The Combination of Flipped Classroom Approach and Project-based Model on "Mobile Learning" Courses to Enhance Students' Project Quality

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ABSTRACT
The mobile learning course is one of the required courses in the informatics engineering education study program at Malang State University. Students are projected to have the ability to design mobile learning that adheres to learning theory after completing this course. Students are also expected to be able to create mobile applications that support mobile learning designs. Up to this point, learning activities in mobile learning courses have relied on the project-based learning model, which has proven to be effective in motivating students to create mobile learning products. This model, however, is insufficient to enable students to create flawless mobile applications. Researchers found that one issue with this was a varying pace of learning. Lack of time for understanding "how to develop mobile applications" is another issue that contributes to the final mobile application's imperfections. Seeing some of these problems, we took the initiative to combine project-based learning with the flipped classroom approach. Students are actively engaged in the learning process in a flipped classroom. Before class, they watch videos, read, and participate in online discussions to help reinforce their understanding of the material. They collaborate in class on coding projects, allowing them to apply their knowledge and skills in a practical setting. Students can work at their own pace and on their schedule thanks to the flipped classroom model. The flipped classroom also promotes personalized learning by allowing lecturers to provide students with personalized support and feedback. Lecturers can use class time to work with students individually, identify areas of difficulty, and provide additional resources and support. Furthermore, flipped classroom model has been shown in studies to improve learning outcomes in programming courses. Students are more likely to retain the material and apply it to real-world problems if they have a more active and engaging learning experience. Given some of the benefits of flipped classrooms, we attempted to design a learning model that combined flipped classrooms and project-based learning in this work. Dick and Carey's method was used, and this model is ideal for developing learning designs. This paper also presenting student responses to learning models and analyzing the improvements in students' learning outcomes.

Keywords: *Flipped classroom, Project-based learning, Mobile learning.*

1. INTRODUCTION

In informatics engineering education, learning innovation is critical. The area of informatics engineering is rapidly evolving, with new technologies always appearing. Learning innovation enables educational institutions to remain relevant and up to date with the latest advancements in the face of this problem. Educational institutions can provide students with the essential information and abilities to become professionals who are ready to face technological advances by introducing new approaches, new learning techniques, and innovative technology.

Learning innovations can help students become more involved in the learning process. Students are more interested and motivated to learn when interactive technology and intriguing learning tools, such as educational games, simulations, and mobile applications,

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are used. Learning innovations can also inspire students to participate actively in the learning process, such as by collaborating on team projects or enrolling in online courses suited to their specific needs.

Building practical abilities that can be used in the workplace is crucial in informatics engineering education. Learning innovations allow for the implementation of a skills-based approach in which students can take part in real-world simulation projects. Students can learn how to solve problems, program, create software, analyze data, secure systems, and much more through these projects.

In addition, by offering tools and technology that can be customized to meet individual needs, learning innovations can help personalize learning. For instance, students can access learning materials catered to their level of knowledge via an adaptive learning management system, allowing them to study at their own speed.

Additionally, learning innovation can make it easier for students, professors, and business executives to work together. Students can communicate with peers, share knowledge, and create networks by utilizing online communication and collaboration platforms. Students who work together can obtain industry insights, improve their social skills, and increase their career options.

One form of learning innovation that can be implemented in informatics engineering education is the Flipped Classroom (FC). The flipped classroom approach allows students to carry out learning according to their individual learning pace [1]. This really helps students to develop themselves and improve programming competence, where in this study, we focused on mobile learning courses. Furthermore, this research will also combine flipped classrooms with project based learning. One of the main reasons why Project based learning is used is compatibility with the main learning outcomes of mobile learning courses, where students are expected to be able to create a mobile learning product that is capable of being a solution to a learning problem.

1.1. Flipped Classroom Approach for Informatics Education

"*The primary purpose of the flipped classroom is to remove simple knowledge acquisition from the classroom setting and to reserve classroom time for knowledge application and clarification*[2]." According to this definition, flipped classroom shifts the learning paradigm from teacher-centered to student-centered [3]. The results of previous studies revealed that this approach proved effective in improving the learning outcomes of computer science students and their independence [4].

