The Influence of the PBL Model to Improve the Student's Mathematical Ability of Reasoning and Proof

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Abstract. Effective learning is a learning that affects students' math skills, one of which is the ability of reasoning and proof. The ability of reasoning and proof consists of several stages: Recognize reasoning and proof as fundamental aspects of mathematics; Make and investigate mathematical conjectures; Develop and evaluate mathematical arguments and proofs; Select and use various types of reasoning and methods of proof. The purpose of this research is to know: (1) Is there any influence of PBL model in improving the students' ability mathematical of reasoning and proof in subject of vector analysis course?; (2) Is the PBL model better in improving the students' ability mathematical of reasoning and proof in subject of vector analysis course? This research is a quasi-experiment research. The data analysis technique is done from test stages of data description, prerequisite test is normality test, and hypothesis test using ANCOVA test. The results showed that: (1) There is an influence of PBL model in improving the students' ability mathematical of reasoning and proof in subject of vector analysis course; (2) The PBL model can improve the students' ability mathematical of reasoning and proof in subject of vector analysis course.

1. Introduction

Mathematics is a universal science underlying the development of modern technology, has an important role in various disciplines and advances the human mind. Rapid development in the field of information and communication technology today is based on the development of mathematics in the field of number theory, algebra, analysis, discretionary theories of opportunity and mathematics. To master and create technology in the future requires a strong mastery of mathematics from an early age.

Mathematics learning has a purpose so that students have the ability to understand mathematical concepts, using reasoning on patterns and mathematical properties, solving mathematical problems, communicating ideas, having an appreciative attitude to the usefulness of mathematics in life [1].

The ability mathematical of reasoning and proof of students has an important role in learning mathematics in the classroom. Shadiq in [2] states that reasoning and proof ability is needed by students in learning mathematics, because the patterns of thinking developed in mathematics are critical and involve critical, systematic, logical, and creative thinking.

The cause of the failure of students in mastering mathematics learning materials is students are less able to use logical reasoning in solving problems or math problems by the teacher. While effective learning is a learning that affects the ability of reasoning and mathematical proof of students. Based on NCTM [3] the instructional program of students' reasoning and proofing ability should enable each student to: 1) Recognize reasoning and proof as a fundamental aspect of mathematics; 2) Creating and investigating mathematical guesses; 3) Develop and evaluate mathematical arguments and proofs; 4) Select and use different types of reasoning and verification methods.

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One of the learning models that can solve the problem one of them is PBL (Problem Based Learning). The problem-based learning model is emphasized on learning with reasoning and proof. Therefore, learning begins with solving problems, and problems posed to students must be able to provide new information (knowledge) so that students acquire new knowledge before they can solve the problem. The goal of learning is not only to find a single correct answer, but more than that the student must be able to interpret the given problem gathering important information, identifying possible reasoning and verification, evaluating choices, and drawing conclusions [4].

2. Method

Determination of the sample by conducting preliminary tests to see the homogeneity of each class. Based on the preliminary tests the researcher assumes that the nine classes are homogeneous, so the researcher concludes taking only one class from nine classes at random (Cluster Random Sampling). This research is a quasi-experiment research with two research variables. The research design is shown in Table 1.

Table 1. Research Design

Group	Pre-test	Treatment	Postest
Experiment	T_1	X_1	T_2
Control	T_1	X_2	T_2

Information :
X_1 = experimental group using PBL model
T_1 = pre-test
T_2 = postest
X_2 = control group using traditional model

The procedures in the study are as follows:

1. The researcher gives a pre-test to see the student's initial ability level.
2. The researcher provided a stimulus for the sample class using the problem-based learning model for X_1 and the conventional model for X_2.
3. Provide a post to see the level of success of students' math skills.
4. Conducting hypothesis test with procedure as follows: 1) test description of data; 2) test data prerequisites; 3) statistical test that is ANCOVA-test to see the influence of PBL model in improving mathematical ability of student of Vector Analysis

3. Result and Discussion

3.1. Result of Research

Descriptive analysis of pre-test and score resulted from descriptive data. Some descriptive data of the results of this study are mean scores and standard deviations shown in Table 2.

