students enjoyed their online learning experience, there were those that still cannot cope and adapt to this online technology-based TnL, even though, for a fact, this was their second semester experiencing the online TnL. Based on one of the feedbacks, the online TnL was challenging because it made the student lazier. Hence the attitude of the student itself jeopardises the effectiveness of online TnL. To counter this, and also to cater for access constraints, it is suggested that lecturers develop asynchronous activities that help to increase the student's engagement with TnL. UTM e-learning platform provides some kind of activities that promote student's TnL such as glossary, lesson, and etc.

Teaching Transferable Skills in Engineering

Research has shown that people learn best by doing things and reflecting on what they have done, not by watching and listening to someone else telling them what they are supposed to know. Hence, in the BSP course, skills relating to the ability to perform critical analysis, such as in the problem of minimising error in signal analysis is acquired using MATLAB/Scilab/GNU Octave software tool as biomedical signals are small signals with artefacts. Previously, to complete a certain assignment using these software tools, students did programming and learned to analyse biomedical signals during face-to-face sessions. All students are required to bring their own laptop during the session, and the lecturer acts as facilitators to assist students in their learning. However, since the learning of analysing biomedical signals using software tool took place online, a different approach is needed as engaging students in online classes while each student develops and run their own code during online class hour poses quite a challenge. Therefore, a tutorial video on step-by-step on how to develop simple coding to analyse biomedical signals was provided to students via the UTM e-learning platform. Apart from that, students also watched and listened to the demonstrations given by one of the lecturers during the online class. Each student was given different biomedical signals with different parameters to analyse as their individual assignment, similar to previous batches.

The current student result of this assignment was compared to previous batches that learned and developed analysis codes during face-to-face sessions. The maximum mark for the assignment was 5%. Batch of 2020/2021 (online TnL) obtained 2.9, 4 and 2 for mean, maximum and minimum marks, respectively. Meanwhile, the batch of 2019/2020 (face-to-face TnL) obtained 4.1, 5 and 4 for mean, maximum and minimum marks, respectively. Comparing these numbers, it is obvious that the

face-to-face approach gave better performance than the online lessons. Another past batch, the batch of 2018/2019 also achieved a higher assignment mark than the current one. The mean, maximum and minimum marks were 4.1, 5 and 2.5, respectively. One reason for higher marks obtained during face-to-face facilitation session is that students obtain immediate feedback when they encounter errors or when they need assistance, and also, since all students were present, they were free to learn from their peers as well. Unless students can share their laptop screen synchronously, it is impossible to achieve the same level of face-to-face TnL for the same assignment via online. To improve the situation, the lecturer needs to be more creative in designing the TnL that involves using software tools. One way is by breaking the process of analysing biomedical signals into smaller tasks and through scaffolding.

CONCLUSION

The new norm of online TnL can be made more effective if some of the key challenges can be addressed. The case study in this paper identified the main challenges of both the instructors and students. In order to have a smooth TnL experience, both instructors and students should have access to good network connectivity that includes low ping and jitter time, and acceptable download and upload speeds – that is, to have a favourable two-way communication. Poor connectivity will degrade the learning experience and the ability to perform webcam-based discussion, screen sharing or active online learning. Network connectivity largely depends on the user's location, whereby it is limited to fibre/cellular coverage areas or even data plans subscribed by the user. Online TnL is not only affected by technical facilities, e.g. network, but the quality of learning also depends on the student's social aspect of the student i.e. home environment, mental state, and motivation. The case study also found that knowledge transfer of engineering skills such as programming and analysis is better through face-to-face learning compared to online. This was supported through the observation of the students' performance over three semesters. As such, future engineering educators must explore new methods to enhance the delivery of transferable skills to students.

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UTM EXPERIENCE DURING COVID-19 PANDEMIC-ENSURING HIGHER EDUCATION EXCELLENCE

Mohd Junaidi Abdul Aziz[1], Nasiibah Ramli*[2]
[1]School of Electrical Engineering,
[2]Academy of Islamic Civilisation,
Universiti Teknologi Malaysia, Johor Bahru, MALAYSIA.
(junaidi@fke.utm.my, *nasiibah@utm.my)

ABSTRACT

This study is to examine whether the implementation of online teaching and learning for Fundamental of Power System and Electrical Machine course (SKEE 2423) in UTM during COVID-19 pandemic affecting the overall performance of the students. A comparison between students results during pandemic and prior pandemic is analysed and discussed in detail whereby the course information and assessment used in both semesters is identical. It is found that the result during pandemic has non-normal distribution.

Keywords: Assessment, Online class, Covid-19, Chegg.com

INTRODUCTION

Embracing new norm during Pandemic Covid-19 is no longer an alien notion among world population in year 2021. People have been facing effect brought about by this pandemic for almost a year. All aspect of live have been facing 360 degrees changes due to the pandemic. Higher education also is not exempted from embracing the new norm. Gone is the traditional method of teaching where professors disseminating knowledge in a hall full of students replaced with blind and muted screen.

Question raised on how to maintain quality for higher education standard since our choices in teaching methods has been limited to teaching through online medium only. How do we ensure the quality of the education if we could not perform just and reliable assessment on the students' understanding of the courses taught in the lectures? The big question is how to ensure that course learning outcome is achieved, and can the student achieve the targeted achievement for the program learning outcome?

In Malaysia, during the first Movement Control Order, some universities had chosen to reschedule university calendar and deferred the semester in order for the university to prepare their lecturers and administration for conducting university day to day operation through online platform. However, there were also universities which opt for continuance of the university operation and improvise along the way.

Initially, the implementation of teaching and learning in UTM is not well prepared to cater the online teaching assessment, whereby the same course information prior pandemic is used during online learning. The objective of this study is to analyze the consequence of using the same assessment which is designed for face to face learning into online learning in SKEE 2423 course. Comparative analysis between student results before and after pandemic is investigated in order to find any abnormality in the student results statistic.

Thus, this paper examines through my experiences as a lecturer in UTM with reference to the regulations [1] set out by the Malaysian Ministry of Higher Education during Movement Control Order in ensuring that higher education excellence is not forfeited.

LITERATURE REVIEW

The first Movement Control Order (MCO) for Malaysia went into effect on March 18, 2020 where all academic employees are required to work from home, with no face-to-face meetings permitted until the MCO is lifted. This situation has greatly affected the day-to-day activity at the university especially teaching and learning activities. UTM then had taken bold action to begin online learning on April 1, 2020, rather than waiting for the MCO to be lifted, and thus being the first university in Malaysia to do so [2].

According to the survey conducted in assessment of effectiveness of online teaching conducted at UTM, in the first two weeks of April 2020, 98.29% of courses (450 courses) had effectively implemented online learning, where 78.36% of the courses were delivered synchronously, while the remainder were delivered asynchronously. Because some students have very limited internet connectivity at home, the asynchronous mode of online learning is critical. The asynchronous mode of online learning gives students flexibility in attending their learning at their own time and pace.

Study conducted by Bozkurt et. al. [5] finds out that major issues commonly faced by 31 countries selected in the research shows the need for alternative assessment other than the traditional face to face students' assessment which can be conducted either through synchronous or asynchronous methods of online learning. The study further highlighted on the current trend of students cheating in the examination and other online assessment which underlined the necessity for online examination proctoring tools to overcome the issue.

METHODS

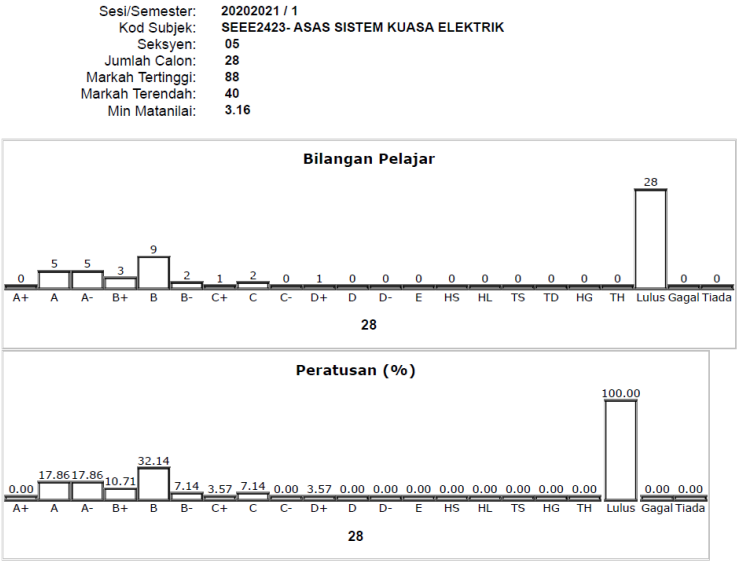
Comparative analysis between student's grade for SKEE 2423 course during pandemic and prior pandemic is assess quantitatively and reference to other literatures describing the same phenomenon are analyzing qualitatively in the findings & discussion.

