

Students' Perspective on Collaborative Research-based Learning in Embedded Systems

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Abstract. The Covid-19 pandemic, which has occurred for more than two years, has left various problems in learning. According to the opinion of most teachers and students, learning using an online approach in some courses was less effective. For example, the Embedded Systems course (ES) stimulates students to do product development. Online learning even tended to cause a loss of motivation, especially in applied studies that require adequate time and facilities to do the practicum. Hence there is a need for a learning method that can be a solution to the problems caused by the online approach. In the ES, students are required to understand the not only theory but also practice comprehensively. Therefore, a more sophisticated strategy is necessary. To enable students to see and assess the events that transpired during product development, collaborated research-based learning (CRL) is expected to be a proper method to tackle such problems. With the RL approach, especially for applied subjects such as Embedded Systems, students must be able to innovate so that the learning process encourages them to find real solutions to the faced problems. CRL encourages students to be able to formulate research designs, data collection, practical research, and interpretation of results. CRL engages students in the process and active participation in acquiring reflective knowledge and critical thinking to build their vision. This report presents a preliminary examination of the implementation of CRL in ES to improve students' engagement. The study measure participants' overview of using project management application in CRL. The study involved 30 students taking the ES. The study finding discovers that the students' perspective of the CRL approach in ES is suitable during pandemic.

Keywords: Covid-19, education, collaborated research-based learning, embedded systems

INTRODUCTION

Learning in the pandemic era presents some challenges for lecturers and students, especially in engineering, which requires a practicum in the learning process. Due to the pandemic, courses requiring practical skills and student competencies are disrupted because most lectures are conducted at home (Potu, et al., 2022). Various studies conducted to discover solutions to these problems. One is using the research-based learning (RL) method (Espinoza-Figueroa, 2021). RL aims to promote and develop student competencies related to research practice and benefit students through research-related activities. This technique implies the application of teaching and learning strategies that link research with teaching. The application of RL for undergraduate students is comprehensive, so it is necessary to determine learning objectives, audiences, expected learning outcomes, and desired competencies to be developed to determine the appropriate methodology and process (Albar & Southcott, 2021).

The current trend of technical education invites us to engage in interactive and active activities for more profound, comprehensive student learning. In this sense, various methodologies have been proposed for active learning based on information seeking (inquiry-based learning), such as problem-based learning (Beneroso & Robinson, 2022), project-based learning, challenge-based learning, and active collaborative learning. In all of these methodologies, the student interacts actively with his co-workers in small teams and with his teacher, exchanging ideas and discussing progress in solutions or proposed solutions for a particular scenario. Scenarios or challenges must address situations or problems objectively to motivate students better (Lipari, et al., 2022). In this sense, research-based learning can also be implemented by seeking the active participation of students with their peers and teachers, discussing and analyzing scientific progress, or proposing their contributions to the particular state-of-the-art disciplines (Murray, et al., 2020; Behzadan & Kamat 2013).

An embedded systems course is a course that requires not only understanding but also the ability to apply it to a single product. So far, embedded systems lectures have been conducted using a project-based learning (PbL) approach. By using this approach, students can create innovations related to the material that has been given. However, there are still many things that are not in line with expectations, especially the ability of students to analyse various problems that arise when the resulting product is implemented. Related to this problem, a survey has been conducted to measure student perspective regarding the implementation of the RL model in the embedded systems course. The survey involves two group of students of engineering education. The first group is student of computer science education master program students who will take the Internet of Things (IoT) lectures. The second group is electrical engineering education undergraduate program students who will take embedded systems and IoT. The research results expected to gauge the participants response with regard the suitability of the model implemented in the courses.

METHODS

The survey conducted in this study assesses the students' perspective of using the collaborative application in learning that applying research-based approach. Hence, it is necessary to measure the participants' views by two research questions. What is the participants' knowledge of established collaborative applications in the market, and what purposes do they use them? The research questions are intended to gauge the participants' knowledge and experience of using the collaborative application. How do they opine that such application could be used for coordination of project for completing the research-based application? The research question is to quantify the participants' consideration in using the application for communication and coordination when doing the project in CRL.

The poll included 70 students divided into two groups. The first group is the master student who took the course of IoT. The class encouraged students to develop IoT hardware and software projects. The second group is the student taking the class of embedded system requisite to develop simpler embedded and IoT projects. The survey was conducted online via Google Form due to the pandemic situation. Despite the fact that the questionnaire is delivered online, it can be processed within a week. Additionally, owing to incomplete responses, one participant's response was disqualified. 69 replies were received in total.

The survey consisted of a collection of questionnaires. To measure the data group, it comprised of Likert-scale closed-ended questions and basic open-ended questions. The questions are about:

1. Demographic data

Participants' age, gender, computer and mobile phone ownership, as well as their use of these devices, were gathered via questions about demographic information. These data were required as primary participant information to meet the requirements for research participation, that is participants should be able to find information of research method when necessary.