Table 2. Decriptive Statistics

Statistik	Pre-test		Post-test	
	PBL	Traditional	PBL	Traditional
Averages	69.03	67.80	81.74	77.23
Standard Deviation	7.83	6.09	7.00	6.21

Based on the results of the descriptive analysis shows that the pretest averages for PBL model 69.03, pretest for Traditional model 67.80, post-test for PBL model 81.47, post-test for traditional model 77,23. As for standard deviation pretest model PBL 7.83, pretest for traditional model 6.09, post-test for PBL model 7.00, post-test for traditional model 6.21.

The normality test is a test of the spread of each score on the pretest score and posttest score, both in the control group and in the experimental group. The scatter normality test scores were performed by Kolmogorov-Smirnov and/or Shapiro-Wilk statistical tests. The results of the scatter distribution normality test are shown in Table 3.

Table 3. Tests of Normality

Model	Tes	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
PBL	Postest	.125	35	.183*	.958	35	.204
Traditional	Postest	.121	35	.200*	.958	35	.202

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Based on normality test results indicate that the value of sig. At Kolmogorov-Smirnov more than 0.05, so the conclusion is good post-test data by using normal distributed PBL model and traditional models.

The homogeneity test of variance was intended to determine the homogeneity of the variance of pretest score between the control group and the experimental group. Likewise, the homogeneity of variance scores post-test between controls and experimental groups. The homogeneity test of variance is shown in the table 4.

Table 4. Tests of Homogeneity of Variance

Levene Statistic	df1	df2	Sig.
1.348	10	58	.228

Based on homogeneity test results indicate that the value of sig. On Levene Statistic over 0.05, it was clarified that the variance of the pretest score between the control group and the experimental group was homogeneous. Likewise, the variance of posttest scores between the control group and the experimental group was homogeneous.

After all assumption tests are met, then hypothesis testing with ANCOVA statistics. The alternative hypothesis tested is "PBL model can improve students' mathematical reasoning and proof skills in vector analysis courses." The test results using ANCOVA statistic produce significance value as shown in Table 5.

Table 5. Tests of Between-Subjects Effects

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1832.261a	2	916.130	37.143	.000
Intercept	836.520	1	836.520	33.916	.000
Pretest	1510.832	1	1510.832	61.255	.000
Model	185.580	1	185.580	7.524	.008
Error	1652.539	67	24.665		
Total	447016.000	70			
Corrected Total	3484.800	69			

a. R Squared = .526 (Adjusted R Squared = .512)

From the above output, it can be seen that the influence of the student Pre-test and the difference of learning model to the Post-test value obtained by the students simultaneously can be seen

from the number of signatures in the Corrected Model. It can be seen that the number of significance is 0.000. Because the value of significance is far below 0.05 then H0 is rejected. So at the level of 95% confidence can be concluded that simultaneously Pre-test students and learning models affect the value of post-test obtained by students.

The significance of the Pre-test variable is 0.000 because of the value of Sig. <0,05 then H0 is rejected. This means that at the 95% confidence level there can be a linear relationship between the Pre-test and the Post-test value obtained by the student. This statement indicates that the ANCOVA assumption has been fulfilled. This test is done by eliminating the effect of differences from the learning model first.

Further testing conducted to determine the effect of different learning models on the value of Post-test obtained by students. This test is done by eliminating the influence of Pre-test of the learning model. From the results of the processing it can be seen that the number of significance for learning model variables is 0.008. Because the value is far below 0.05 then H0 is rejected. Without influence of Pre-test, at 95% confidence level there is influence of learning model difference to post-test value obtained by student. So it can be concluded there is influence of PBL model can improve the students' ability mathematical of reasoning and proof in subject of vector analysis course. If a student's average posttest score is examined, it appears that the average score of the experimental group posttest is higher than the control group's posttest mean score. From this posttest average score, the conclusion that can be drawn is the PBL model can improve the students' ability mathematical of reasoning and proof in subject of vector analysis course.

Based on the results of hypothesis testing, it can be concluded that there is influence of PBL model in improving the students' ability mathematical of reasoning and proof in subject of vector analysis course. Seen from the value of sig model is 0.008 less than 0.05. For the results of the second hypothesis test, it can be concluded that the PBL model can improve the students' ability mathematical of reasoning and proof in subject of vector analysis course, as seen from the pretest values in PBL model 69.03 and posttest PBL model 81.74. Shows the posttest value is better than pretest.