Results of SKEE 2423 During Pandemic and Prior Pandemic

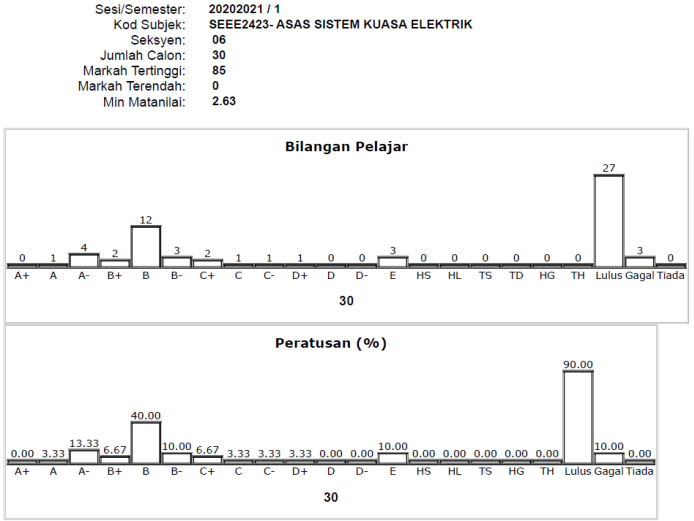
In 20202021 semester 1, our choice of teaching and learning methods has been limited through online mediums only. Therefore, all classes for SKEE 2423 were conducted through synchronous online teaching. Since UTM students are scattered all around the globe, some of them have limited/slow internet connection speed and unstable connectivity. Therefore, recorded video of all classes has been shared in e-learning. Additionally, if students faced difficulty in understanding the shared material, a discussion in WhatsApp group/e-learning may help students understand the materials better. It is presumed that by using this method, all students are not left behind.

Apart from the whole online class, synchronous online examination using UTM e-Learning with manual online invigilation has been applied for two tests and the final examination. Using this method of examination, students answer questions in the online system using the same traditional exam questions, but they must turn on Webex video conferencing throughout the online exam session.

Figures 1(a) and 1(b) show the results of SKEE 2423 for session 20202021 semester 1 for section 05 and section 06, respectively. For section 05, all 28 students passed the course with a mean value point of 3.16, while for section 06, three out of 30 students were failing the course, and thus the mean value point of 2.63. Those three students who had used Chegg.com to cheat in the final exam were given zero marks for this course which is equivalent to grade E. In both sections, most of the students managed to secure a grade of B for this course. Both graphs portray a non-normal distribution, where for section 05, 35.72 % of student received grade A and A- while for section 06, 16.67 % students received grade A and A-.



(a)

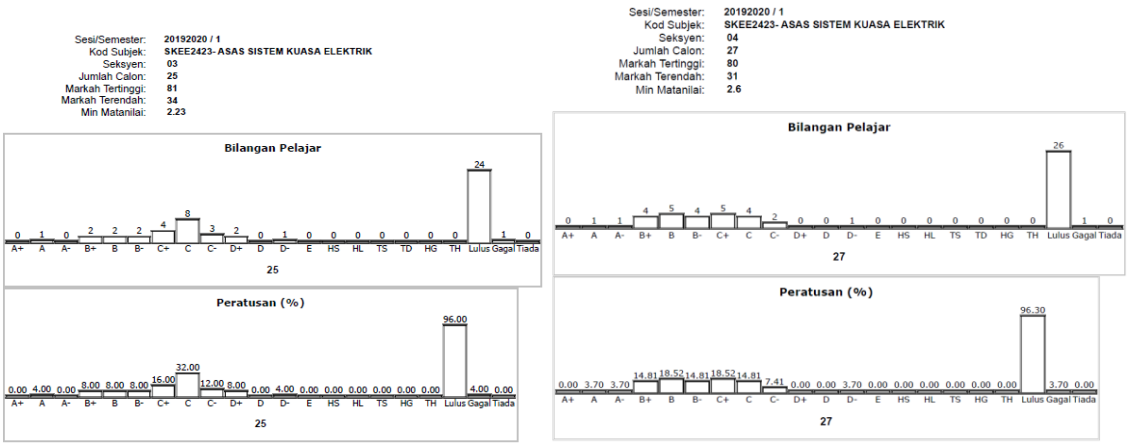


(b)

Figure 1. Analysis of SKEE 2423 in session 20202021 semester 1 for (a) section 05 and (b) 06.

In session 20192020, semester 1 was the pre-pandemic period. Our teaching and learning in UTM was 100 % face-to-face class combined with e-learning activities. Tests and final examinations were conducted in the examination hall in UTM, where lecturers and supporting staff invigilated the test and examination. Therefore, it is almost impossible for the students to cheat in the test and examination.

Figures 2(a) and 2(b) show the results of SKEE 2423 for session 20192020 semester 1 for section 03 and section 04, respectively. For section 03, 25 students passed the course, and only one student failed, which contribute to a mean value point of 2.23, while for section 04, all 27 students passed the course with a mean value point of 2.6. From course learning outcome (CLO) analysis taken from iOBE, the failed student shows poor performance in both the final exam and coursework marks. In section 03, most of the students managed to secure grade C for this course, while for section 04, the majority received between grades C+ to B. Both graphs portray a normal distribution whereas for section 03, only one student received grade A while for section 06, only two students received grade A and A-.



(a) (b)

Figure 2. Analysis of SKEE 2423 in session 20192020 semester 1 for (a) section 03 and (b) 04

FINDINGS & DISCUSSION

Student evaluations of the teaching system online (ePPP) demonstrated that all students enjoy the learning process and understand the content of the lectures both face-to-face and online class in both semesters. The rank for lecturer performance for both semesters varies between P3 (40%-60%) and P5 (above 80%), ranging from average to excellence compared to overall lecturers in UTM. This is because the lecturer gives 100% effort in ensuring the teaching and learning process is delivered successfully regardless of the situation. However, some of the students complained that two hours classes were too long for an online class. This is understandable since they have to focus on the screen for quite some time.

Figures 1 and 2 show that the mean value point of the results during a pandemic is superior to the prior pandemic. However, the non-normal distribution of statistics indicates that the result is questionable. The reason might be resulting from the recorded video that may help the student revise after the class. Another possibility might be caused by the online test and examination, which is difficult to monitor. The three students who caught cheating in the final exam during the pandemic by uploading the final examination question to Chegg.com prove difficulty monitoring online examination. It is possible that the other students were also cheating by sharing their answers in the WhatsApp group or using additional electronics devices. However, it is complicated to prove the

misconduct. This assumption is in line with [3,4] where they stated that for an institution used to face-to-face oral or written exams, the assessment may be the most challenging part of the transition to distance learning, as the shift in control to the students makes it difficult to ensure that students are not cheating.

Though synchronous online examination using UTM e-Learning with manual online invigilation has been applied for tests and the final examination during pandemic to mimic the face-to-face examination. A more stringent approach should be applied in order to avoid student from cheating. In 20202021 semesters 2, supporting staff from school of electrical engineering is continuously monitoring Chegg.com website to ensure no student upload the final examination question during the exam. Additionally, every page of UTM exam paper is added with watermark to make it more difficult for student to upload the examination questions.

CONCLUSION

In conclusion, the assessment is the most challenging part of the transition to online learning. The non-normal distribution of statistic during pandemic supports the statement. As a result, the course information and assessment need to be improvised, self-regulation must be included in the evaluation, such as through self-reflections or portfolios. The more general approach includes asynchronous activities in the students' learning process (always within a pre-determined timeline) and clearly defines ways to assess their participation. It is of utmost important that the intended learning outcome is achieved through constructive alignment. The student construct knowledge through teaching and learning experiences and show evidence of how they meet the outcomes through assessment where they show construction of knowledge and skills.

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THE EFFECTIVENESS OF COMPLEX PROGRAMMABLE LOGIC DEVICE FOR LEARNING DIGITAL SYSTEMS DURING THE COVID-19 PANDEMIC

Muhammad Mun'im Ahmad Zabidi[*1], Ismahani Ismail, Shahidatul Sadiah and Musa Mokji
School of Electrical Engineering, Faculty of Engineering,
Universiti Teknologi Malaysia, 81310 Skudai
Johor MALAYSIA.
([*]munim@utm.my, ismahani@utm.my, shahidatulsadiah@utm.my, musa@utm.my)

ABSTRACT

Traditionally, digital electronic experiments involve the construction of designs based on discrete integrated circuits (ICs) implemented on bulky digital trainers found in laboratories. However, the COVID-19 pandemic has forced students to stay at home and conduct learning online. As a result, physical experiments were replaced with pure simulation, thus producing students with little real-world experience. This paper discusses the strategies used at UTM to ensure that students did not lose their hands-on activities. Experiments previously conducted based on ICs and trainers were replaced with experiments based on inexpensive complex programmable logic devices (CPLD). In our context, inexpensive means the students could afford to buy the devices and conduct experiments at home. The efficacy of the CPLD on courses taken by second year students at the School of Electrical Engineering UTM is investigated. The focus is on the usefulness which covers affordability, portability, efficiency, and reliability of the CPLD device compared to the traditional way. Students' feedback shows that the majority agree that CPLD helps in achieving learning objectives and getting a better understanding. In addition, more than 75% are satisfied with their improvement on the level of knowledge at the end of the course.

Keywords: digital trainer, CPLD, pandemic, Covid-19, digital electronics

INTRODUCTION

The world is moving to online learning as a result of the COVID-19 epidemic. Due to university restrictions and the necessity for social distancing, students were unable to access physical laboratories [1]. Teaching laboratory courses can be challenging since many experiments require laboratory-specific equipment. Some physical experiments were substituted with pure simulation due to a lack of access, leaving students with no real-world experience.

