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CONTENTS

Performing Active Learning through Project Based Learning in Electrical and Computer Engineering Curriculum

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Abstract

Most of the subjects in higher education can be categorised as theoretical subjects. Generally, most students can pass with good marks in these fields. Conversely, they face difficulties to apply and integrate all of those knowledge to answer many problems in the society. Hence a new subject has been added in electrical and computer engineering department. Therefore the paper will analyse the implementation of the subject with active learning method through project based learning. The results have shown that most students actively participated in all learning activities. None of students failed to the subject. This learning method has been successfully implemented in small class, on the other hand it will be a challenge to apply in big size of class.

Keywords: Active Learning, Project based Learning, Engineering

1. Introduction

Generally speaking, curriculum for bachelor degree in the university has been set for three years up to four years study period. The same as in Electrical and Computer Engineering Department in Udayana University. Its curriculum has been set for four years study period with subjects can be classified as compulsory subjects and elective subjects. Most of the subjects are theoretical fields. Commonly, most students achieve good marks in the theoretical fields. However, they face difficulties to apply and integrate all those theories to solve many problems in the society. Therefore since year 2014, the Department has revised and updated its curriculum. A new subject has been added, namely 'Applied Information Communication Technology'. The subject is to assist the students to be innovative and creative as problem solvers for their society. Therefore in this paper will discuss the implementation of the subject which will focus on "how to perform active learning through project based learning in the subject?" Hence the paper proposed active learning accomplishments on the subject implementation.

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2. Active Learning and Project based Learning

When MOOC's tries to achieve its popularity in this modern era, there is a research found that face-to-face classroom cannot be thrashed by MOOC's as long as active learning approached is not accommodated well [Ubell, 2017]. Since active learning classes are proven to reduce number of undergraduate students of science, math, and engineering to fail the subjects, when compared to traditional lecture classes [Freemana, 2014], [Bhatia, 2014]. Many examples have been explained in [Bhatia, 2014], such as learn how to ride a bike, that active learning approach was more successful for students in mastering subjects, as the students engaged enthusiastically through series of accomplishment. They explains that STEM fields are still favourite choice for students in US. However more than half of them then shifted their major either to a non-STEM field or drop out of college. On the other hand in [Husamah, 2015] states that blended project based learning likely effectively to produce a professional biology teacher with future vision. The learning activity must meet learning characteristics which is part of active learning strategy, such as effective learning, thinking skills learning, and learning strategies.

Other paper states that students should be provided professional education for their future career [Srinath, 2014]. For that purpose, active learning has been picked as a mainframe tool for providing managerial and team skills to meet the Industrial and companies requirements, especially for Science, Technology, Engineering and Management (STEM) education. The active learning can be applied through practical examples in the classroom. Then according to [Songkram, 2017] that both creativity and innovative skills are very important in the 21st century. Both skills have to be output or outcome of learning process. An integration of modern teaching management with learning principles, such as using modern technology, is utilized to promote creativity and innovative skills. The integration is to create changes, at the same time as the current education emphasizes on creating changes. They proposed open learning that involves students, instructors, foreign students, foreign friends, and local and international experts who did information exchange at any time and any place. Seven steps of learning process were utilised, i.e. Preparation, Identifying a topic or issue to be studied, Brainstorm, Creating innovation, Testing, Evaluation, and Presentation. Moreover the major characteristics of active learning approaches is explained by [Bonwell, 2017]. The characteristics involves of active listening of the students; reading, discussing, writing activities; more developing on student skills; increase of student motivation; more exploration of attitudes and values; quick feedback from their instructor; and encouragement of higher order thinking (analysis, synthesis, evaluation). As long as the students have some challenges in the class by giving them some questions or problems, giving them time to respond, and encouraging them to share their responses / idea / solutions, either they work individually or in a group, this activity can be classified as an active learning process too [Felder, 2009]. Furthermore Authors [Bell, 2006] define that active learning objective is to build understanding of facts, ideas, and skills through the completion of lecturers or instructor directed tasks and activities. The discussion about applying new technologies of virtual learning environment for the project based learning on socio-health subjects is described in

[Márquez, 2014]. They used process and final steps of learning as assessment points with rubric, logs, and peer evaluation matrices as instruments.

