Integrated learning and project-based learning for project of electrical measurement and instrumentations in electrical engineering course

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Abstract :
Using integrated learning and project-based learning can make correlation of knowledge and skills in order to make students apply the knowledge to become a new knowledge for creating project to be prepared for Thailand 4.0 with the topic electrical measuring instrumentation project with the Internet of thing. The research process divided into 3 parts: 1) topics analysis and objectives analysis for integrated learning 2) project-based learning for projects assignment and 3) Integrated learning and project-based learning. The sample were 18 4th year students in Electrical engineering manufacturing department, Bansomdejchaopraya Rajabhat University. The assessment stages were followed by 1) project proposal 2) project planning and design 3) project implementation 4) project evaluation and 5) project presentation and report. The result found that: students can create their electrical measuring instrumentation group's project from this learning method and the students' evaluation and feedback were agree with this learning model. In conclusion, leaning by using integrated learning and project-based learning can improve thinking skills, teamwork skills, use of technology and other skills related to their project topic such as microcontroller and computer programming also promoting students-centered and gives the opportunity to make discussion between students and lecturer to suggest and solve students problems.

Keywords: integrated learning, project-based learning, engineering project

Introduction

Due to Thailand has been facing lots of challenging problems such as, many of people living under the poverty, high level of inequality and living depend on the external technology (Puncreobutr, 2017). At present, Thailand was classified as a country driven by efficiency and classified as a middle income group. To developing the country in accordance with current situation need to develop in the field of research and development in technology and innovation (Office of the National Economic and Social Development Council, 2019). In 2016, Thai government announced Thailand 4.0 model which have focused on bringing the knowledge and updated technology to increase the ability, creating own technologies and innovation for driving the country to be free from the middle income trap to creating innovation requires knowledge, ability and creativity (Knowledge Management Institution, 2016). However, the important factor to make Thailand 4.0 success was to delivered the knowledge to the society because ecation is one of the important elements to improve the quality of human in order to be able to face the globalization and 21st century era (Shidiq and Yamtinah, 2019). Education has a function to shape one's and to raise dignity. In addition, education can ensure a better life. As time goes by, it challenges a person to have a good education. However, a good education was only seen in its results beside the learning process (Gerhana, 2017) from this reason educating the people in Thai society must come from cooperation of the education in university by adapting learning model in classroom (Chularut, 2018 ; Tanjitanont and Junoysuwan, 2016).

In learning model in education, the integrated learning is a learning model that combines two or more subjects to form a specific theme, integrated learning can enable students in learning, developing knowladge, thinking skills, social skills, and organizing skills (Fogarty, 1991) so the implementation of integrated learning can be increase students' literacy (Tsai et al., 2007) especially in engineering field which was an important field of national development. One of the efforts for the learning process which was predicted to be able to overcome these problems were through learning tools with the project-based learning model combined with the process skills approach. The process skills includes experimental skills, observing, measuring, and processing data (Jeenthong et al, 2014), classify, make hypothesis, control variables, make conclusions, implement, and communicate so this approach can support the implementation of the project- based learning model also project based learning model was a learning model that focuses on the activeness of students (Ergul and Kargın, 2014).

As problem mentioned, using integrated learning and project-based learning could correlation knowledge and skills together in order to make students apply the knowledge to become a new knowledge for creating project to be prepared for Thailand 4.0 (Wiboonyasake, 2018 ; Policy and Innovation Center, 2014 ; National Broadcasting and Telecommunication Commission, 2018). In this research bringing integrated learning and project-based learning for Electrical engineering course from the method mentioned to create an electrical measuring instrumentation project with the Internet of thing (IoT) technology as a guideline to create innovation for Thailand 4.0.

Research methodology

The research method for this research divided into 3 parts: 1) topics analysis and objectives analysis for integrated learning 2) project-based learning for projects assignment and 3) integrated learning and project-based learning.

Topics analysis and objectives analysis for integrated learning
In the first part, bringing 2 subjects integrated which were Principles of electronics subject and Electrical measurement and instrumentations subject for connecting the knowledge and concepts to create the necessary knowledge for students by way of selecting the most important and necessary topics for learning which focused on the apply existing knowledge, thinking skills, create creativity for improve learning outcome. In figure 1 shown the topics analysis method for integrated learning (Centre for Excellence in Learning and Teaching, 2017). Moreover, the other knowledge that related to students' project topic will be teaching too.
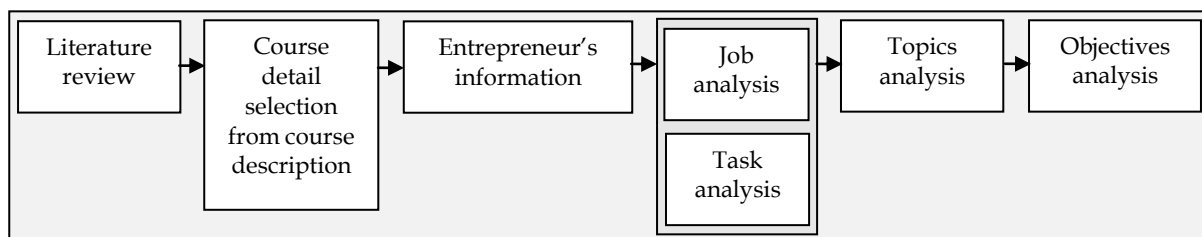