LITERATURE REVIEW

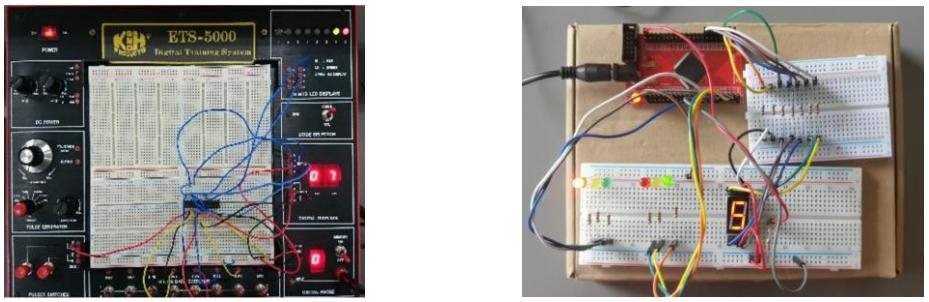
The COVID-19 pandemic has forced students to stay at home and conduct learning online. This poses a challenge for subjects that require the physical hardware which normally are only available in the laboratory. Work by [1] has overcome the issue by deploying a remote laboratory system in replacing the traditional physical laboratory sessions for hardware programming related subjects. They observed that the students are able to gain similar experience as when they are conducting the experiments in the physical lab. Second-year students in the School of Electrical Engineering at

UTM who were enrolled in Digital circuit related courses participated in this study. Traditionally, experiments have used ICs (such as the 74 series) to create digital electronic designs on a bulky digital trainer [2][3]. To maintain the hands-on experience, our school implemented the experiments using Complex Programmable Logic Device (CPLD) devices. The devices are simple, affordable, and meet all our learning objectives. Students could afford to buy the devices and conduct experiments at home. The devices are also available from online stores, thus students do not have to expose themselves to the coronavirus unnecessarily to buy them. The CPLDs were mainly employed in two courses. In the Digital Systems course, the students implemented a complex system design within one semester based on six stages or milestones [4]. Work [4] has presented the designed teaching and learning activities by applying the CPLD to reach the outcome of the course based on the constructivist learning theory. Meanwhile, in the Digital Laboratories course, the students implemented a traffic light controller within four 3-hour sessions.

The objective of this study is to assess the effectiveness of using portable and simple CPLD as the alternative to the traditional digital trainer to implement the digital circuit design. The findings from this study shows the students' perception on the usability (affordability, portability, efficiency, reliability) of the device compared to the former way.

APPLICATION DESIGN

The digital electronics trainer is an instrument that serves as a tool for digital electronic circuits learning, training and testing. To encourage exploration, it allows a student to rapidly construct, alter and fix all kinds of designs based on digital ICs. Trainers are composed of a breadboard and various additional elements, such as LEDs and switches, as shown in Figure 1(a). The gadget is non-portable and has high acquisition and maintenance costs. Trainers have long been the staple of digital electronics laboratories to meet the learning objectives of digital electronics courses.



(a) Digital trainer-based design. (b) CPLD miniboard-based design.

Figure 1. Circuit design implementation on different platforms.

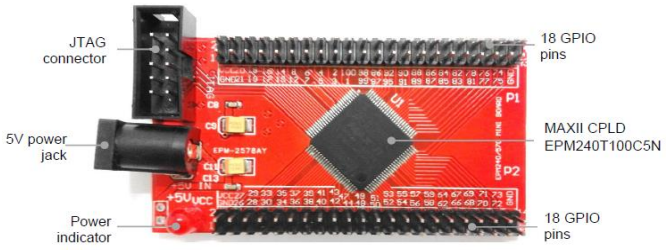


Figure 2. EPM240 board

The CPLD is a device that functions as a complete digital circuit by software configuration [5]. CPLDs packaged with input/output elements have pricing beyond the grasp of most students. The low-cost EPM240 miniboard does not even have an LED or switch to keep the board cost-effective. Figure 1(b) shows a typical EPM240 miniboard-based circuit design which consists of the mini board, breadboard(s), components and wires. The device has 100 pins; 64 are available as general purpose input/output (GPIO) ports accessible through the two 22×2 headers as shown in Figure 2.

Using the CPLD typically involves configuring the device for implementing the algorithmic part of the problem, and wiring the external input/output components. The CPLD is managed using the Quartus II software package [4]. Initially students develop and simulate the algorithmic part of the circuit with the tool. Once the circuit is validated, the tool is again used to program the circuit into the CPLD. At the same time, the accompanying input/output part is implemented on the breadboard.

The main benefit of CPLD is its rapid reconfiguration, which allows students to explore various alternatives much quicker than discrete ICs. When using the miniboard, external components must be attached. Although it might be considered to be a disadvantage of our strategy, students are now developing psychomotor skills that were not required to use trainers.

FINDINGS & DISCUSSION

At the end of semester, an observation survey was held to gather students' perspectives on the effectiveness of using CPLD for lesson and laboratory. For that purpose, a questionnaire with closed questions was designed, where a total of 100 students participated. There are two sections in the questionnaire. First, participants were asked about their transformation of skill and knowledge level at the start and end of the courses. Skill and knowledge are referring to the course learning outcomes of digital circuit lesson and digital circuit laboratory, respectively. Figure 3 shows the student's feedback on this inquiry. The result shows about 60% of the students admit having poor and fair knowledge at the start of the course. The level of knowledge improved at the end of the course with more than 75% of the students being on either satisfactory, very good, or excellent level. Less than 25% said they are at a fair level and none of them is at a poor level. This result comes as expected where students' skill and knowledge should be improved throughout the semester.

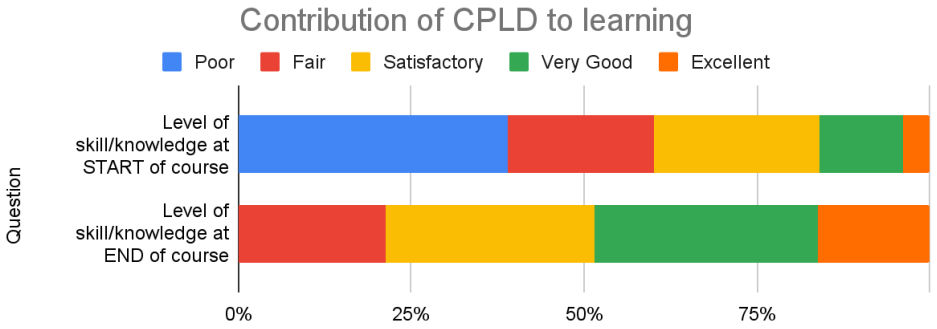


Figure 3. Student's feedback on the contribution of CPLD to learning.

Next, participants' feedback on the usefulness (affordability, portability, efficiency, reliability) of the CPLD were asked. Referring to Figure 4, the majority of students agree that the CPLD is useful in terms of portability, giving better understanding through hands-on experience, giving them a feeling of achievement compared to just a pure simulation experiment, and helps them to achieve learning objectives. The majority also agree that CPLD encourages them to experiment on other circuit designs. The only usefulness that was not agreed by the majority is affordability. However, almost 50% of them either agree or strongly agree on the CPLD as an affordable experiment kit, while less than 20% think otherwise. The rest were neutral. Therefore, the CPLD is a great replacement for ICs and trainers in the laboratory room.

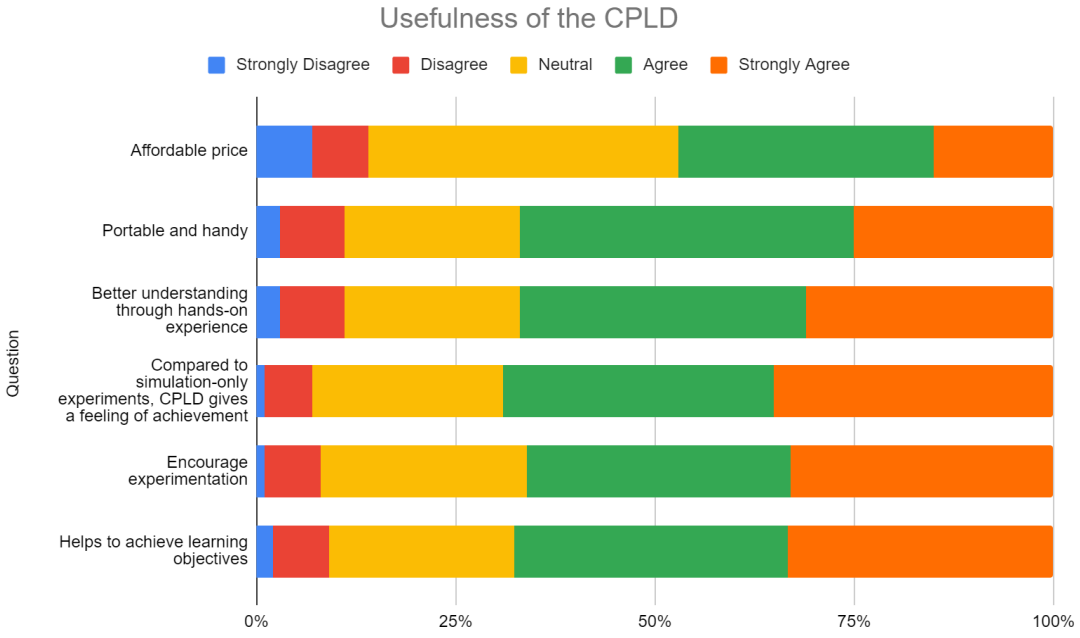


Figure 4. Student's feedback on the usefulness of the CPLD

CONCLUSION

Learning in classroom is challenging during pandemic. Hence, interest in alternative technologies to support the academic process has risen sharply. This study explored the usability of CPLD in term of efficiency, portability, reliability, and affordability to replace the traditional method, through students' feedback on a questionnaire. We found that the CPLD to be more than adequate for the intended purpose as the majority agree with CPLD helps in achieving learning objectives and getting a better understanding. In addition, more than 75% are satisfied with their improvement on the level of knowledge at the end of the course. We are likely to keep using it when the pandemic is over.