In addition limited opportunity in higher education to practice how to innovate is discussed in [Gerber, 2012]. Therefore extracurricular design-based learning model is proposed to practice creating innovating solutions to authentic, pro-social, and local challenges in an extracurricular setting. They found that students build innovation self-efficacy through successful task completion, social persuasion, and vicarious learning in communities of practice with clients, peers, industry professionals, and faculty. The comparisons of project based learning with problem based learning implementation on Medicine and Engineering curriculum are found in [Bédard, 2012]. The students' engagement and persistence were analysed. Results presented a variation in nine variables predicting engagement and persistence, with the most significant predictor being stress related. Finally in [Guven, 2014] investigates an impact of project based learning method which was supported by prediction-observation- explanation method on attitude and behaviour towards environmental problems. The investigation used explanatory mixed method, such as Attitude Scale towards Environmental Problems, Behaviour Scale towards Environmental Problems and a semi-structured interview question for data collection tools.

3. Electrical and Computer Engineering Curriculum Revision

Electrical and Computer engineering department of Udayana University has updated its curriculum regularly based competency to prepare the students with skills of creativity and innovation. The curriculum revision is based on the Ministry of National Education of Republic of Indonesia guideline [DGHE, 2008], as seen in figure 1. The guideline also refers to the UNESCO's 4 pillars, i.e. (i) learning to know, (ii) learning to do, (iii) learning to live together, and (iv) learning to be and learning throughout life.

The project based learning method which is doing and developing projects systematically and presents the output in a forum or in a class, is recommended in the guideline. Starting with identification of graduate profiles, the curriculum of the department has been revised in year 2014. The profiles remain the same with previous curriculum [Linawati, 2013], i.e. to be a professional engineer, an academician such as teacher or researcher, an entrepreneur, a consultant, and a professional manager. However some new subjects are added in this curriculum. One of the new subjects is called 'Applied Information Communication Technology'. The subject is classified as one of compulsory subjects in the 7th semester or last year of study period. The subject syllabus is shown in table 1.

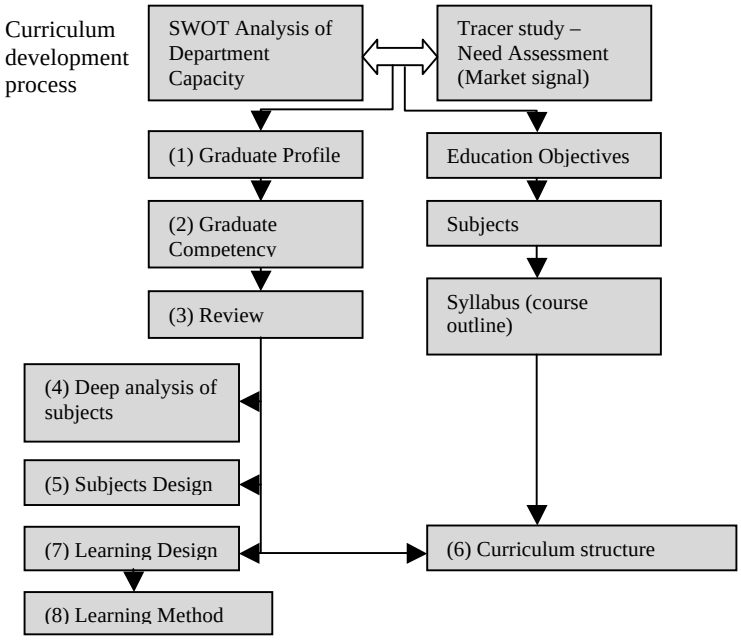

Figure 1. Curriculum Development Guideline [DGHE, 2008]