Figure 1. Topics analysis method

After analyse the topics from the above method to identify the sub-topics, objectives for integrated learning of both subjects, the result presented that in Principles of electronics subject, the topics was electronic devices the sub-topics were resistor, inductor, capacitor, diode, transistor, and integrated circuit. In Electrical measurement and instrumentations subjects the topic was voltage measurement the sub-topics were DC voltage measurement and AC voltage measurement, which were important topics and frequency used in the electrical engineering field. The objectives analysis of both subjects can be seen in table 1 and 2.

Table 1. Objectives analysis result of Principles of electronics subject

Sub-topics	Objectives
Electronic devices	A1. Writing an electronic symbol
	A2. Electronic devices classification
	A3. Describe the electronic devices internal structure
	A4. Describe the electronic devices properties
	A5. Describe the advantages and disadvantages of electronic devices.
	A6. Connect the electronic devices in a circuits
	A7. Calculate the electrical value in the electronic devices circuits

Note: electronic devices are resistor, inductor, capacitor, diode, transistor, and integrated circuit

Table 2. Objectives analysis result of Electrical measurement and instrumentations subject

Sub-topics	Objectives
Voltage measurement	B1. Writing a voltmeter symbol
	B2. Connect the voltmeter in a circuits
	B3. Describe the electrical value formula of voltmeter.
	B4. Describe the advantages and disadvantages of voltmeter
	B5. Describe the voltmeter internal structure
	B6. Describe the operation of the voltmeter
	B7. Describe the method to increase multi-range voltage of voltmeter
	B8. Calculate the electrical value from voltage measurement in a circuit
	B9. Calculate and analyse the measurement error from voltage measurement in a circuits

Project-based learning in electrical engineering course
In the second part, project-based learning emphasizes that students can be received experience while studying and gain various skills informed to Revised Bloom's Taxonomy which believed that exploration of problems from guiding of the lecturer to create their own projects to accept the challenges in the real world (Schuetz, 2018). The project-based learning and detail activities in sequences consist of the following stages: 1) finding topic and project proposal, 2) project planning and design, 3) monitoring project activities and implementation, 4) project evaluation and 5) project presentation and report. In electrical engineering course, the projects are first designed and selected based on the learning outcomes with the project briefs: 'Design and develop an Electrical measurement and instrumentations with IoT technology.

Integrated learning and project-based learning
In the third part, a combination between integrated learning and project-based learning. The integrated learning makes the students combine knowladge from 2 subjects and apply existing knowledge and thinking skills. While the project-based learning involves the student to active in discussion, make a plan and solve the problem according to Mioduser and Betzer (2008) represent that project-based learning improves the motivation, knowledge, skill, and the critical thinking. To use this integrated learning and project-based learning the implementation process for lecturer can be seen in figure 2.
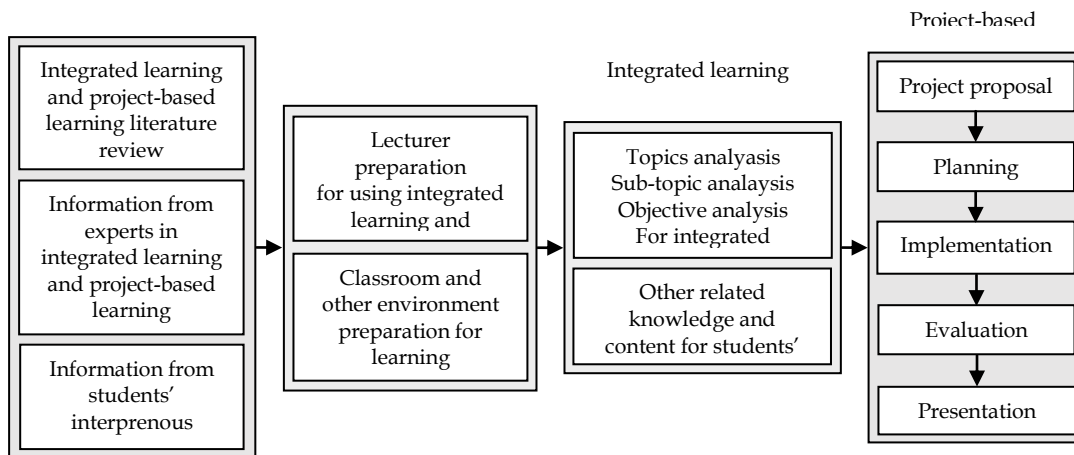
Figure 2. The integrated learning and project-based learning

