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The Differences in Student Learning Outcomes using the Project-Based Learning and the Problem-Based Learning Model in the Electric Power Installation Course

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ABSTRACT
This article aims to reveal student learning outcomes in the electric power installation course using project-based learning (PjBL) and problem-based learning (PrBL) models, as well as to find out the differences in learning outcomes in the experimental and the control class. This type of research is quasi-experimental. The subjects of this study were students who took the electric power installation course with a total of 60 students, where the experimental class consisted of 30 students and the control class consisted of 30 students. The results of this study indicate that there are significant differences in student learning outcomes in the experimental class and control class, where the average value of the experimental class is 92.5, while the control class has an average of 70.6.

Keywords: *Project-Based Learning, Problem-Based Learning, Student Learning Outcome.*

1. INTRODUCTION

In recent years, educators have been exploring innovative teaching methods to enhance student engagement and improve learning outcomes. Two such approaches, project-based learning (PjBL) and problem-based learning (PrBL), have gained popularity due to their student-centered nature and ability to promote critical thinking and problem-solving skills. This article aims to compare and contrast the effects of PBL and PrBL models on student learning outcomes specifically in the context of the Electric Power Installation course [1], [2].

Understanding Project-Based Learning (PjBL): PjBL is an instructional approach that revolves around students working on complex, real-world projects. In the context of the Electric Power Installation course, PBL would involve students undertaking practical tasks such as designing electrical systems, troubleshooting installations, or creating energy-efficient solutions. PBL emphasizes collaboration, inquiry, and self-directed learning, allowing students to develop both technical skills and broader competencies such as teamwork and communication [3]–[5].

Exploring Problem-Based Learning (PrBL): PrBL focuses on presenting students with authentic problems that require critical analysis and solution development. In the Electric Power Installation course, students may be given scenarios involving faulty electrical systems, safety concerns, or energy consumption optimization. Through PrBL, students engage in active problem-solving, research, and analysis, enabling them to develop a deep understanding of the subject matter and hone their problem-solving skills [6].

Comparing Learning Outcomes:

1. Knowledge Acquisition: Both PjBL and PrBL facilitate the acquisition of knowledge. PjBL encourages students to explore topics in-depth while working on their projects, fostering a comprehensive understanding of electric power installation concepts. PrBL, on the other hand, prompts students to delve into specific problems, leading to targeted knowledge acquisition directly related to the identified issues [7], [8].
2. Critical Thinking and Problem-Solving: Both models emphasize critical thinking and problem-

solving skills, albeit through different approaches. PjBL nurtures critical thinking through complex project design, requiring students to identify challenges, analyze alternatives, and make informed decisions. PrBL, with its focus on problem-solving, enhances students' ability to identify, analyze, and resolve electrical power-related issues systematically [9].

3. Collaboration and Communication: PjBL and PrBL promote collaboration and communication, but PBL places more emphasis on teamwork due to its project-centric nature. PBL projects often require students to work in groups, fostering effective communication, division of labor, and collaborative problem-solving. PrBL, while also encouraging collaboration, places greater emphasis on individual analysis and research before sharing findings with peers [10].
4. Transferable Skills: Both PjBL and PrBL provide opportunities for developing transferable skills applicable beyond the Electric Power Installation course. PBL hones skills such as project management, time management, and creativity, which are valuable in various professional contexts. PrBL cultivates research skills, data analysis, and critical evaluation, enabling students to tackle complex problems in diverse fields [11].

2. METHOD

This research is included in the type of Quasi Experiment research method. This design does not use randomization at the start of determining groups and also groups are often influenced by other variables and not solely because of treatment [12]. This research design can be seen in table 1 below:

Table 1. Design of research

Class	Model	Posttest
Experiment	X1	O1
Control	X2	O2

Information O1: Experimental class learning outcomes test. O2: Control class learning outcomes test. X1: Project based learning model. X2: Problem based learning model. The instrument used in this study was in the form of 32 objective questions. Before the test items were used, a test was carried out to find out the validity, reliability, level of difficulty of the questions and the differential power of the questions.

Based on the results of the validity calculation where if rcount > rtable then the test item is said to be valid and if rcount < rtable then the test item is invalid and declared invalid then the number of questions declared valid and can be used to capture learning data for Electric Power Installation, namely 28 questions, while the other 4 questions were invalid and declared invalid. The results of the data reliability test were carried out using the KR-20 formula where the calculated result was 0.895 consulted with the scale table for the level of reliability of the questions, so that it could be seen that the sol test was included in a very high level of reliability.

Data on student learning outcomes were analyzed using descriptive statistics, namely calculating the average score (mean) and standard deviation (standard deviation). Before testing the research hypothesis, student learning outcomes data must meet the requirements of the normality test and homogeneity test.

