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PjBL vs PBL Models in Higher Education: A Comparative Study Using Analysis of Covariance

Fadhilah [1*)], Muhammad Husin [2], Rian Fadia Raddhin [3]
Universitas Negeri Padang, Indonesia[1, 2, 3]
[*)]Corresponding E-mail: fadhilah@ft.unp.ac.id

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ABSTRACT
A learning model is a form of process or way of presenting learning activities from beginning to end. This learning model serves as a means of communication in the classroom. This study aims to determine whether there are differences in the evaluation of pure learning outcomes by applying the Project-Based Learning (PjBL) and Problem Based Learning (PBL) learning models with the Pretest score as a controller. The number of subjects in this study was 42 mining engineering students in applied physics courses using the purposive sampling method. Data was collected by asking questions before being given treatment and after being given treatment. The data analysis technique used is the analysis of covariance (ANCOVA) in evaluating student learning outcomes. The findings indicate that there are significant differences in learning outcomes between the Project-Based Learning (PjBL) learning model and the Problem Based Learning (PBL) learning model by controlling the Pretest score. The significance of the PjBL learning model gives different and higher results compared to the PBL learning model. The application of the Project-Based Learning learning model provides many more meaningful and meaningful learning experiences for students in improving the evaluation of learning outcomes.

INTRODUCTION

The rapid and unstoppable development of the industrial world affects the education system. The industrial revolution 4.0 or also known as the cyber-physical system with a concept centered on automation, where humans do work can be reduced [1] [2] [3]. This era resulted in a change in the perspective of education [4] [5]. This change has an impact on how an educator teaches by applying methods that can have a direct impact [6] on students' knowledge.

The challenges of education in the 21st century with technological advances and digital transformation can help students gather various sources of the latest information and knowledge as well as with the entry of Society 5.0 which aims to create a society where social challenges are solved by incorporating

industry 4.0 innovations [7] [8]. Education in Indonesia will enter the global competition. The world of education will determine what the future of Indonesia will be. Then, how do achieve progress in the world of education? Among them applying a model or learning method that can have a direct impact on students. Innovative learning is a learning process that is designed differently from learning in general that is carried out by educators (conventional). More innovative learning focuses on student-centered learning. The learning process is designed, structured, and conditioned in such a way that students can learn [8] [9] [10] [11]. Therefore, this innovative learning model is well suited to be applied to the current learning process.

Many learning models are included in the criteria for innovative learning models, including the Project-Based Learning (PjBL) learning model and the Problem Based Learning (PBL) learning model [12] [13] [14] [15]. PjBL is a student-centered learning model for conducting an in-depth investigation of a topic [16] [17]. Involve students in problem-solving and other meaningful tasks, focusing on key concepts and principles in the field. Students are allowed to work independently to construct learning independently or simultaneously and finally produce a feasible and realistic product. PjBL uses projects as a learning tool [18] [19] to achieve the expected competencies, so this model can increase student learning motivation, and improve student problem solving and improve teamwork in groups. Through Project-Based Learning (PjBL) educators act as facilitators [20] [21] in providing problems in the form of projects that must be completed by students. This model has a relatively long duration and is integrated with practices and issues that exist in the real world. Students will have great potential in creating interesting and meaningful learning experiences and can prepare themselves by having the latest abilities with the times and being ready to work later. Educators as facilitators convey topics and questions about how to solve these problems. Then students design a product to overcome the problems that have been raised [22]. Educators integrate and monitor student activity and project progress, testing and evaluating project results.

Problem Based Learning (PBL) is a pedagogical approach that allows students to learn and be actively involved in learning on a given open problem [23], besides that this learning model is also included in the collaborative learning model [24]. Students can solve problems in collaborative situations [25] [26]. The PBL model is the same as the PjBL model, also student-centered [27] [28]. Students are directly involved in the problem-solving process, so they will form independent study habits through practice and reflection. In this model, it is expected that students can increase their independence in learning [29], participate actively in learning [30], improve skills according to what is in the field [31], and solve problems by working together in groups [27].

