The Effect of Online-Project Based Learning on Learning Outcomes of Pre-Service Physics Teachers

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Abstract: This study aims to examine the effectiveness of the Online-Project Based Learning (Online-PjBL) model in improving student learning outcomes in research methodology courses. This research is a quasi-experimental study with a posttest-only control group design. The population of this study was all physics education students who were taking research methodology courses, namely 60 people. The sample consisted of 42 students who were divided into two class groups, namely 21 students in the experimental class and 21 students in the control class. Students in the experimental class were treated with the online-PjBL model while the control class was treated with the offline-PjBL model. The learning outcomes data in this study were taken from the results of the midterm exams and the task of compiling a research proposal. Data on the learning outcomes of the two class groups were then analyzed using a different test (t-test). Based on the results of the t-test at the 95% level of confidence ($a = 0.05$) with degrees of freedom ($dk = n_1 + n_2 - 2 = 40$) it shows that there is no significant difference in learning outcomes between the experimental class and the control class with $t_{count} = 0.24$ and t_{table} value = 2.02 ($t_{count} < t_{table}$). This means that there is no significant difference in effectiveness between online-PjBL and offline-PjBL in improving the learning outcomes of prospective physics teachers in research methodology courses.

Keywords: Project based learning, learning outcomes, pre-service physics teachers

INTRODUCTION

Currently, the world is entering the era of the fourth generation industrial revolution (industrial revolution 4.0). The industrial revolution 4.0 is a phenomenon where the industrial world is starting to use automation systems, and digitalization, has even started to utilize Artificial Intelligence to make production more effective and efficient. The industrial revolution 4.0 can certainly have a direct impact on the human work system because most of the products that originally used human power are now being replaced more by the use of technology. This is of course an opportunity and even a threat to a nation that is not ready to face changes due to the development of science and technology.

As an effort to prepare the nation's generation to have competencies that are relevant to the needs of the times, the government through the Ministry of Education and Culture issued the independent Learning-Independent Campus (MBKM) policy. MBKM is a government policy that aims to improve the competence of graduates both soft skills and hard skills. There are eight forms of activities in the MBKM program at the tertiary level, one of which is student exchange (Dirjendikti, 2020). The exchange of lessons is a cross-campus learning activity both at home and abroad. This student exchange activity opens opportunities for students to take part in the learning process at any tertiary institution in Indonesia as part of an effort to strengthen and or expand their competence. Besides that, through the student exchange program, students are expected to be able to increase national insight, love for the motherland, and have an understanding of diversity and tolerance. Students will also have a broad understanding of the diversity of cultures, customs, ethnic groups, languages, and various potential wealth of resources and other potentials owned by the nation and state.

Besides having several advantages, student exchange activities also have several challenges or obstacles. One of the factors that become an obstacle for students or institutions (Higher Education) in organizing student exchange activities is the cost factor. Universities that take

the initiative to independently carry out student exchange activities with other tertiary institutions, tertiary institutions must be prepared to bear costs starting from transportation costs, housing, and even student pocket money independently. Another option is that all costs are borne by the student. If this happens, of course, it will be very burdensome for students. Therefore, to overcome this, the physics education study program at the University of Mataram has so far carried out student exchange activities with the Jambi University's physics education study program which are carried out online (Online) by utilizing various supporting platforms such as SPADA Unram, zoom meeting, google meet, and other platforms.

The learning process in the MBKM program is a form of student-centered learning. In other words, the learning process should always provide opportunities for students to be able to independently build understanding in their cognitive structures, as well as develop skills, and form personalities through activities in the learning process. The learning activities referred to here can be in the form of problem-solving processes, discussions, collaborations, project work, and other activities. One of the learning models whose activities are oriented towards these activities is the Project Based Learning (PjBL) model.

Project Based Learning (PjBL) is a learning model that emphasizes student activities in carrying out project assignments by applying their knowledge to produce certain authentic products (Boss & Krauss, 2007; Robert et al, 2013; Kosasih, 2014). In this learning model, all learning activities are centered on students (students). The lecturer's task is only as a guide for students to complete the project assigned at the beginning of learning. Project learning provides opportunities for students to apply knowledge in the form of problem-solving processes and work on project assignments so that students acquire a variety of knowledge, attitudes, and skills. Project-based learning is an alternative for carrying out innovative, creative, and fun learning according to 21st-century learning (Tan & Chapman, 2016; Krajcik & Czerniah, 2018). In addition, various empirical evidence related to the application of the PjBL model in improving student learning outcomes has been done before. Kencana & Rifa'i's research results (2022); Hidayati (2021); Putri et al (2021); Hakim et al (2021); Ramadhani, (2021); Rahra et al (2021), Budiningsih, (2021); shows that the PjBL model can improve student learning outcomes.