2. The behaviour of using internet dan related devices for learning during pandemic

This question was required in order to evaluate the participants' technology and gadget usage habits. The questions were aimed to determine the frequency of smartphone usage, the purpose of using the devices to assist everyday living, and the amount of Internet use each week. Participants were questioned about their perspectives on utilizing the Internet to learn from home during the outbreak (LFH). Participants were also asked to rank their reasons for using gadgets on a five-point scale, with "least significant reason" being the least significant reason and "most major reason" being the most significant reason.

3. Students view of collaborative research-based learning in embedded system

This question was to know the participants' knowledge about the application in the market categorized as collaborative application such as Asana, Trello, Basecamp, and etc.

4. Students view of collaborative research-based learning in embedded system

This set of simple open-ended questions was to collect participants' opinions if they could involve in research-based learning. This question was to know the participants' knowledge about the application in the market categorized as collaborative application.

Participants from two student groups gathered at different times. The first group was asked to complete an online survey with instructions. This means that in order for the survey to be completed by all participants of the presentation, attendees must complete the questionnaire as verification of their participation at the conference. The second group, on the other hand, requested that the survey form be filled out without any instructions. As a result, more than 90% of those polled responded to the questions.

RESULTS AND DISCUSSIONS

1. Demographic Data

The initial inquiry pertained to demographic information. The data reveals that 65 percent of gender statistic participants were male and 35 percent were female. The participants' ages ranged from 20 to 30, with a mean of 21.57 years and a standard deviation of 2.25 years.

2. Student View of Learning Platform During Pandemic

The results of the preliminary questionnaire to assess learning from home in terms of students' perceptions of utilizing a collaborative application in learning (LFH) Table 1. Messaging was the popular platform for learning among participants. There was no significant difference between males and females ($Z=1.11$, $p=0.13$). It is followed by web-based applications such as Learning Management System (LMS). There also were no significant differences between males and females ($Z=1.06$, $p=0.15$). Video platform including the video posted on YouTube is the next platform for learning in pandemic situations chosen by teacher and student. It was also not so different between males and females to use such a platform ($Z=1.08$, $SD=0.14$). However, there were other ways to establish learning in the LFH approach, such as Google Classroom, Edmodo, and Twitter ($z=0.27$, $SD 0.39$).

3. Knowledge of collaborative application

The results of the student understanding of the collaborative platform illustrated by Table 2. Slack ranked #1 ($Z=1.07$, $SD=0.14$), followed by Basecamp ($Z=1.07$, $p=0.14$). However, there was a significant difference in male and female ratings of Trello as the most popular collaboration application ($Z=1.86$, $p=0.03$). The participants were familiar with a variety of different collaboration tools, such as Asana. For the quiz on the potency of collaborative application in learning, the majority of participants believed that such a collaborative application is appropriate for the learning strategy. They believed that the collaborative application will encourage students to participate in learning since it is simple to study together.

Table 1. Student overview of learning platform during pandemic

The way of learning from home (LFH)	Male		Female		Man-Whitney U Test	
	Md	SD	Md	SD	Z	p
Messaging	8,00	1,86	8,00	1,65	1,11	0,13
Web-based	8,00	1,59	8,00	1,52	1,06	0,15
Video	8,00	2,09	8,00	2,05	1,08	0,14
Other application	6,00	2,83	6,00	2,86	0,27	0,39

Table 2. Student understanding of the collaborative platform for CRL

Knowledge of collaborative application	Male		Female		Man-Whitney U Test	
	Md	SD	Md	SD	Z	p
Slack	4.00	0.72	5.00	0.69	1.06	0.14
Basecamp	4.00	0.82	4.50	0.81	1.07	0.14
Trello	4.00	0.77	5.00	0.69	1.86	0.03
Others	4.00	0.93	4.00	0.84	0.55	0.29

CRL is a potential strategy in the midst of a pandemic, particularly for an applied course in where students are asked to generate the real product, like as a software development course. The CRL promotes students to work together to attain the learning objectives. As a result, it is vital to investigate the participants' perspectives on a collaborative application for studying such courses. The outcomes of the study show that the majority of courses given during pandemics continue to employ the conventional approach, despite certain technological adoptions. For example, they employed messaging apps to provide course content and track student learning progress. However, adopting a collaborative tool seems promising for some courses that encourage students to work on group projects. According to the findings of the study, the majority of participants believed that employing the collaborative application in these courses would have some benefits. For example, students can study together with ease, may ask more from others when they have issues, and can enjoy learning.

CONCLUSION

Project management application, for example, Basecamp, Trello, Asana, and Slack are the collaborative application that have potency to be used for learning, especially in CRL approach. The research findings revealed that the student who took CRL course agreed that such application was suitable for supporting them to complete the outcome of the course in ES. Hence, these applications should be utilized in collaborative research-based courses. To extend the study of using project management application in CRL, we plan to develop similar application integrated with the LMS. This system will also utilize code repository application such as GitLab for maintaining student project in software development.

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