The normality test is used to determine the distribution of student learning outcomes data, whether the data is normally distributed or not. With the following test criteria: If X^2count ⩾ X^2table, it means that the data distribution is not normal. If X^2count ⩽ X^2table, it means that the data is normally distributed with $\alpha = 0.05$ and degrees of freedom (dk) = k – 1. The homogeneity test aims to see whether the two samples have homogeneous variance or not.

The hypothesis test aims to determine whether the student learning outcomes of the experimental class are better than the control class and to determine whether the student learning outcomes of the two sample classes are different or not. Hypothesis testing is carried out after carrying out the normality test and homogeneity test. The determination of the t-test formula used depends on the results of the normality and homogeneity tests.

3. RESULT AND DISCUSSION

The description of the data from this study is in the form of data on student learning outcomes in the experimental class and control class students. The learning outcome data is in the form of scores for each student in the experimental class which totals 30 people and the control class which totals 30 people. Based on data analysis, the average value, standard deviation and variance of the experimental class and control class students were obtained as can be seen in table 2 below:

Table 2. Summary of Highest Score, Lowest Score, Average Value, Standard Deviation and Variance

Class	Highest Score	Lowest Score	Average	S	S^2
Experiment	96	55	92,5	12,4	154
Control	93	50	70,6	11,8	140

Based on table 2, it can be seen that the average student learning outcomes in the experimental class is

92,5 and the average student learning outcomes in the control class is 70,6.

1. Normality Test

From the test, it was obtained the price of X^2count and X^2table for both classes of subjects at a significance level with $\alpha = 0.05$, as listed in table 3.

Table 3. Post-test Normality Test Summary

Class	X^2count	X^2table	Category
Experiment	1,53	42,5	Normal
Control	4,6	41,3	Normal

From table 3 it can be seen that both classes obtained X^2count < X^2table, this means that the data obtained from the subject class of this study was normally distributed.

2. Homogeneity Test

Homogeneity test to see whether the two classes are homogeneous or not. Testing the homogeneity of the research data used the F test. The test results were obtained from data such as table 4

Class	S^2	Fcount	Ftable
Experiment	154	1,09	1,9
Control	140		

From the table 4 it can be seen that the value of Ftable in the experimental class and control class with $\alpha = 0.05$ with dk quantifier = n – 1 = 30 – 1 = 29 and dk denominator = n – 1 = 30 – 1 = 29 then look for table F obtained Ftable = 1.9, while Fcount is 1.09. Thus Fcount < Ftable means that both classes have a homogeneous variance.

3. Hypothesis Test

Based on the normality test and homogeneity test of the final test variance, it was found that both classes were normally distributed and had homogeneous variances, so the appropriate test for differences between the two classes was to use the t test, as shown in table 6 below:

Class	tcount	ttable
Experiment	3,46	2,02
Control		

From the results of the calculation of the hypothesis test, the t-test value (tcount) is 3.46, while for ttable with $\alpha = 0.05$ degrees of freedom (dk) = n1 + n2 – 2 = 30 + 29 – 2 = 57, look for the table t distribution values obtained t table = 2.02. Thus 3,46 > 1.671 (tcount > ttable), then Ho is rejected and Ha is accepted. From these results the hypothesis that there is a significant difference in learning outcomes between PjBL and PrBL in the subject of experiment and control class, is accepted at a significance level of 0.05.

In this experimental study, the experimental class and control class departed from the same initial conditions. From the tests carried out to determine whether the two sample classes can be used as research subjects for the electric power installation course. Based on these data, it can be concluded that the two sample classes depart at the same point. Therefore, for further assessment activities the two classes can be given different treatment, namely the experimental class is given PjBL treatment while the control class is given PrBL treatment. After learning was carried out by giving different treatment to the two sample classes, a final learning test (post-test) was carried out [13], [14].

From the results of the final sample class test, the distribution of values varied, namely for the experimental class the average value was 92.5 and for the control class the average value was 70.6. Before the distribution of the final test data was analyzed for hypothesis testing, the normality test and homogeneity test were first performed. Once it is known that the data are normally distributed and the two samples have a homogeneous variance, then hypothesis testing can be carried out [15], [16].

4. CONCLUSSION

Both PjBL and PrBL offer distinct yet valuable approaches to enhance student learning outcomes in the Electric Power Installation course. PjBL's focus on project-based learning enables comprehensive knowledge acquisition, while PrBL's problem-solving emphasis fosters critical thinking and analysis. Ultimately, educators should consider the learning objectives, student preferences, and desired outcomes when selecting the most suitable instructional model. By employing either PjBL or PrBL, educators can engage students in meaningful learning experiences, equipping them with essential skills for success in the field of electric power installation and beyond.

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