The problems faced by Indonesian education today are that many students are less creative, and they receive more than find out. In addition, if faced with a problem students will find it difficult to find a solution. Then something new is needed to stimulate students' ability to think creatively, increase their curiosity, and able to solve problems in learning. Based on the application of the two models, it can be said that the PjBL and PBL learning models have a positive effect on the evaluation of student learning outcomes, besides that this model can hone students' ability to solve problems. To see whether there are differences in the application of the PjBL and PBL learning models to the evaluation of student learning outcomes, a study was conducted to compare the two models by setting a pretest as a controller. From the findings of this study, it is hoped that it can provide solutions in the application of appropriate learning models and can be developed for further research.

METHOD

The type of research is experimental research. Experimental research is research that is carried out intentionally by giving certain treatments to research subjects [32]. This study aims to compare the results of the learning evaluation of mining engineering students with the PjBL and PBL models. The number of samples in this study was 42 mining engineering students in Applied Physics course, Faculty of Engineering, Universitas Negeri Padang. Sampling was carried out randomly and in 2

groups, namely experimental group 1 and experiment 2. The design of the research scheme can be seen in Figure 1.

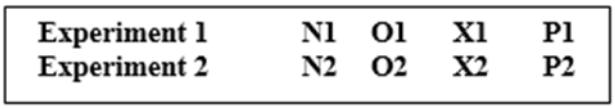

Fig 1. *PjBL and PBL Implementation Design*

Description:
N1: Number of students in experimental class 1 (21 students)
N2: Number of students in experimental class 2 (21 students)
O1: Pretest in experimental class 1
O2: Pretest in experimental class 2
X1: PjBL Model
X2: PBL Model
P1: Posttest in experimental class 1
P2: Posttest in experimental class 2

Before the two models were applied, students were first given a pretest once, then the two models were applied to each class, after which a posttest was carried out. The instrument used in this study was an essay test consisting of 10 questions that required answers in the form of problem-solving. Data analysis techniques to see the differences between the two models in evaluating learning outcomes using analysis of covariance (ANCOVA) using the SPSS version 20 application, with pretest results as covariates. The pretest is controlled to ensure that the evaluation of learning outcomes is not influenced by the results of the pretest, but is determined by the learning models applied, namely Project Based Learning (PjBL) and Problem Based Learning (PBL). Before testing the hypothesis, the assumptions or requirements of the analysis are carried out in the form of normality, homogeneity, and linearity tests.

RESULTS AND DISCUSSIONS

The implementation of PjBL and PBL learning models was carried out on 42 students who were divided into 2 groups randomly, namely experiment 1 by applying the PjBL learning model to 21 people and experiment 2 with the PBL as many as 21 people.

Table 1. Descriptive Statistics Pre-test and Post-test

	Groups	N	Mean		Std. Deviation
			Statistic	Std. Error	
Pre-test	Experiment 1	21	72.62	1.15	5.30
	Experiment 2	21	71.09	0.83	3.82
Post-test	Experiment 1	21	85.05	1.12	5.17
	Experiment 2	21	80.76	1.35	6.18

Table 1 shows the average pre-test and post-test scores for the Project-Based Learning (PjBL) and Problem Based Learning (PBL) learning models. From Table 1, it can be seen that there are differences in the evaluation of student learning outcomes for classes that apply the PjBL model and the PBL model, to see if the difference in the application of the two models is significant, an exit test is carried out using ANCOVA. Before performing the analysis of covariance (ANCOVA) to see whether the comparison of the two learning models proved significant, a normality test was first performed to determine whether the data came from a normal distribution or not. The test was carried out with the help of Kolmogorov-Smirnov.

Table 2. Normality Test

		Unstandardized Residual
N		42
Normal Parametersa,b	Mean	0E-7
	Std. Deviation	5.60222018
Most Extreme Differences	Absolute	.143
	Positive	.090
	Negative	-.143
Kolmogorov-Smirnov Z		.924
Asymp. Sig. (2-tailed)		.360

Table 2, on the Asymp row. Sig 0.360 > 0.05 means the data is normally distributed and fulfilled [33]. Then the homogeneity test was conducted to see whether there was a significant interaction between the learning model and the pretest in its effect on the post-test and student linearity test.