Acknowledgment: We appreciate Universiti Teknologi Malaysia for the excellent teaching and learning environment and also to UTMLEAD for providing teaching and learning training courses.

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SUB THEME 3

TEACHING & LEARNING TECHNOLOGY

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ENHANCING STUDENT'S KNOWLEDGE ON ENGINEERING MANAGEMENT SUBJECT BY USING REAL CASE SCENARIO APPLICATION

Teh Zaharah Yaacob and Siti Suraya Abd Razak*
Azman Hashim International Business School, Universiti Teknologi Malaysia, Skudai, Johor, MALAYSIA.
(tehzaharah@utm.my, *sitisuraya@utm.my)

ABSTRACT

The need of business and management subject to the engineering students is crucial to ensure the future engineers can face the challenges in managing a business. In Engineering Management subject, students are well equipped with the knowledge on the product, processes, technological leadership to ensure they are well prepared for the technological advancement in today's global economy. The application of the real case scenario or case study has been applied throughout the learning activities in this subject either in assignment or weekly assessment. The real case scenario was based on the current issues happening throughout the world. Assessment and feedback on this learning activities had showed good response and attentiveness from the students. Consequently, with the exposure to the real case scenario will make the future engineer become alert with the technological, societal challenges and opportunities for future business. Nevertheless, the application of real case scenario will improve the student's ability to grasp and execute responsibility professionally and ethically in engineering profession and business management.

Keywords: Engineering Management, Real Case, Case Study, Project Management

INTRODUCTION

Real case scenario can be defined as the ability to understand different scenario based on actual cases that happening in many situations in different manners. Case scenario or case study can be interpreted as a description of a real or stimulated managerial situation along with personal history of an individual, institution, or business faced with a problem that must be solved [2]. As quoted by [1], teaching with cases can be either written, oral or in an audio-visual form that are being synthesized by the instructor and learner as derived with an ultimately comprehend conclusion. Teaching a management subject to the engineering students with a different background require a comprehensive and detail explanation to ensure their understanding on the subject matter. Thus, an application of the real case scenario was considered as the effective way to understand the application of the theory learned with the real situation in today's business. The real case scenario will give an opportunity for the students to understand the issues and developed the method of problem solving based on the real case scenario of any organization, community, or individual cases. Many learning activities has been developed in the class by using the real case scenario such as the synchronous learning of online quizzes, simulation case, case presentation and other activities. While for asynchronous learning it is more towards the coursework assessment of group project and individual assignment. Henceforth, the aim of the study is to enhance the student knowledge on Engineering Management subject by using real case scenario associated with business and risks. The real case scenario application enhances student's knowledge and improve student's engagement skill whilst optimize their blended learning [3]. Additionally, the real case

scenario application encouraged the awareness of the students on the real-world business issues and problem associated with technological advancement, risks, and global economy issues. Students able to articulate idea, communicate effectively based on the situation and develop their own idea to solve the issues addressed based on simulation case and the organization project [4]. Adopting business simulation and case scenario will enhance student's generic skill such as critical thinking and decision making, and it is proven as a successful strategy in teaching and learning.

RESEARCH METHODOLOGY

A survey was conducted by using web-based questionnaires such as Google Form which consists of open and close ended questions. The form was distributed to 85 students in Engineering Management class. This study adopted qualitative data analysis to examine the students understanding and knowledge enhancement by using real case scenario in studying the Engineering Management subject. Thematic analysis was used to analyze the qualitative data. Open, axial, and selective coding was being adopted to derive with the main theme of knowledge enhancement in this subject.

MAIN RESULT

In this study, the data was being analyses by using the grounded theory method as the procedure for qualitative data analysis. The first procedure started with the development of the categories of information collected. Apart from that, the themes have been identified based on the open, axial, and selective coding. Consequently, the core variables of the study have been identified based on the grouping themes of knowledge, experiential learning and problem solving based on selective coding.

Table 1. List of theme development based on the study findings

No.	Theme Category	Theme	Code
1.	Knowledge	Experience	I can relate with real business case
		Enhance Knowledge	I learned a lot through the case given
		Theory Application	Apply the theory to real practice
2.	Experiential Learning	Real Time	It is related with real situation of the current business and issues
		Simulation Approach	I can learn real business strategy
		Practicality	Apply the theory to case study
3.	Problem Solving	Decision Making	I feel confident with the decision
		Critical Thinking	Able to reflect think independently
		Creativity Skills	Come with something new that has never been done before

The study had come out with the result that the application of real case scenario in teaching and learning for Engineering management subject is a suitable approach to increase knowledge and influence positive effect on the student's understanding of the subject. The approach of real case scenario will develop the student's understanding by applying the theory learned and linked with the strategy and decision-making process. Based on the findings, many of the student's agreed that

their understanding on the subject has been developed with the learning activities either through synchronous or asynchronous learning based on the assessment given during the learning session. The other theme developed from the study which is experiential learning also considered as the best learning outcome achieved in this subject. The students can experience the real situation of business process and concept with the meaningful learning activities during class such as quizzes, company case study, group project and presentation and business simulation in class. It was indicated that the learning activities able to develop the problem solving and decision-making skill by enhance the critical thinking to analyses the scenario and generate the solution based on the factors of technological societal challenges and opportunities in business. Students can understand the logical relationship between the ideas generated during the learning activities and able to solve problem of real case scenario in a systematic way.

CONCLUSION

Adopting a real case scenario application in teaching and learning in Engineering Management subject has proven to be the most effective tool to enhance student's generic skill such critical thinking, decision making process and problem solving. Several generic skills have been developed from the learning activities especially during the synchronous learning of online quizzes, business simulation, case study and project-based learning. Findings shows that majority of the students agreed that the learning activities enhanced decision making skills given the scenario of the real case that need to be analyses. The study would like to suggest for the future research to be conducted by measuring the level of the application of the real case scenario to the students while they are undergone their internship placement. This is to ensure the students can apply all the knowledge, experiential learning and problem solving in real situation of a business and organizational operation during the internship placement and as an evaluation of the achievement of the program learning outcome for this course.

Acknowledgment: The authors would like to express their appreciation for the students of Section 1 and 2 of Semester 2020/2021-01 of Engineering Management (SHAS 4542) for their corporation on the responses collected from the questionnaire distributed throughout the semester.

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ONLINE JIGSAW FOR PROBLEM-BASED LEARNING USING E-LEARNING MOODLE

Nor Aini Zakaria*, Muza Mokji Syed Abdul Rahman Syed Abu-Bakar, Zaid Omar and Khairul Hamimah Abas
School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, Johor Bahru, MALAYSIA.
(*norainiz@utm.my, mmusam@utm.my, e-syed@utm.my, khairulhamimah@utm.my)

ABSTRACT

People all over the world has being affected by corona virus disease 2019 (COVID 19) and changed their behavior unexpectedly. In order to avoid the virus transmission, it has indirectly change the learning behavior in teaching and learning from face-to-face to online environment as an alternative to avoid the disease. . The objective of this paper is to describe the used of Jigsaw method in implementing the problem-based learning from face-to-face to online course using Universiti Teknologi Malaysia(UTM) E-learning Moodle, in Digital Signal Processing course. The paper discusses the method, challenges and opportunities that were found to be common to the implementation of Jigsaw method online.

Key words: Problem-based learning, Online Jigsaw method, Online active learning, E-Learning portal

INTRODUCTION

Collaborative learning is a method of teaching and learning in which students were team together to explore a significant question or create a meaningful project. Cooperative learning is a specific kind of collaborative learning. In cooperative learning, students work together in small groups on a structured activity. They are individually accountable for their work, they work of the group as a whole is also assessed and they learn to work as a team. In small groups, students can share strengths and also develop their weaker skill, which indirectly could develop their interpersonal skill, and could learn to deal with conflict. If cooperative groups are guided by clear objectives, students engage in numerous activities that improve their understanding of subjects explored.

Cooperative learning an active learning technique that has been extensively studied and proven to be effective in helping students to learn and give them feedback about their current performance and provide chances for improvement [1]. In engineering area, it is a must for all students to engage with the problem base project to challenge them with a complex, and real-world problem and also to ensure students could collaborate and work in teams in understanding the problem and propose solutions. In order to provide students with the knowledge to identify the know-how information, analyses the nature of the problem and able to apply the lesson learned in generating ideas for possible solution, we propose to use non-convectional activity in the cooperative learning strategies.

Cooperative learning is an instructional method in which students work in small groups to accomplish a common learning goal under the guidance of the teacher. The Accreditation Board for Engineering and Technology (ABET) emphasizes six professional skills to be integrated in the undergraduate curriculum that includes communication, teamwork, understanding ethics and professionalism,

engineering within global and societal context, lifelong learning, and knowledge of contemporary issues, project management and critical thinking [2]. Strategies can be used both in pairs and groups and are designed to fulfill all principles. This method enables the students participating in class activity, they may practice and hands-on directly able to apply what they had learned in class. This method indirectly empowers students to learn more compared to the conventional method [3].