Informatics education also requires students to understand abstract concepts and apply these concepts to produce the desired software. For example, in the mobile learning course, students are asked to understand programming concepts to make it easier for students to create the desired product. Seeing the character of the course, the Flipped classroom approach is considered very suitable for this course, where the flipped classroom is proven to be suitable for making it easier for students to understand difficult material. [5]. This is due to the flipped classroom's ability to allow students to study content supplied in video form repeatedly based on their particular learning pace.

Flipped classroom is also proven to be able to improve learning outcomes in the informatics field, especially in the field of software engineering [6]. The research conducted by [6] also shows that students' problem solving skills can increase by using a flipped classroom. This is in line with research [7] [8] which shows an increase in learning outcomes in students who study software engineering and programming [9] using a flipped classroom.

Additionally, the flipped classroom can boost students' Higher Order Thinking Skills (HOTS) [10]. The study conducted by [10] discovered an increase in student HOTS when the teacher implemented flipped classroom learning. Of course, other advantages of the flipped classroom can be generated if it is correctly implemented and designed. Therefore, in this study, we attempt to create a flipped classroom for mobile learning courses in the hopes of enhancing the quality of student final projects.

1.2. Project Based Learning for Informatics Education

Project based learning (PjBL) is one of the popular learning models used in the field of engineering, due to its several advantages [11]. Based on several previous studies, PjBL has proven effective for engineering education [12], where this model is student-centered and uses an active learning approach. PjBL has also proven to be more effective than traditional learning, and proven to be very suitable for implementation in engineering courses [13].

According to Larmer [14], PjBL has several learning stages that are characteristic of this model, namely:

1) Choosing topic,
2) Pre-communicative activities,
3) Asking essential questions,
4) Designing project plan,
5) Creating project timeline,
6) Finishing the project,
7) Assessing the project result, and
8) Evaluating the project.

These stages of learning are consistent with the nature of informatics engineering education, particularly in mobile learning courses where students are encouraged to design a mobile learning application at the end of the semester. These stages also teach students to think critically and creatively in order to produce project results.

In terms of the learning process in informatics engineering education, PjBL has been shown to help students understand information in the field of software engineering both conceptually and practically [15] . PjBL can help students learn programming by increasing their comprehension of programming topics and making it easier for them to complete final projects [16] [17] . This learning model has also proven easy to implement in informatics engineering education where the results of research [18] show that teachers and students really enjoy learning activities. We attempted to create PjBL specifically for mobile learning courses after seeing some of its advantages for informatics education and the applicability of its learning stages in the informatics field.

1.3. Incorporating Project Based Learning in Flipped Classroom

We examined the benefits of flipped classrooms and PjBL in informatics education in subsections 1.1 and 1.2. Given the benefits of the two learning methodologies, we attempted to combine them in this work. The goal of integrating the flipped classroom and PjBL is, of course, to combine the benefits of the two learning models in order to have greater positive effects on informatics education, particularly in mobile learning courses.

Combining learning models is feasible as long as the characteristics of the two models are not significantly different. PjBL has been used with many game elements in earlier research to boost student engagement and motivation [19] . The flipped classroom approach has done the same thing, where the flipped classroom is mixed with a gamification strategy that has been shown to improve student motivation [20] . Some of these combinations have been shown to improve informatics engineering learning.

Furthermore, past research have used a combination of PjBL and Flipped classes. According to a study conducted by [21] [22] , integrating these two approaches has been shown to improve students' critical thinking. The combination of these two models undoubtedly requires careful planning in accordance with the features of the courses and pupils. Of course, an effective design will result in a learning model that can increase HOTS and student learning outcomes [23]. Based on past research findings regarding the potential for combining PjBL and flipped classrooms, in this study, we attempted to create a combined learning design that meets the characteristics of mobile learning courses.

2. RESEARCH DESIGN AND METHOD

This study was separated into two key stages: 1) developing flipped and PjBL designs for mobile learning courses, and 2) testing the efficacy of the models created on the quality of students' final projects.