Table 3. Tests of Between-Subjects Effects (Homogeneity)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	356.050[a]	3	118.683	3.965	.015
Intercept	463.773	1	463.773	15.492	.000
Learning Model * Pretest	13.372	1	13.372	.447	.508
Learning Model	8.674	1	8.674	.290	.594
Pretest	109.162	1	109.162	3.646	.064
Error	1137.569	38	29.936		
Total	290168.000	42			
Corrected Total	1493.619	41			

Judging from the row (Learning Model * Pretest) in Table 3 that the value F = 0.447; dB = (1:38), with a value of Sig. 0.508 > 0.05 means that the assumption of regression homogeneity is met [34]. So statistically there is no significant interaction between learning models in their influence on the evaluation of mining engineering student outcomes (posttest). In Table 4, the value of Sig. 0.015 < 0.05 indicates that the linearity test is met. This means that the use of covariates in the pretest is appropriate and significant.

Table 4. Linearity

		Evaluation of Learning Outcomes	Pretest
Post-test	Pearson Correlation	1	.372*
	Sig. (2-tailed)		.015
	N	42	42
Pre-test	Pearson Correlation	.372*	1
	Sig. (2-tailed)	.015	
	N	42	42

Furthermore, hypothesis testing was conducted to see whether there was a significant difference between the application of the PjBL and PBL models to the evaluation of student learning outcomes by controlling for the pretest scores obtained by students. By controlling the pretest, the evaluation of pure learning outcomes will be influenced by the application of the PjBL and PBL learning models without any intervention from the pretest value.

Table 5. Hypothesis Test (ANCOVA)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	342.679[a]	2	171.339	5.806	.006
Intercept	460.053	1	460.053	15.589	.000
Learning Model	135.839	1	135.839	4.603	.038
Pretest	149.822	1	149.822	5.077	.030
Error	1150.940	39	29.511		
Total	290168.000	42			
Corrected Total	1493.619	41			

Based on Table 5, in the learning model row, F = 4.603 and Sig. 0.038 < 0.05 [35] means that there is a statistically significant difference in the evaluation of learning outcomes between the PjBL and PBL learning models by controlling the students' pretest scores (in other words, this learning model has a significant influence on the evaluation of outcomes learning). Table 5 also shows a significant effect or relationship between pretest and posttest by controlling the learning model with the value of Sig. 0.030 < 0.05. From Figure 2, it can be seen that the graph is increasing, so it can be ascertained that high pretest results tend to get a high post-test and the correlation is positive.