The corona virus disease 2019 (COVID-19) pandemic introduced an unexpected in human behavior globally. It has indirectly affected many organisms and processes by changing the behavior of humans to avoid being infected. The pandemic also changed our learning behavior by affecting the relative importance of information and forcing teaching and learning into a framework that accommodates human behavioral measures to avoid disease transmission. Ultimately, these changes in our learning behavior led to the migration to the online environment as an alternative way to avoid disease transmission.

Although e-learning has gained acceptance in universities around the world, the UTM started to develop e-learning center as an application under the umbrella of the UTM Cyber Campus project, was implemented back in 1998 by the Ministry of Education. When it was first implemented, e-learning was known as virtual learning [5]. E learning provide an easy access platform to students and lecturers in UTM on their subjects throughout the semester. By implementing e-learning, students were granted access to sources of information and knowledge that were uploaded and updated by the lecturers. To assist students and lecturers to use e-learning, some application model prototypes were created and developed, such as an examination system, quiz, electronic lectures and a forum.

Before the pandemic, face-to-face classes facilitated the learning process. The problem-base assignment was distributed through the e-learning system, and the presentation were happening face-to-face in class. The active learning activity such as Jigsaw could increase student engagement through group work that facilitates peer-to-peer learning, efficiently be handled in class. Keeping students engaged in online general education courses may present a particularly difficult challenge, especially for courses that rely on class discussion for students to master course content, develop the skills necessary for reasoned debate, and enhance their oral and interpersonal communication skills [3].

The objective of this paper is to describe the used of Jigsaw method in implementing the problem-based learning from face-to-face to online course in Digital Signal Processing course. This study involved third year students of Bachelor of Engineering (Electrical-Electronics) Program from the School of Electrical Engineering, UTM who registered in Digital Signal Processing course in 2019/2020-2 academic sessions. All groups from different sections under different lecturer's supervision were allocated with the same course learning outcomes (CLOs). Basically, there are four CLOs that stated in the course information (CI) for Digital Signal Processing, which are: CLO1 - Apply the concept of discrete signal processing; CLO2 - Analyse complex engineering problems in signals and systems using discrete signal processing; CLO3 – Solving complex engineering problems that involve digital filters using software; and CLO4 - Communicate effectively. However, only two CLOs will be underlined in this study, CLO3 and CLO4. The paper discusses the method, challenges and opportunities that were found to be common to the implementation online JIGSAW strategy.

METHODOLOGY

In this study, involved third year students of Bachelor of Engineering (Electrical-Electronics) Program from the School of Electrical Engineering, UTM who registered in Digital Signal Processing course in 2019/2020-2 academic sessions. There are four sections, in total 140 students under supervision of different lecturers were participate in this study. To assess the CLO3 and CLO4. A problem-based assignment was introduced in the SKEL4223, Digital Signal Processing(DSP) course. This is mainly to serve CLO 3 and CLO 4 to make sure students will be able to use software in solving DSP problem and for students to communicate effectively in delivering the solution for the given problem respectively.

The assignment was distributed to the students in phases to assist them in discussing and analyzing their understanding in solving the given problem through UTM E-learning portal. Referring to the assignment timeline as shown in Figure 1, the activities for the assignment were divided into two phases with the duration for each phase is four weeks long. In Phase One, students will apply their knowlege on MatLab/SciLab functions that can be used to implement and analyze a Linear Time-Invariant system. Students who enrolled this course had learnt how to use MatLab in their first year of degree, however, to refresh and assist student with the assignment, notes regarding MatLab for DSP were provided to the student. Due to some student could not access to MatLab for some reasons, student were allowed to use the open access software, which is similar to MatLab; SciLab. In Phase Two, students were use the MatLab/SciLab functions as a tool to help student in analysing and solving the filtering problem.

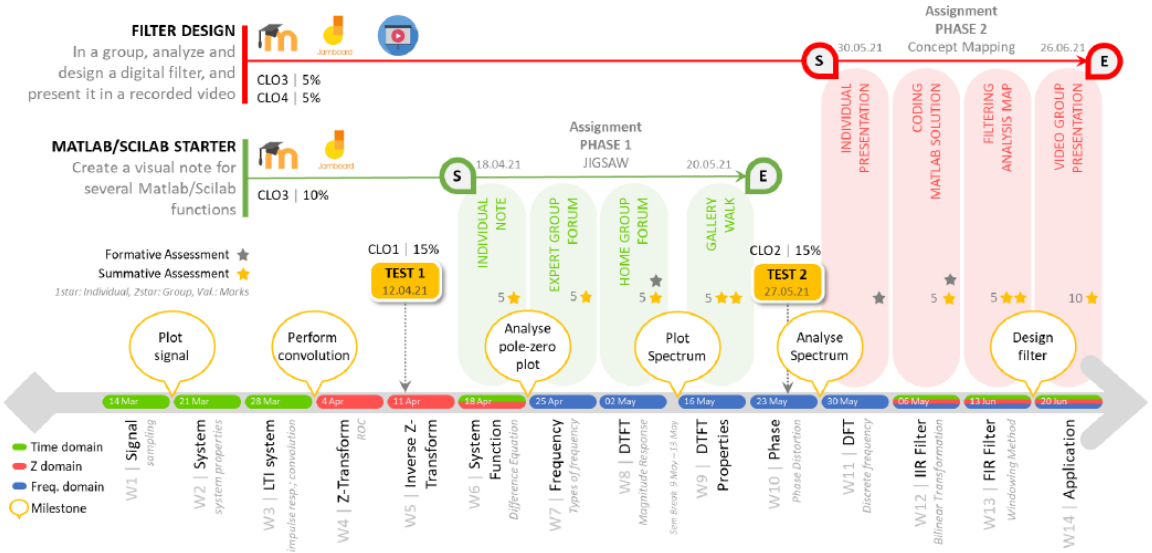
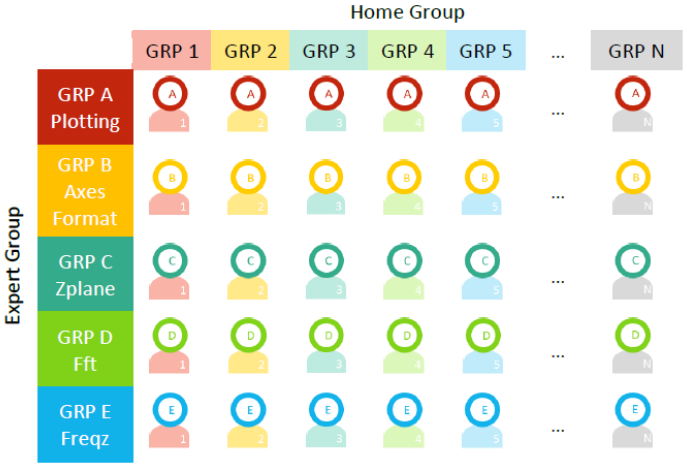


Figure 1. Assignment Timeline.

The assignment was conducted in grouping. To implement Jigsaw method in this assignment, each student is randomly assigned to two types of group, namely Home Group and Expert Group as illustrated in Table 1. Basically, within the home group, each student will explain their assigned topic to the other group members. Before that, the students will learn together within their Expert Group about the topic. The discussions and information sharing among the home and expert group member were done using *Forum*; which is one of the functions provided by the UTM E-Learning portal. Before pandemic, students are able to do Jigsaw activities in class, they would do the discussion among Home and Expert group physically, and present the result to their respective group physically. Teacher would monitor the activities and assists student throughout the discussion by visiting each

group during the session. In implementing the Jigsaw online with the help of UTM E-learning portal, the assignment was assigned to students through the *Assignment* function in the portal. The students were also divided into Home and Expert group randomly, by the portal. To ensure the Jigsaw activities success, the *Forum* function in the E-learning portal was utilized as a platform for the student to do their discussion whether in Home or Expert group. The will share their ideas, videos, mind-map and others in order to reach their agreement for the final project assignment. Student's information sharing, comments and discussions among their group members in improving their assignment were monitored by the respective lecturer. Team working assessments also were done through this forum. All activities throughout the assignment were conducted using UTM e-learning portal.

Table 1. Students grouping



CONCLUSION

From the observation, students were successfully do their discussion through the *forum* discussion session in phase One using Jigsaw method. Although student could not meet their group member face-to-face, the discussion was fruitfully since students are more open to feedback from a peer than feedback from the teacher. Distributing the assignment into phased could assist student to solve the problem step by step, however, it is resulting a lot of works to be submitted. As for the teacher, monitoring the online-Jigsaw assignment to a big number of groups is not easy. This affects the effectiveness of the activity. Therefore, this method is not suitable for a big size of class since teacher need to do a lot of evaluation in phases for each student. The truth be told, engaging students is a two-way communication, no matter what the technique or venue. As for the other instructional techniques, there are advantages and disadvantages in translating these engagement strategies to an online environment. Notwithstanding the foregoing, students generally satisfied on how the lecture was delivered during the online teaching period. As online learning becomes essential during the pandemic, and a common there can be pressure to emphasize its cost-saving potential through teaching larger classes with little student interaction. Understanding the strengths and pitfalls of how to engage students online continues to motivate the authors. Moreover, as cultures evolve toward more virtual interaction, these engagement techniques may become more broadly applicable as ways to create and sustain all types of social bonds. Figuring out how to create online communities of interaction and shared responsibility thus becomes even more critical to developing more sustainable modern societies. To improve the online teaching and learning for the next cycle of this course, teacher will use Jam board Google Function in Google to replace the Gallery Walk activities during face-to-face class in monitoring student's activities.