2.1. Developing Flipped Classroom and PjBL

In the first stage, we use Dick and Carey model [24] which has several 10 stages, as seen in Figure 1, namely: 1) Identify instructional goal(s), 2) Conduct instructional analysis, 3) Analyze learner and contexts, 4) Write performance objectives, 5) Develop assessment instruments, 6) Develop instructional strategy, 7) Develop and select instructional materials, 8) Design and conduct formative evaluation, 9) Revise instruction, 10) Design and conduct summative evaluation.

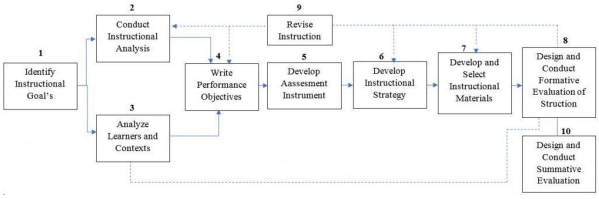

Figure 1 Dick and Carey Model.

The Dick and Carey model begins with Identify Instructional Goal which includes identifying potential problems (step 1) and collecting data (step 2). At this stage the researcher identifies the data needed for product development and the general goals to be achieved from the creation of the product. The next stages are carried out sequentially starting from Step 1 to Step 10, namely design and conduct summative evaluation. This development model was chosen because it proved to be very comprehensive and very suitable for the development of PjBL learning models combined with the flipped classroom approach. The end result of this development stage is the PjBL design which is combined with the flipped classroom, complete with objectives, assessment instruments, detailed learning strategies, materials, and learning evaluation.

2.2. Testing the Effectiveness of the Model on the quality of the final student project

We conducted evaluations to determine the validity of the content as well as the validity of the model once the steps of constructing the PjBL model with the FC technique were completed. This procedure is performed to guarantee that the learning model and the material contained within it are suitable for use in classroom learning activities. We involve material experts and

learning model experts to test the learning models that we have developed.

When the learning model and its content are approved for usage, we use it in lecture activities on mobile learning material. We used a quasi-experimental research method, Nonrandomized Control Group, Pretest–Posttest Design. Two classes of the informatics engineering education study program were involved as a control class and an experimental class (Table 1).

Tabel 1. Nonrandomized Control Group, Pretest–Posttest Design

Group	Pretest	Independent Variable	Posttest
A	Y_1	X	Y_2
B	Y_1	_	Y_2

3. RESULTS AND DISCUSSION

The study's findings include flipped classroom and PjBL designs tailored specifically for mobile learning courses. Table 2 shows the details of the PjBL and FC combined learning design. Table 2 describes the PjBL stages and FC settings at each stage. FC is divided into two sections, which include pre-class and in-class activities. Pre-class activities in the form of video tutorials, online discussion forums and assignments are organized in the Learning Management System under the name SIPEJAR. SIPEJAR is a web-based learning management system created by the State University of Malang. SIPEJAR was chosen due to its ease of use and the comprehensiveness of its features, which can accommodate the needs of activities in the FC design. This is relevan with research [25] which also uses a web-based system to accommodate FC needs.

The PjBL and FC designs that were created have been applied in the experimental class and validated by expert learning models and learning material validation. According to the validation results, the PjBL design combined with FC has a high validity (96%) as a learning model. Furthermore, the validation results for material expert validation indicated that the "mobile learning" learning materials provided in this study were also highly valid, with a validity rate of 94%.

After the PjBL and FC model designs and their learning content were declared valid, we implemented these models in the experimental class to determine their effect on the quality of the final mobile learning course project. We used a quasi-experimental design, and involved two classes of informatics engineering students. Class A as the experimental class and class B as the control class. The control class applies the PjBL model only, while the experimental class applies the PjBL model combined with the FC setting. We did some data analysis and a pretest before implementing the learning model to check that there were no major disparities in initial abilities between the two classes. The results of the t-test on the pretest of the two classes showed that the two classes did not have significant differences in initial ability (programming). As a result, this experimental design is feasible and has high validity.