Result and Discussion

From the research methodology and the integrated learning and project-based learning, the project will be given to students in group of three and students will select the group project's topic independently. The main tools used in the project was arduino microcontroller. The sample were 18 4th year students Department of Electromechanic Manufacturing Engineering, Faculty of Engineering and Industrial Technology, Bansomdejchaopraya Rajabhat University selected by purposive sampling method.

The result shown that students can create their group project and all the assessments were related to the students' project which follow the main stages of a project-based learning, the course assessment details (Shekar, 2014) and mean scores as shown in table 3 and students' project results as shown in figure 3.

Table 3. Course assessment details and students' score

Assessment stages (Weight)	Details	Mean score (SD)
1. project proposal (20)	• Group discussion, searching and analysing related research to find the project topic from the identify problems after learning by integrated learning • Each group choose a project topic according to a vote taken by the group after a discussion • Students were presented with the topic needed for preparing a project and project topic • Lecturer suggestion about their project topic	17.56 (2.04)
2. project planning and design (20)	• Each group design a timeline for project components and set all the activities • Lecturer suggest how to schedule their tasks and direction for managing their time	18.78 (1.40)
3. project implementation (20)	• Each group worked on the project for two months • Lecturer suggestion and help students solve problems they faced • Lecturer monitor the students and the progress	17.28 (1.71)
4. project evaluation (20)	• After the project was completed, all the students met and conferred the project's result and	15.56 (1.15)

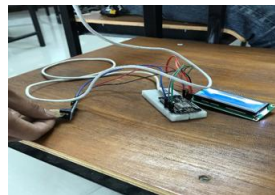|		
	discussion with the lecturer	
	• Students received permission from lecturer to show all the presentations	
5. project presentation and report (20)	• Each group presented what it had prepared for 15 to 20 minutes, including the procedure used for preparing the project and writing project report	15.50 (1.04)
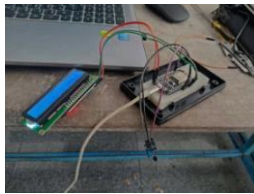
(a) Infrared IR Flame detector   (b) Temperature Humidity Meter   (c) Load cells censors scale

(d) Ultrasonic distance meter   (e) Speedometer for counting coins   (f) Soil moisture meter

Figure 3. Students' project result

From the result of students' project, the lecturer found that: in project topic finding and project planning and design stages, most students did not understand how to search queries from the internet and unable to analyse the important objectives of the research so the lecturer suggest how to search for information using keywords and asked the student to write down a mind mapping in each group for presenting the idea in front of the class. In project implementation stage, students did not understand the meaning and writing of flowchart and block diagram so the lecturer explained and gave an examples moreover, students cannot connect the circuit correctly in some circuits of their project and some of the microcontroller program had bug so the lecturer show how to connects some circuits and help debugging the microcontroller program. Finally, in project evaluating and project presentation and report stages, students cannot explained or represent the result in term of table or graph also cannot discuss the results to conclude the experiment so the lecturer make the students to write mind mapping in each group with their experiment result to summarize and grouping the ideas.

Students' evaluation and feedback from integrated learning and project-based learning for subject of electrical measurement and instrumentations in electrical engineering course were agree that: the project contributed to their learning, students prefer the methodology of active learning, the project should be continued for the next semester and the projects helped students to develop various skills and knowledge which referencing to the research of Fregolentea et al. (2018). Finally, the lecturer must bring the problem and obstacle caused by the learning to improve the learning model for future research or work.

Conclusions

In conclusion, this research represent the integrated learning and project-based learning, which improve scientific thinking, cooperative working skills, interpersonal communication, creativity, self-regulation, use of technology and other skills related to their research topic (Ravitz et al., 2012) such as microcontroller and computer programming also promoting students-centered and gives the opportunity of teamwork and discussion between students and lecturer especially engineering field. Moreover, it can also developing lecturers' pedagogical knowledge and improving students' self-regulation ability in learning and motivation, as well as changing their attitudes of learning (Kortam et al., 2018).

Acknowledgements

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