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KNOWLEDGE ACQUISITION OF RENEWABLE ENERGY INTEGRATION SYSTEM DESIGNING USING CONSTRUCTIVISM LEARNING THEORY

Norzanah Rosmin
Centre of Electrical Energy System (CEES),
POWER Department, School of Electrical Engineering, Engineering Faculty, Universiti Teknologi Malaysia, Johor, MALAYSIA.
(*norzanah@utm.my)

ABSTRACT

This paper presents a specific methodology for the knowledge acquisition of a hybrid renewable energy system designing using Constructivism learning theory. To help students mastering this designing skill, Five "E" Constructivism Model learning theory was considered to help the students construct their own knowledge and find practicality of the learning process. This however has been imposed for a subject named SKEE4663 Electricity for Sustainable Energy, and Hybrid Optimization Multiple Energy Resources (HOMER) software was used to achieve the learning outcome. During the learning process, it has been observed that the knowledge acquisition can be gained dynamically constant using this method, whereby the subject and modelling principles can be developed and experienced deeper and wider over time. Using the Five "E" Constructivism Model implementation, students have been found able to design the hybrid renewable energy system successfully (either for off-grid or on-grid system using HOMER software) in 3-week time.

Keywords: Knowledge acquisition, Renewable energy subject, Constructivism learning theory, HOMER Software, Five E model.

INTRODUCTION

As a signatory to the Paris Agreement and to support the Kyoto protocol, Malaysia has committed to reduce the greenhouse gases emission intensity of GDP by 45% by 2030 [1]. Therefore, Malaysian Government has set an ambitious aim for achieving a higher penetration of Renewable Energy (RE) in the Malaysian energy mix. Nowadays however, energy mix for Malaysia power generation is primarily supplied by natural gas and coal, and only 2% of its energy is supplied from RE generation sources. In the eleventh Malaysia Plan (2016–2020), Malaysia has put the target to promote and encourage the development of reliable and affordable renewable energy generation and reducing the energy dependency on fossil fuels. To respond to this national call, authors in [2] has suggested that RE subject should be organized in school and university levels to educate young people regarding the importance of RE awareness and its related technical knowledge in Malaysia. Thus, a subject named SKEE4663 Electricity for Sustainable Energy has been developed and offered to the final year students at School of Electrical, Engineering Faculty, UTM as an elective subject, in supporting this effort. This subject was designed to give an overview of energy resources such as conventional and non-conventional energy resources, with an emphasis on electrical energy system as well as understanding of demand growth, impact on environment and energy sustainability. Students also introduced to the method how energy efficiency measures and demand side management (DSM) options can be implemented in the residential, commercial, and industrial sectors to reduce the total

energy consumption in our country. After completing these sub-topics, students will be asked to model a hybrid renewable energy system using HOMER software. At the end of the course, students are expected to be able to design an RE system installation for both off-grid and on-grid connected system, apply and critically evaluate the energy resources potential and DSM options, and justify the best choice based on cost benefit analysis. It is therefore, through this subject, it is projected graduates who were taking this subject will have sufficient technical knowledge and experience of designing RE systems. As consequence of this, it is hoped that this competent graduate can support and help Malaysia to further accelerate the progress of RE power plant development in Malaysia, towards achieving the national renewable energy mix target. Therefore, the methodology used for the knowledge acquisition of a hybrid RE system designing using Constructivism learning theory is used and presented here.

LITERATURE REVIEW

Traditionally, basic learning theory consisting of three main elements, called as behaviourism, cognitivism and constructivism [3]. The difference between these three theories can be defined as: (1) Behaviourism defines learning as the acquisition of a new behaviour or change in behaviour, (2) Cognitive defines as learner processes the received information, rather than simply responds to stimuli, and (3) Constructivism defines that learner constructs his own vision of the world, based on his individual experiences and knowledge. In this paper, the knowledge acquisition on hybrid RE designing will be emphasized in the context of constructivism theory as this theory is believed to have a profound and effective effects on the learning objective. In [4], author quoted that Constructivism is 'an approach to learning that holds that people actively construct or make their own knowledge and that reality is determined by the experiences of the learner'. This elaborates that leaner will enhance their skills through experience that is influenced and obtained by interaction of the prior knowledge and the new knowledge or actions. Furthermore, in [5], authors have stated that students have better chances and responsibilities to handle or manage of their learning in a constructivist classroom. To accomplish the Constructivism model, five constructivist principles can be employed to help instructors design a course that supports the students build their own knowledge and experience instead of being passive receptors of information, and finally discover the practicability of the imposed learning [6]. The five elements also usually referred as 5 "E" theory where elements involved including Engagement, Exploration, Explanation, Elaboration and Evaluation [7]. This model was first created by Robert Karplus and the learning circle involved three consecutive phases known as the exploration, concept introduction and concept application. However, it then has been revised and expanded to be five elements to give greater impacts in science education, better reasoning skill and enhanced process skills than would be the case with the traditional instructional approaches.

APPLICATION DESIGN

The 5 'E' Constructivism learning circle model shown in Figure 1 is an instructional model based on the constructivist approach that implemented to provoke knowledge acquisition of RE integration system designing in subject SKEE4663. To encourage students to learn system design faster and convenient, HOMER software was proposed under this course. HOMER is a free software application developed by the National Renewable Energy Laboratory in the United States. This software application is used to design and evaluate technically and financially the options for off-grid and on-grid power systems for remote, stand-alone, and distributed generation applications. HOMER was chosen due to its simple approach, serve friendly environment, free for 30-day trial student version, but able to demonstrate significant impacts on the design skills and design process experience. The 5 "E" model as depicted in Figure 1, constitutes five discrete elements named: Engagement;

Exploration; Explanation; Elaboration and Evaluation. The phases of 5 "E" learning circle model are further described below:

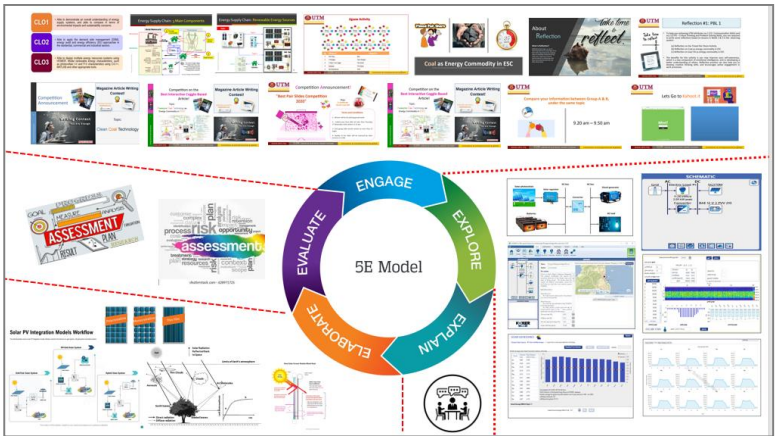

Figure 1. The 5 'E' Constructivism learning circle model for Hybrid RE System Designing Skill

Engagement phase (E1): In this phase, instructor sets the course learning outcomes (CLOs) with an engineering phenomenon. In the CLOs, students are incited to set goal for the skills they develop with the "Able to" statement. In SKEE4663 subject, three CLOs have been imposed. In CLO1, students are expected to be able to demonstrate an overall understanding of energy supply systems, and able to compare in terms of environmental impacts and sustainability concerns. To achieve CLO1, instructor begin to give the basic knowledge on the conventional and renewable energy sources such as solar, wind, biomass, biogas, ocean and tidal, geothermal, nuclear, hydro. Student will be exposed to the principle of the operational systems and its components, technology advancement, and its impacts to the environment. While to achieve CLO2 (students able to apply the demand side management (DSM), energy audit and energy efficiency (EE) approaches in the residential, commercial, and industrial sectors), students are exposed to the introduction of energy efficiency measures, energy audit and 5-step DSM implementation in all sectors. In the CLO3 (3-week), students are expected to be able to design multiple energy resources systems using HOMER Software. In all topics of CLOs, instructor will assess the students' prior knowledge and help them become engaged in a new concept with short active and cooperative learning activities that generated enthusiasm and accessed prior knowledge. Example activities including timed pair share, gallery walk, jigsaw and compare notes/slides. To encourage students' motivation, several competitions have been done such as best pair slide competition, magazine article writing contest and best interactive coggle-base article. To create a cheerful learning environment, games using Kahoot also used while to encourage students to work in an interactive way, Jamboard and Coggle were also used. Through the planned activities, students begin to make connections between previous knowledge and the present learning experiences. This process of engagement helps assess current understanding, establishes the organizational groundwork for the lesson ahead, and stimulates student involvement in the anticipation of learning RE supply chain. This is the opportunity to grab the students' attention and get them excited about what they will be learning.