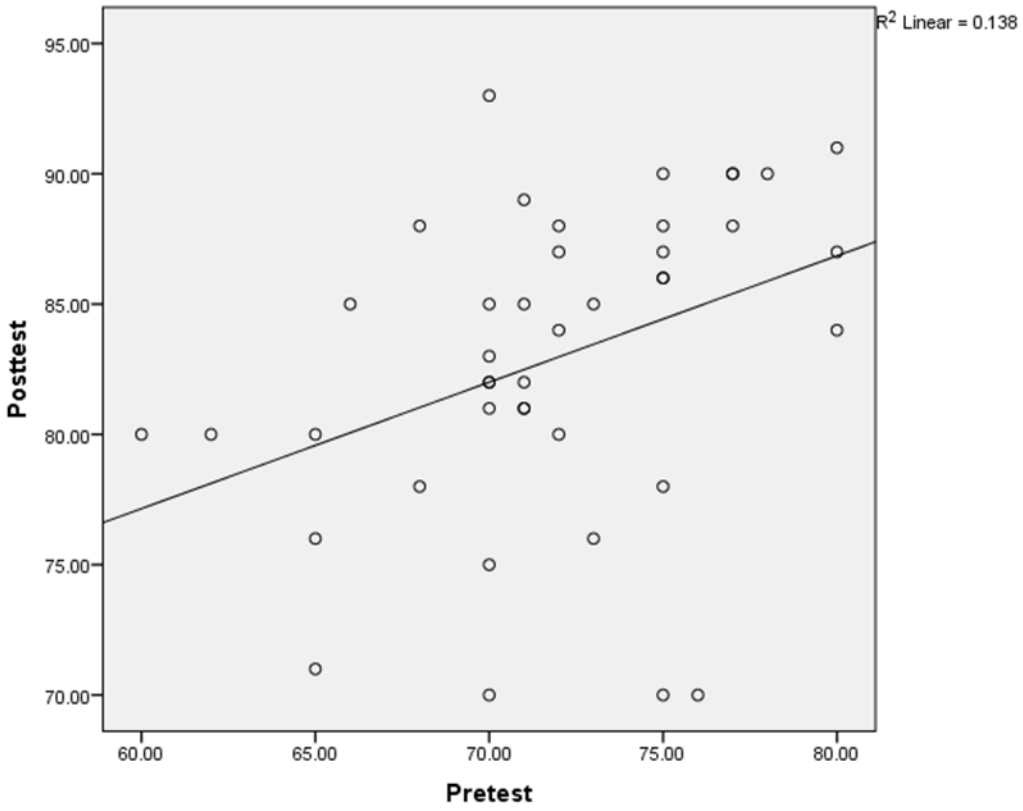

Fig 2. *Effect of Pretest and Posttest*

The significance of the treatment, where there is a significant difference in the evaluation of student learning outcomes in learning using the PjBL and PBL models is supported by an average of 2 sample groups where the average evaluation of learning outcomes in the PjBL is 85.05 while the PBL model is 80.76. This means that the difference in the average evaluation of learning outcomes and the significance proves that the PjBL learning model has a different and higher impact than the PBL learning model. This is because the activity experience obtained in the PjBL learning model is higher than in the learning model with PBL [18] [36] [37]. PjBL through the procedure of how to drive students [38] [39]. This will greatly assist students in developing their ability to solve problems and be able to provide appropriate solutions.

The role of educators during learning activities is as someone always ready to accompany students [40]. Educators provide suggestions and input so that the project can be completed on time [41]. Not only from educators but feedback is obtained, from other teams or friends as well [42]. Students can reflect on feedback provided by other teams, friends, and educators [43]. Project designs are completed by working together in groups [44]. Students will make a regular schedule in completing the projects that have been planned [45]. Then students will make presentations after the project or product they are working on is complete [46].

From various aspects, PjBL and PBL have different characteristics. This can be seen from the form of knowledge, the organization of knowledge, the types of activities, the role of students, and the role of educators during the learning process [47] [48]. Tasks have been arranged and planned in such a way in the PjBL learning model, while in the PBL learning model all problems are presented openly [49] [50]. The roles of students and educators in these two models are also different. In the Project-Based Learning (PjBL) learning model, educators act as task makers and project supervisors where the role of students, in this case, is to complete projects, in this case, develop solutions and strategies [51]. Problem Based Learning (PBL) students are active as inventors and have their own learning experiences while the role of education is to provide opportunities for students to learn [52] [53].

The main focus of the PjBL learning model is problem management and problem-solving [54] [55]. Meanwhile, PBL became the main focus in developing strategies to facilitate group members and learning [56]. The development of students' creativity (aspirations) is a representation of Project-Based Learning (PjBL) [57]. Freedom in making projects is given to students to design and develop products according to their wishes of students. In Project Based Learning (PjBL) students will be able to make good reports that contain all aspects such as titles, objectives, theories, materials and tools, procedures, results, discussions, and drawing conclusions.

CONCLUSION AND SUGGESTION

Control of the pretest value was carried out to see the pure effect of the application of the two learning models. Project-Based Learning (PjBL) and Problem Based Learning (PBL) learning models with pretest as a covariate provide significant differences in evaluating student learning outcomes. The significance of the Project-Based Learning (PjBL) and Problem Based Learning models is also seen in the mean scores of the 2 sample classes, where the class with the PjBL learning model is higher than the PBL learning model. The application of blended learning can be applied to further research, saving time and money. Learning in blended learning can also use the LMS platform to share learning videos and supporting animations.

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