Based on the background above, this study aims to examine the effectiveness of project-based learning conducted online (Online-PjBL) in improving the learning outcomes of students participating in student exchange programs, especially in research methodology courses. This is important to do in order to respond to online learning which is mostly done at this time.

METHODS

The method used in this research is quasi-experimental with a posttest-only control group design. The research design that researchers use is as follows.

Table 1. *Posttest-only control group design*

Treatment	Posttest
X_1	O_1
X_2	O_2

The population of this study was all physics education students who were taking research methodology courses, namely 60 people. The sample consisted of 42 students who were divided into two class groups, namely 21 in the experimental class and 21 in the control class. Students in the experimental class were treated with the online-PjBL model while the control class was treated with the offline-PjBL model.

The stages of the PjBL model as developed by The George Lucas Educational Foundation 2007 (Gunawan et al, 2017), namely; (1) Learning begins with essential questions. Essential questions are questions that can stimulate students related to real world conditions and problems. (2) design a plan for the project; at this stage, the lecturer and students make plans together and discuss the rules for working on project assignments (research proposals). (3) Create schedules and work plans: lecturers and students jointly develop work plans and project completion schedules. (4) monitor the students and the progress of the project: at this stage, the teacher monitors the development of project assignments, in this case, the preparation of research proposals. (5) assess the outcome: at this stage, the lecturer assesses the final product produced by the students. Students are asked to present the final results (research proposals) that they have compiled (6) evaluate the experience: lecturers and students together reflect on all the

activities of completing project assignments that have been carried out.

The learning outcomes data in this study were taken from the results of the midterm exams and the task of preparing research proposals. To find out the differences in the learning outcomes of the two class groups, the data on student learning outcomes were then analyzed using a different test (t-test). The following is the equation for conducting the t-test (Sugiyono, 2012).

$$t_{count} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{n_1+n_2-2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

The results of these calculations (t_{count}) are then consulted with t_{table} provided that if $t_{count} < t_{table}$ indicates that there is no significant difference in learning outcomes between the experimental class and the control class. Vice versa if $t_{count} > t_{table}$ this indicates that the learning outcomes of the experimental class and the control class are significantly different.

RESULTS AND DISCUSSIONS

The learning outcomes in this study were viewed from two aspects, namely students' ability to master research theories and students' skills in preparing research proposals. Data on student learning outcomes for the two class groups can be seen in the following graph.
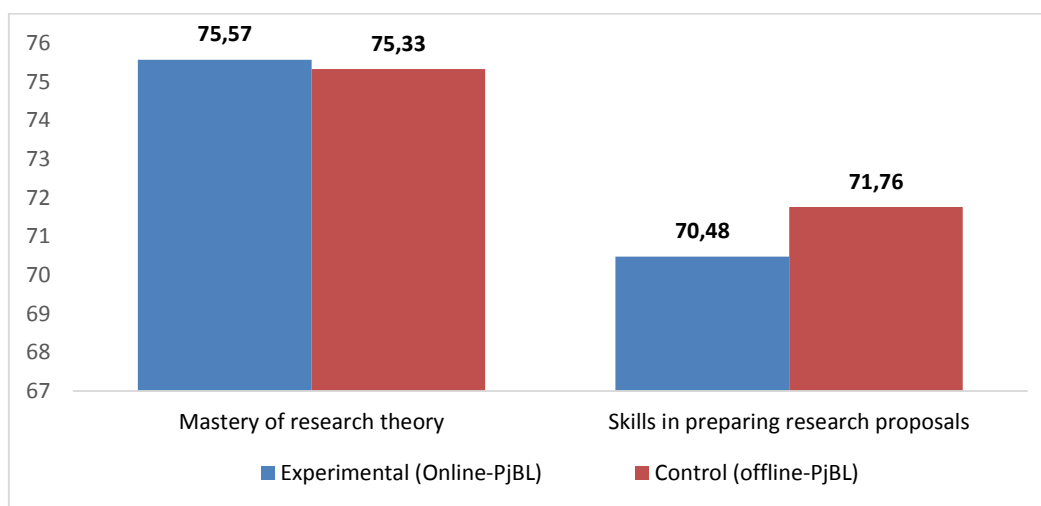
Figure 1. Comparison of student learning outcomes between the experimental class and the control class

The data in the graph above shows that there are slight differences in learning outcomes for aspects of mastering concepts or research theories. For the aspect of research theory mastery, students in the experimental class got a slightly better learning achievement score when compared to the control class. The average student learning outcome in the experimental class is 75.57 while in the control class, the average student learning outcome is 75.33.