Exploration phase (E2): In the Exploration stage, the students directly explore the topic of the lesson and related materials. These activities are experiences that ground students in the lesson. Students will work in group to allow and encourage them to help with and learn from others. But, at some stage they can work independently also. For example, to design a hybrid solar, wind and battery stand-alone system, students need to work in group whereby they need to discuss among themselves where plant location should be chosen, what are the components involved, which one is in AC signal and DC signal, how load will be fulfilled, and etc. But, at other situation, students need to explore the HOMER Software manual by him/herself to enable they explore how they can use HOMER to model their

hybrid RE system. They can do the modelling by themselves and then compare the developed model with the team members, or perhaps, some of them prefer to do the modelling together. As the outcome, students can build a common understanding of the topic of the lesson. During group work, instructor facilitate them in which facilitator will provide materials and guidance but allow the students to guide their inquiry. Facilitator will ask questions to stimulate students' thinking or give support, but exploration is about students' discovery. Direct instruction should be minimal, if at all. Students also encouraged to find supporting materials from the open source as well, such as videos that could help them understand faster the subject contents by visualize simulation.

Explanation phase (E3): In this phase, the students begin to put the experience of the activity into a communicable structure. Students may need to articulate the process they used, the sequence of components, their thought processes (which block/components should be considered and connected first, what location or data should be chosen, what is the power rating for the inverter, what is the size for the battery, and etc) and results. When students got results from their simulation work, they do not know either their results are correct or not. So, they need to validate their model by communicating with peers and the facilitator during in and outside of class time. Again, working in groups, students support each other's understanding as they articulate their observations, ideas, questions, and hypotheses. Explanations from the facilitator, an expert, can aid novices with acquiring and using language to articulate their learning.

Elaboration phase (E4): In this stage, students expand on the concepts learned, make connections to other related concepts, and apply their understandings to their world. For SKEE4663 example, while student exploring the solar radiation phenomenon, student constructs an understanding of the intensity of solar radiation will be influenced at a given location depends on the geography location, season, time of day, and atmospheric conditions. Examining the terrain, weather, and other obstacles such as cloud, building and trees, student may notice that the shadow of the building/trees changes the intensity of radiation on the photovoltaic (PV) panel. Then, how about the PV output efficiency? How if solar radiation too high? How charger controller acts? This observation can lead to further inquiry as to possible connections between the shadow's changing location, the changes in direction of the sun, and the importance of solar charger controller. Applications to real-world events, such as where to install PV panels, how many panels should be considered, what is the best array configuration, where should inverter or converter is connected between the energy sources, do they need to use DC load or AC load, how can they choose the battery size and type, and many more questions will be erupted on their mind. These connections often lead to further inquiry and new understandings.

Evaluation phase (E5): The evaluation phase is an on-going process of assessing students' understanding and knowledge of concepts. In SKEE4663 subject, useful feedbacks were given from time to time, to enable students do the improvements and modifications to the lesson for next time. Formal and informal evaluation and assessment are involved, like posing questions for students to answer in class or listening in on conversations that groups are having during the activity. In this subject, assessments involved are final exam, tests, report based on the project-based, and assignments. Tools such as rubrics and reflection are used in evaluating outcomes.

FINDINGS AND DISCUSSION

Based on the 5 "E" Constructivism Model that has been adapted into SKEE4663 subject in order to achieve CLO3, in has been found that the knowledge acquisition of renewable energy integration system designing has been discovered via the assessment result and also the observation experience. In Table 1, the knowledge acquisition effectiveness can be discovered by referring to the key performance index (KPI) achievement that has been set by the university. For UTM, the minimum

KPI for engineering faculty is 0.65 (Premiere program) and 0.5 (SPACE program). Table 1 depicts the KPI of the set CLOs for cohort 20202021 semester 2. For CLO1 and CLO2, they have been mapped with the program outcome, PLO1 and CLO3 has been mapped to achieve program outcome PLO5. Results indicates that the CLO3 (for RE designing skills) is 0.84, which is obviously higher than the minimum KPI targeted by UTM. In Table 2, the distribution marks for the report submitted by all six groups based on the students' hybrid RE designing project is depicted. As highlighted in the dashed box, it refers to the KPI achieved on the understanding and knowledge quality of the hybrid RE system designing skills. Results indicates, high performance of effectiveness has been achieved.

Table 1. CLO AND PLO Achievement

CLO1	0.76	CLO2	0.65	CLO3	0.84
PLO1				PLO5	
0.74				0.841	

Note: PLO1 = Ability to apply knowledge of mathematics, science, and electrical engineering to the solution of complex engineering problems. PLO5 = Ability to design solutions for complex system, component, or process within a defined specification that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

Table 2. Marks for CLO3's Report

Criteria	Allocated Marks	Achieved Marks						KPI
		G1	G2	G3	G4	G5	G6	
Scenario	5	5	5	5	5	5	5	0.500
Methodology	10	7	10	8	9	9	8	0.850
Results	10	7	9	7	10	10	6	0.817
Analysis & Discussions	10	6	6	8	9	8	5	0.700
Writing Style	10	8	9	8	9	8	5	0.783
References	5	5	5	5	5	5	5	0.500
Total Marks	50	38	44	41	47	45	34	

From class activities observation, under SKEE4663 Electricity for Sustainable subject, students can think more critically, thinking bigger even in a small box, and more geared to seek alternative ideas and creative solutions, in the context of engineering design study, particularly on the subject of designing hybrid system of RE system. Through the provision of technical expertise provided by this subject, the adoption and success of hybrid RE designing project was facilitated. Final year undergraduate students more or less can benefited in terms of hands-on experience in helping them to bring the designed project experience to life, getting on the knowledge and skills they had acquired throughout the designed subject.

CONCLUSION

To create a learning conducive environment and to be a constructivist instructor, one needs to provide a Constructivist classroom that allow students to take responsible over their learning, hence students will be able to obtain better opportunities to plan and experiencing their learning. Using the proposed 5 "E" Constructivism Model embedded in the SKEE4663 Electricity for Sustainable subject, the knowledge acquisition of renewable energy integration system designing using HOMER Software has been indicated to understand and apply the knowledge. From the subject assessment, it has shown that students were able to design the hybrid RE system in 3-week time through the

interaction of the prior knowledge with the future events that are crossed in their minds while designing the RE system.

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VIRTUAL CAPSTONE: ENGAGING FACILITATORS AND STUDENTS

Musa bin Mohd Mokji, Lim Cheng Siong , Suhana Mohamed Sultan*,
Rashidah@Siti Saedah Arsat and Zulkarnain Ahmad Noorden
School of Electrical Engineering, UTM Johor Bahru, MALAYSIA.
(musamm@utm.my, lcsiong@utm.my, *suhanasultan@utm.my, rashidaharsat@utm.my,
zulkarnain-an@utm.my)

ABSTRACT

The capstone design project in the School of Electrical Engineering is a compulsory course for final year undergraduate students. This course is offered to produce community-cognizant individuals who are able to address community or industry based problems using appropriate techniques, skills, and modern engineering tools. In addition, elements such as project management and teamwork in diverse teams are included and assessed throughout the study. The course was originally offered in a face-to-face format. In the new norm version, an online course was developed for 14 weeks, intended to be as faithful as possible to the classroom version. This paper reports the design, delivery and assessment of the virtual capstone using Google Classroom as the Learning Management System. Google classrooms were used intensively to produce a centralized student-facilitator engagement platform for all the 85 participating teams. Besides, Google sheets were intuitively designed for facilitators to key in students' marks for periodical assessment. The system was also designed for coordinators and the lead coordinator to monitor the evaluation process. From the student and the facilitator feedbacks, they were satisfied with the online course delivery. Students' results also show a degree of improvement compared to the face-to-face implementation.

Key words: Capstone, Cooperative Learning, Google Classroom, Google Sheet

INTRODUCTION

In the current situation of pandemic, education from primary to university level is vastly affected globally. The closure of educational institutions raises challenges in students' learning. In this unprecedented time, the contribution of information technology has gained momentum and seen to serve solution for the ongoing learning process through innovative and learning management systems.[1] It provides opportunities for educators to implement digital solutions for teaching as well as evaluation for the completion of course work of students. More efforts are required to integrate pedagogy with technologies in order to enhance student learning.

Capstone Project is an Integrated Design Project for engineering students. This course was introduced in the School of Electrical Engineering(SKE), Universiti Teknologi Malaysia in 2013 as a compulsory laboratory course for 4th year students. It is conducted for SKE students in a small team facilitated by one academic staff and an industry partner as advisor whenever possible. Each team will consist of four students with different electrical engineering programme; Power, Telecommunication, Control & Mechatronics, and Electronics. Each team of students should provide solutions and working prototypes for real-life complex engineering problems for an industry or community.

In this course, cooperative learning approach that includes face-to-face interaction, positive interdependence and individual accountability are fully embedded.[2] In 2020, the face-to-face interaction in this Capstone Project is increased to 3-hour contact time with the facilitators. In

addition, students are required to prepare minutes of weekly meetings that encourage students to discuss with their teammates outside of class hours. Tasks among teammates will be equally distributed to solve a particular engineering problem. This is reflected in the Individual Report preparation among the students. Additionally, students also required to present their product as a team followed by completion of a group technical report at the end of the semester. The periodical reporting by the students enhances the positive interdependence and the individual accountability to complete the Capstone Project.

So it is important to design an online learning system that can embed all the cooperative learning elements in the Capstone Project. Though online learning platforms are gaining acceptability from educators and students due to its flexibility and controllable environment, students still suffer from social isolation, lack of face-to-face interaction, connectivity issues etc. [3] How can we break these barriers of social isolation?

Besides this, every year the Capstone Project receives over 300 students with 80 facilitators. It is imperative to integrate these students' work in a unified platform for ease of reference in the future. In addition, an online system that promotes student-to-instructor engagement is also essential.