We implemented the PjBL model paired with FC in the experimental class after determining that the initial abilities of the two classes were equivalent. Then we performed a final project evaluation in both the experimental and control classes. In addition, we provide questionnaires and interviews about their learning experiences with PjBL and FC. The results of the final project data analysis demonstrate that the experimental class final project has a higher average value than the control class. This demonstrates that the combination of PjBL and FC has been advantageous in increasing the quality of informatics engineering students' final projects, particularly in mobile learning courses.

Furthermore, according to the findings of student interviews in the experimental class, they felt tremendously facilitated by the FC environment, which allowed them to study programming content at their own pace. They can repeat learning videos or video tutorials as needed, and they don't have to worry about falling behind their classmates. Class activities in PjBL are also more lively and student-centered. They can question their group members and the professor if they have any problems while working on the final mobile learning subject project.

4. CONCLUSION

We have combined the PjBL and FC models in the mobile learning course using the Dick and Carry development model. We also validated the results of this development with media professionals and material specialists, with positive and expected results. After confirming that the model and content we created are appropriate for use in learning activities, we examined the model's effectiveness using quasi-experiments. The experimental results suggest that the combination of PjBL and FC improved the quality of the final project in the mobile learning course.

We hope that the findings in this study can become the basis for the development of PjBL and FC models in other courses in informatics engineering education. We are aware that the combination of PjBL and FC that has been developed is still not perfect, but it can be a good start for the development of further learning innovations, especially in the field of informatics engineering education.

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Table 2. Project-based learning and flipped classroom scenario.

Project-Base Learning (PjBL)		Flipped Classroom (FC)	
PjBL Stages	**Activities**	**Pre-Class Activities**	**In-Class Activities**
Choosing topic	The teacher stimulates students by displaying images/videos/stories connected to the topic. The teacher describes numerous learning challenges that can be handled with mobile learning.	Videos	Lecture/Micro-lecture
Pre-communicative activities	At this stage, the teacher delivers information on what resources (hardware and software) students will need to accomplish the final project.	Videos (React native installation tutorial)	Collaborative group work/discussion
Asking essential questions	This stage's major goal is to guarantee that students understand what will be done to create a mobile learning application that satisfies their expectations. Lecturers ask questions related to the compatibility between the applications they will make and the learning problems they want to solve with mobile learning.	Videos	Engaging learning activities
Designing project plan	Students design the final project based on the answers to the previous stage's questions. At this point, the lecturer serves as a facilitator, guiding students on the final project to be completed and ensuring that the project is reasonable and can be completed within the student capacity.	Online discussion/forum	Collaborative group work/discussion
Creating project timeline	The main objective of this stage is to teach students how to organize and schedule the processes involved in developing the final project. There are certain things to conduct when creating a project timeline, such as. 1) In groups, students create a timeline from project planning through project completion. 2) The planned schedule must include activities, deadlines, and the person in charge. 3) Once all groups have completed scheduling, the teacher receives the project timeline sheet from each group. 4) The project timeline sheet can be utilized by the teacher to track the project's progress.	Online discussion/forum	Collaborative group work/discussion
Finishing the project	At this step, students work on the final assignment according to the schedule that has been created. They participate in the following activities: 1) Designing the application's user interface 2) Converting the UI design into program code to generate a UI that functions as intended. 3) Create mobile learning features that are compatible with the design	1) Videos: Turorial react native 2) Online discussion/forum 3) Weekly planning report	Collaborative group work/discussion
Assessing the project results	Assessing the project outcomes aims to confirm that each group member is responsible for their project outcomes. As a formative assessment, the teacher can also analyze student performance and project outcomes. The steps taken to evaluate the project's outcomes are described below: 1) Students give a presentation on the project's findings and explain how it was made. 2) The other group members may ask questions regarding the project's outcome. 3) In the meantime, the instructor administers a formative evaluation to evaluate the project's progress and outcomes against the rubric.	Assignment	Group Presentation
Evaluating the project	The teacher provides feedback for the project outputs during the project evaluation process, and the students also reflect on their learning experiences. This phase attempts to encourage students to discuss any challenges they encountered while working on the project and assess their proficiency.	Online discussion/forum	Lecture/Micro-lecture

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