Table 1. Syllabus of Applied Information Communication Technology

Week	*Core Topic*	*Assignment*
1	Introduction of the subject	-
2	What are project, ICT project, and applied technology?	-
3	Identification of humanity, social problems, and environmental problems in the society	Explanation of mini project assignment
4	How to develop idea or solution for the problems?	Part 1 of the assignment: Discussion of students' short report of the public problems
5	Writing log activity of the project and discussion on innovative solutions using ICT	Part 2 of the assignment: Discussion of students' short report of their proposed solutions to the problems. Starting to write log activity as an attachment of the report.
6	Discussion on some case studies that proposed ICT solutions for humanity, social, and environmental problems	Part 3 of the assignment: Discussion of students' short report of prototype scheme
7	Discussion on how innovative the	Discuss and share part 1 to part 3 of

	students' proposals	students' short reports.
8	Design and simulation of the project	Part 4 of the assignment: Short report on prototype design and simulation scenario, such as schematic design, data flow diagram, flow chart, board design, database design, pseudo code, etc.
9	Discussion and evaluation of project design and its proposed simulation	Discuss and share part 1 to part 4 of students' short reports.
10	Budget and timeline of the project	Part 5 of the assignment: Short report on budget and timeline of the project.
11	Explanation on specification of prototype components and how to do prototype testing	Part 6 of the assignment: Short report on all components and their specifications for building the prototype.
12	Discussion on presentation of the project and demonstration of the prototype	Part 7 of the assignment: Poster for presenting the project. Video recording of the prototype testing
13	Discussion the whole project	Discuss the students' progress.
14	Discussion the whole project	Discuss the students' progress.
15	Discussion the whole project	Discuss the students' progress.
16	Examination	Presenting the project and displaying the prototype.

4. Active Learning Strategy and Project based Learning Implementation

An art and discipline can create innovation [Miller, 2007]. Thus skill to build innovation is also implemented for this subject. The skill is practiced by engaging the students to build simple prototype in one integrated mini project assignment. They actively identify the problems in the society and then propose simple solutions with high good impact to the society. Simple means that the project is realistic and practical to build as a student project and low cost budget. High good impact means that the project brings effective solutions. Table 1 shows that active learning is applied in this subject by encouraging student to develop prototype as one solution to society problems such as health problem, environmental problem, safety problem, etc. The prototype is an individual project. The objectives why the project is individual project, are, 1) to train and practice the student as a professional person to be a solution maker, and 2) to build students' understanding on knowledge to integrate all relevant subjects of the previous semester. One student has to do totally one mini project as one assignment. Two evaluations were designed. The first one was weekly evaluation through discussion of their progress. The second one was final evaluation by assessing their prototype and supporting documents (report, poster, and video).

5. Results and Discussions

The subject has been implemented for two years, starting from year 2015. Totally 65 students enrolled the class. Overall the students have shown their interest and excitement in this learning method. Most of their comments were positive. Below are some interesting projects of the students.

- Wireless hand band for kid's safety.
- Smart helm for motor bike rider.
- Smart assets monitoring and protection for museum.
- Parking Slot Finder System based on Web Application
- Adaptive traffic light for emergency services.
- Wireless detector for gas leakage.
- Smart pollution monitoring.
- Voice detection for parking system.

One of the project, i.e. 'Parking Slot Finder System based on Web Application' was a winner in national IEEE IOT Competition in year 2015. The prototype objective is to save fuel consumption for cars when they are finding park in a big city. Figure 2 presents the project of parking slot finder. The project is categorised as an innovative solution for transportation system in a big city and a low cost project as it costs only USD 153. Figure 3 displays the project poster.