Google Classroom is an application that allows the creation of classrooms online. Maman *et al*. have conducted study on the use of Google Classroom at a university at East Java, Indonesia. [4] It was found that maximizing the use of Google Classroom helps the lecturers to focus on delivering the materials to students and also evaluations and assessments can be carried out continuously online. In another work by K A'yun *et al*, Google Classroom feature allows collaboration between teachers and students in virtual classes as well as communicating through forums and face-to-face connections via Google Meet.[5] This work had conducted survey to vocational students in Indonesia and it was found that Google Classroom could easily be accessed by students.[5] Most students were also understood how to use the Google Classroom in learning because the interface is easy and friendly to use.

In another survey conducted by M.A.Khan *et al* on online learning platform, the data indicated the instructor presence does influence student satisfaction on the course. It was concluded in this study that student engagement increases student satisfaction, enhances student motivation to learn, reduces the sense of isolation and improves the students' performance in the online learning environment[6].

The review of literature reveals that most studies are undertaken to identify students' perception and attitude towards online learning platform as an individual learner. Studies related to designing online platform to encourage teamwork among students in a cooperative learning environment is still new.

The objectives of this work is to design an online learning system using Google Classroom for Capstone Project to promote student-student engagement through the tasks assigned in the project. This work also designed to continuously monitor the students' work and give feedback in real-time for improvement by the facilitators. In addition, the online learning system is used for the facilitator to evaluate their students' performance continuously using Google sheet. Finally, the aim of this online learning system is to be able to generate Course Assessment Report (CAR) automatically at the end of the semester.

APPLICATION DESIGN

A total of 333 students registered for this course in 2020. The students were teamed up into 85 teams managed by four coordinators. There are three main engagements to be promoted; student-student interaction to complete certain tasks, student-facilitator discussions on project and assessments, and

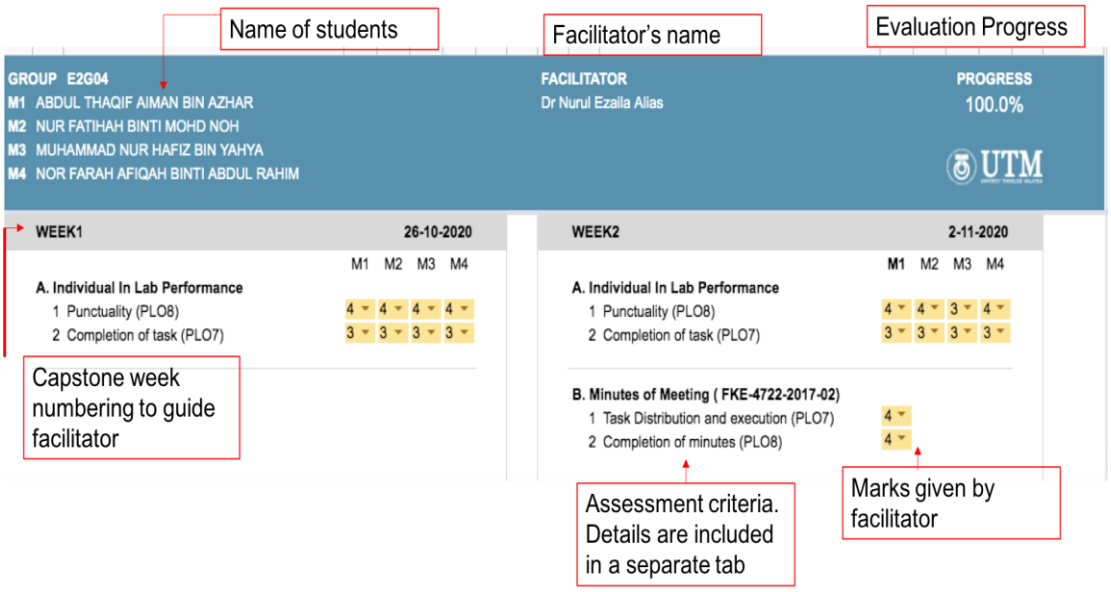
facilitator-coordinator engagement to monitor the facilitators' evaluation progress. It is essential to monitor these different types of engagements weekly after each meeting with the students.

Google classroom is like a virtual extension of a real classroom. It starts with creating classes and adding students. In this work, each classroom represents each group. The teacher is the facilitator of that group shared with the course coordinator. Every week, students need to complete tasks such as minute of meeting(MoM) writing, individual reports, bills of material (BOM), updating Gannt Charts etc. The Google Classroom was sectioned based on 14-week tasks.

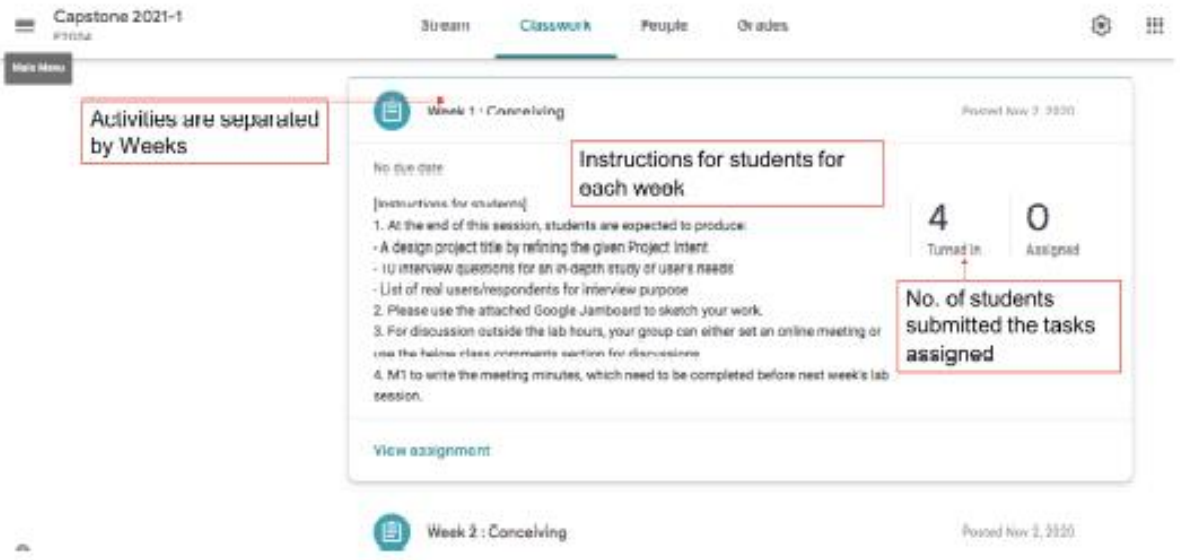
On the other hand, Google sheets are used by the lecturers to monitor different aspects of the Capstone Project as the followings:

1) Google Sheet for the Lead Coordinator - to monitor the progress of Course Learning Outcome (CLO) achievement of all registered students.
2) Google Sheet for Coordinators – to monitor the progress of evaluation progress in the respective coordinator's division (Power, Control and Mechatronics, Telecommunication, Electronics)
3) Google Sheet for Facilitators – to assess their respective students weekly.

Figure 1(a) shows an example of the Google sheet designed to assist the facilitator in keying in marks based on weekly tasks. Figure 1(b) shows the Google classroom interface, which promotes interaction between the students and the facilitators through various applications such as Jamboard and Google documents.



(a)



(b)

Figure 1. (a) Google sheet developed to monitor students' progress
(b) Google Classroom interface to promote student-facilitator interaction

FINDINGS & DISCUSSION

At the end of the course, feedbacks were collected among students and facilitators involved. Table 1 shows some of the feedback from the facilitators and students when asked which online features are valuable.

Table 1. Feedback received from students and facilitators on the use of Google Classroom

Students' Feedback	Facilitators' Feedback
" google classroom because it helps me a lot by giving step by step every week."	"As one of the capstone facilitators, I have used the capstone online system provided by the coordinator, and I found that the system is really easy to use. And I think that the system could be very beneficial for all course coordinators to help them to prepare for the course assessment report in order to be presented to the CQI committees at the end of every semester."
" Google Classroom itself is better than using words."	
"Google classroom was so useful to me especially in the first four weeks, data collection and clustering, minute of meetings and individual reports all were written and submitted using this platform, and it was simple to use. And the fact that everything was in one place makes it even better compared to face-to-face where you need to submit the papers to a specific place while you can simply just submit it online."	

In terms of students' grades, 50% of the students achieved A+ during the online version of capstone. This is a 10% increase compared to the previous session, where 40% achieved a grade of A+. The minimum grade obtained by students was B-, similar to the previous sessions. The results indicate

some degree of improvement in students' results. One of the factor for this improvement could be due to the students' higher quality project presentations compared to the face-to-face version as also reported in [7]. Besides, in the online environment, the facilitator can request the students to improve their work and can reconsider the resulting marks given. Our findings suggest that the key to a successful adaptation to the online version is how various course components are structured to encourage continuous engagements among students, facilitators, and course coordinators.

CONCLUSION

In conclusion, the virtual Capstone course was conducted successfully for 14 weeks for the first time. The important elements of cooperative learning in the Capstone course were still maintained without losing fidelity and energy among students. Google Classrooms were used intensively to produce a centralized student-facilitator engagement platform for all 85 participating teams. While it was observed both pros and cons in online implementation of this Capstone course, students' results show a degree of improvement compared with face-to-face implementation.

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