Furthermore, to find out whether the increase is significantly different or not, a comparative statistical test is performed using the t-test (significance test). Based on the results of the t-test at the 95% confidence level ($a = 0.05$) with degrees of freedom (dk = $n_1 + n_2 - 2 = 40$) it shows that there is no significant difference in learning outcomes between the experimental class and the control class with $t_{count} = 0.24$ and t_{table} value = 2.02 ($t_{count} < t_{table}$). In other words,

there is no significant difference in the effectiveness of the two treatments (online-PjBL and offline-PjBL) in improving the learning outcomes of prospective physics teachers in research methodology lectures.

For aspects of student skills in preparing research proposals, students in the control class get a slightly better learning achievement score when compared to the experimental class. The average student learning outcome in the control class is 71.76 while in the experimental class, the average student learning outcome for this aspect is 70.48. This means that the group of students who were treated with the offline-PjBL model got better scores when compared to the group of students who were treated with the online-PjBL model. However, a different test using the t-test showed that there was no significant difference in learning outcomes between the experimental class and the control class with $t_{count} = 0.45$ and

$t_{table} = 2.02$ ($t_{count} < t_{table}$). In other words, there is no significant difference in the effectiveness of the two treatments (online-PjBL and offline-PjBL) in improving the learning outcomes of prospective physics teachers, especially in terms of students' abilities in preparing research proposals.

The experimental class and the control class are two class groups that are treated with the same learning model, that is, they both apply the Project Based Learning (PjBL) model. Therefore, the activities and stages of learning experienced by students for the two class groups are the same. The difference lies in the method or way of presenting the lesson. In the experimental class, the PjBL model was carried out online (online-PjBL) while in the control class it was carried out conventionally (offline-PjBL). For the tertiary level, the differences in online and offline learning methods do not have a significant impact on differences in the quality of learning. For the tertiary level, the average student has independence and intrinsic motivation that comes from within themselves. This is in line with the research results of Ashadi & Suhaeb, (2020); Ferazona & Suryanti, (2020) stated that online learning can increase student independence and learning outcomes. In line with the results of this study, research conducted by Astuti et al (2020); Fitriyani et al (2020); Hakim & Mulyapradana, (2020) show that for the Higher Education level, online learning can increase student learning motivation.

Dabbagh, (2007) states that several factors can determine the success of learning online, namely; (1). Students must have a high enthusiasm for learning because this can determine the quality and quantity of their learning independently. The independence of student learning causes different success differences. Based on research conducted by Hasanah, et al, (2020), as many as 95.8% of students have high or high enthusiasm when learning is done online. This means that for the enthusiasm for learning factor, online learning has a positive influence on student learning activities. (2) Students must have literacy in the technology used in online learning. This factor does not seem to be a problem for students studying at the tertiary level. The results of research conducted by Hasanah, et al, (2020), show that 89.8% of students have good or fairly good technological literacy. That is, the technology literacy factor is not an inhibiting factor in the process of achieving student learning outcomes. (3) Students must have good intrapersonal communication skills. Interpersonal skills are needed for interaction and relationships with other students. In PjBL learning whether done online or offline, students are always involved in communicating either communication between students and students or communication between students and lecturers. When studying online, it appears that students are a little more active in communicating. This can be seen from the intensity of the questions during the learning process. The number of students who asked and responded to questions during class discussions tended to be more in the group of students who were taught online. This is because students seem to be more daring to express questions and opinions online than directly in class (offline). (4) Students must collaborate with other students. In PjBL learning whether done online or offline, students are formed into small groups. Each group discusses and collaborates to solve the given problem (task). However, during online learning, the lecturer had little difficulty in monitoring the involvement of each group member in discussing and collaborating. This is identified as the cause of the slight difference in learning outcomes between the experimental class and the control class, especially for aspects of the ability to carry out project assignments in the form of preparing research proposals. The control class which is taught offline tends to have slightly higher learning outcomes compared to the experimental class. (5) skills for independent learning. In online learning, it is very necessary to be skilled at studying independently. Because during the learning process, students will search, find and conclude what they have learned independently. Based on the research results of Hasanah, et al, (2020), 54.9% of students stated that they did 3-4 times of study a day outside of the online learning schedule that had been carried out, then as many as 38.6% carried out independent study activities less than 2 times in a day. The rest of the students do more than 5 times a day. In addition, based on research conducted by Ashadi & Suhaeb, (2020) states that online learning can increase student independence in learning.

Based on the results of an analysis of student activities during learning using the PjBL model both online and offline and referring to the results of several previous studies, it can be concluded that the impact of differences in

learning methods (online and offline) for the tertiary level is not that significant. Therefore, as long as the model or student activity during learning is designed the same for both class groups, it is likely that both class groups will obtain the same learning outcomes. This is what causes the learning outcomes of the experimental class and the control class are not significantly different.

CONCLUSION

The research data show that there is no significant difference in learning outcomes between students taught by the online-PjBL and offline-PjBL models. This means that the PjBL model is effectively applied both online and offline, especially in Research methodology courses.

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