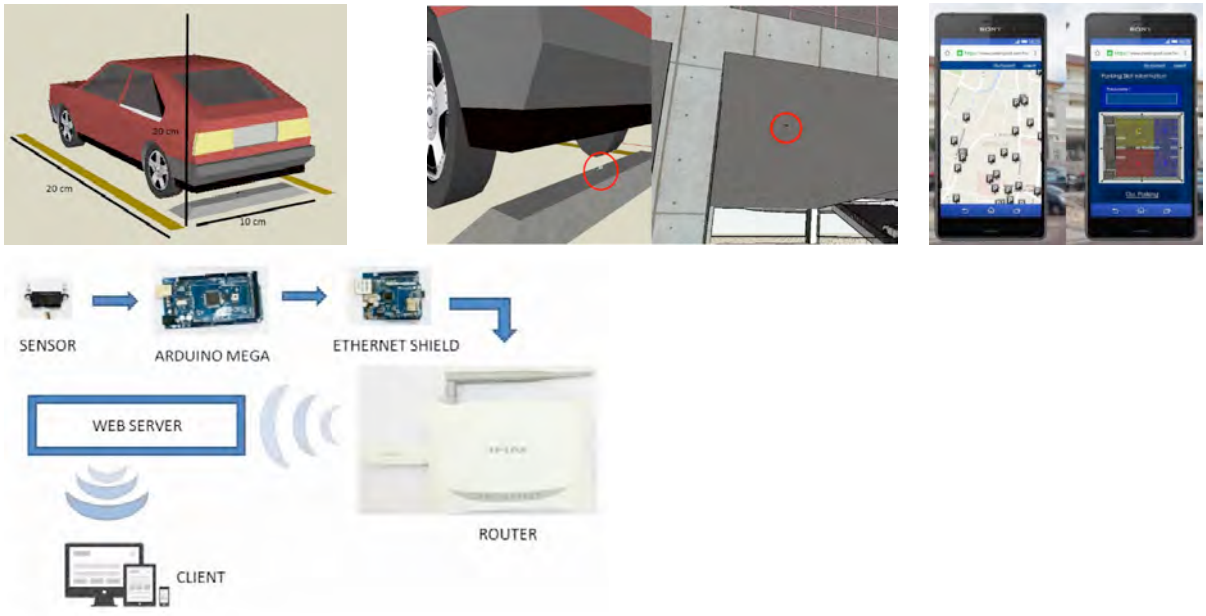

Figure 2. Prototype of the project of parking slot finder

Figure 3. Example of Project Poster

At the end of the course, most students obtained the highest score. More 80% of students got 'A' mark, the rest got 'B'. The explanation why students got 'B' mark is that their prototype did not worked properly. Although they demonstrated good design, suitable simulation, report, poster, and presentation. These results have evidenced that the course has provided the students with skills of innovation and creativity at the initial phase.

Finally, all students in the department must fill a questionnaire. The same type of questionnaire is for all subjects which has been standardised by the department to evaluate learning process of all subjects. The questionnaire has 17 questions or statements that are categorised into 4 groups. Nine questions are categorised as class implementation assessment, three questions as for appropriateness of learning contents assessment, two questions as for

quality of learning content assessment, and three questions as for learning output assessment. The students then can choose strongly disagree, or disagree, or agree, or strongly agree to the statement. The filled questionnaires then are statistically analysed. Table 2 shows the results.

Table 2. Evaluation Result of Learning Process

Group	*Categorization*	*Results (%)*			
		Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*
1	Assessment of class implementation	0	1	31	68
2	Assessment of appropriateness of learning contents	0	0	21	79
3	Assessment of quality of learning content	0	0	16	84
4	Assessment of learning output	0	0	22	78

In general, table 2 demonstrates that more than 60% of students strongly agree that they experienced beneficial learning process of the subject. The highest percentage of 84% is for the quality learning content. This indicates that the contents are very useful, very interesting, and innovative. The lowest percentage of 68% is for the class implementation assessment. This indicates that very few students still faced difficulties to obtain good references of the subject and they needed more assistance in learning process. Therefore the lecture should pay more attention on managing the class especially for 'learning delivery in the class for easy and better understanding by the students', 'increase tutorial for students who dealing with difficulties', and 'give more links and access to the references'. In summary, all evaluation results have shown that the learning process has successfully motivated all the students to be active learners.

6. Conclusion

Active learning through project-based learning method for subject of applied technology to engineering students have shown the students ability in creativity, innovation, discussion skill, promoting idea, and developing the idea. The method was successfully implemented in small class and it will be challenging to implement in big size of class.

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