3.2. *Research Discussion*

Further testing conducted to determine the effect of different learning models on the value of Post-test obtained by students. This test is done by eliminating the influence of Pre-test of the learning model. From the results of the processing, it can be seen that the number of signatures for learning model variables is 0.008. Because the value is far below 0.05 then H0 is rejected. Without the influence of Pre-test, at 95% confidence level there is the influence of learning model difference to a post-test value obtained by the student. So it can be concluded there is the influence of PBL model can improve students' reasoning and mathematical proof in the subject of vector analysis. If a student's average posttest score is examined, it appears that the average score of the experimental group posttest is higher than the control group's posttest mean score. From this posttest average score, the conclusion that can be drawn is the PBL model can improve students' reasoning and mathematical proof in the vector analysis course.

Based on the results of hypothesis testing, it can be concluded that there is the influence of PBL model in improving students' reasoning and mathematical proof in vector subject analysis. Seen from the value of sig model is 0.008 less than 0.05. For the results of the second hypothesis test, it can be concluded that the PBL model can improve students' math skills in vector analysis courses, as seen from the pretest values in PBL model 69.03 and posttest PBL model 81.74. Shows the posttest value is better than pretest.

The PBL model, the teacher gives students an orientation about the problem and motivates the students to engage in problem-solving activities. Orientation about the problem in question is the teacher gives a problem according to the topic to be discussed; the student is expected to solve the problem in the group. Teachers organize students to research, help students to define and organize learning tasks related to problems, teachers assist independent and group investigations, encourage students to get the right information, carry out experiments, and seek explanations and solutions. To

organize the students in question is to form groups and make patterns or maps of thoughts on students looking for solutions to solve problems within the group. Teachers develop and present artifacts and exhibits, help students plan and prepare reports, and help them to communicate to others. Developing and presenting the intended ones is that students should be able to present the results of group discussions in front of other groups. Discussion results are the reasoning and verification of the problems given by teachers within the group. Teachers analyze and evaluate problem-solving processes, help students reflect on their investigations and the processes they use. Based on the stages of learning above it is clear that learning requires more active students. Because in the students' learning directly involved in the investigation and find the solution of the problem, so in the end, students are helped to become autonomous students who can help themselves, in solving the problems it faces.

The PBL model is a model of group learning, so the PBL model is part of the cooperative learning model. Mandal [5] said that cooperative learning can develop high-level thinking skills, create an active learning environment, improve student performance with less academic ability, and tolerate different learning styles among students.

Some principles in applying the PBL model, namely: (1) all participants listen well to what is delivered by students or other groups; (2) opinions must be based on sound proof and reasoning and proof; (3) the discussion process should be in a dialogical setting. So that students are expected after learning PBL model not only have the cognitive ability but also effective or soft skill ability and skill or life skill.

Some of the obstacles encountered in applying the PBL model are: (1) the PBL model is an oral book study, each student or group must have many references on the topic being discussed. So that students have to collect many sources of reference, because at the beginning of the teacher's learning only provide topic material and problems to be solved in the group; (2) high-order thinking that causes students to take time to adjust to the PBL model. The solution given to overcome these problems is to direct and guide students using IT-based technology. Technological advances not only have a negative impact but actually, have a positive impact when used properly and correctly.

4. Conclusion

Based on the results obtained in this study, it can be concluded that there is the influence of PBL model in improving students' reasoning and mathematical proof. PBL model can improve students' reasoning and mathematical proof. This shows that the application of PBL model influences students' reasoning and mathematical proof in vector analysis courses. Thus, the PBL model can improve students' reasoning and mathematical proof in vector analysis courses.

Based on the results achieved, suggestions can be made as follows. First, the application of the PBL model is emphasized on learning by reasoning and proof. Second, the PBL model can be used as an alternative learning model by lecturers to improve students' reasoning and proofing ability. Third, the use of PBL model is applied to high learning high. Fourth, the PBL model is an oral book learning model so students can learn independently.

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