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The Effect of Project Based Learning Assisted by Manipulative Learning Media on the Understanding of Elementary School Students

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ABSTRACT

Project Based Learning is a learning model that is carried out to solve problems by making real projects or products. The purpose of this study was to see how much influence the application of the project-based learning model had on students' understanding of the triangle material of grade IV elementary school pucangarum 1. This type of reserch is quantitative, quasy Exsperimental reserch type, reserch design nonequivalent control group design. This study consisted of an experimental class and a control class. The instruments used were a student questionnaire, a Pretest, and a Posttest. The data analysis technique uses the N-gain test for the experimental type, the average is 0.69, which is pretty compelling. The project-based learning hypothesis test has an average significance of 84.67, and the conventional learning model has an average of 76.00. Ho is rejected, and ha is accepted, meaning that there is an influence of the project-based learning model on student understanding.

Introduction

Education has an important role to educate the nation's children. One of the important things that must be considered in advancing an education is managing thinking potential, managing skills so that student understanding increases. (Maunah, 2009). In the education process, teachers are needed to provide experience, skills, and even develop the potential of thinking in students as a means to develop quality in the learning process. (Nurhayati et al., 2022). The learning process of teachers must have the ability to process learning as interesting as possible, especially in mathematics learning. math lessons are a lesson that is proven to be true through detailed, reasonable, and rational steps. (Inanna, 2018).

Learning mathematics in elementary school has a useful purpose for the life of a country. Pemendiknas No. 22 of 2006 states that the learning objectives that contain the Basic Education Content Standards are the first to understand mathematical concepts in solving problems in everyday life, the second to train students in using their reasoning, the third is that students are trained to solve problems by using mathematical learning models and formulating solutions, the fourth can communicate ideas with diagrams or tables symbols to clarify problems, the fifth is to foster students to have curiosity, interest, and attention in studying mathematics. (Muchtar & Suryani, 2019).

To maximize learning, learning media is needed as a learning aid. one of the learning media used in this study is manipulative learning media. (Falahudin, 2014). Manipulative learning media is an abstract learning media used in learning activities with the aim of helping students explore ideas actively with the help of this form of learning media. (Thobroni, 2017). This manipulative learning media is used by teachers as a tool to assist teachers in explaining various theories. One of the abstract concepts in mathematics is triangular flat shapes taught to fourth grade elementary school students of SDN Pucangarum 1. In this lesson, students need media to gain concrete experience related to abstract concepts such as triangular flat shapes. In addition to using learning media in conducting a learning activity, it must also be balanced with an effective learning model to help students to learn more practically and enjoyably. One of the learning models that is in accordance with the development of the current era is the Project Based Learning model. (Farhana et al., 2022).

Project-based learning model is an innovative learning model that involves project work where students work independently in constructing their learning by collaborating in real products. (Anggraini & Wulandari, 2021). In the application of this learning model students are given the opportunity to explore, determine learning objectives and activities as an interesting concept. Students are given the opportunity to access sources of information and other supporting equipment so that students are encouraged and supported to develop not something that is controlled and limited. (Sulisworo, 2010).

Method

This study uses quantitative research with the research method Quasi Experimental design Nonequivalent Control Group Design. To test the effect of the Project Based Learning model applied using Pretest and Posttest (Syahza, 2021). The research design of the Nonequivalent Control Group design in order to know and see the test results before and after treatment can be described below:

Table 1. Research Design *Non Equivalent Control Group Design*

Kelas	Pretest	Perlakuan	Posttest
Experiment	O_1	X_1	O_2
Control	O_3	X_2	O_4

Keterangan
O_1 = Pretest of experimental class
O_2 = Pretest of control class
X_1 = Project Based Learning model treatment
X_2 = Conventional learning model treatment
O_2 = Posttest of experimental class
O_4 = Posttest of control class

The population based on this study were fourth grade students of SDN Pucangarum 1. (Susanto, 2012). The 12 students were made into two groups, namely the experimental group and the control group. The research data instrument is a tool used by researchers in collecting observation data on the implementation of the implementation of the Project Based Learning model, filling out student response questionnaires, and Pretest and Posttest to make it easier to process. (Matondang, 2009). After obtaining data from the results of the research instrument, the next test is to analyze the data to answer the hypothesis. The research data obtained will be analyzed through the following stages:

1. N-Gain Test
   The N-Gain test is needed in this study to show the effectiveness in improving the concept mastery ability of students who are normally distributed or otherwise using the SPSS application. (Susanto, 2012). The achievement table to see the effect based on the average N-Gain value is as follows:

Table 2. Average Value of N-Gain and its Classification

Rata-Rata N-Gain	Klasifikasinya	Tingkat Pengaruh
$(g) \geq 0{,}70$	High	Effective
$0{,}30 \leq (g) < 0{,}70$	Medium	Moderately Effective
$(g) < 0{,}30$	Low	Less Effective

2. Prerequisite Test
   a. Uji Normalitas

This normality test is used in this study to find out whether the data generated is normally distributed or not using the *Chi-Quadrat* statistical test *Kolmogorov-Smirnov* formula (Pratama & Permatasari, 2021). Data is normal if the significant degree of distribution is > 0.1 or 10%.

b. Homogeneity Test
This homogeneity test is used to test whether the two samples are homogeneous or not. (Budiwanto, 2017). This test uses the Bartlett method. The data is said to be homogeneous if the significant data> 0.1 or 10% (Pratama & Permatasari, 2021) .

c. Hypothesis Test
This hypothesis test uses the Anova analysis technique. Anova is used to determine whether or not there is a difference between the values given treatment and those not given treatment. (Arifin, 2018). The hypothesis test results are seen if *Probabilitas Value* (sig) > 0,1 or 10% then Ho is rejected and Ha is accepted, if Ha is accepted then there is a significant effect on the analyzed data.

Result and Discussion

1. Results of Research Instruments

The results of the analysis of student understanding tests of triangle material. This student understanding test instrument as a support for testing the level of student understanding used to measure students' understanding of triangle material. Instruments made in the form of Pretest and Posttest descriptions. The test was given to give treatment to class IV SDN Pucangarum 1, totaling 12 students. The results of the test instrument analysis are as follows:

Table 3. Experimental Class Pretest and Posttest Values

Score Description	Classification	Level of Influence
	Pretest	Posttest
Lowest Score	26	82
Highest Score	80	90
Maximum Score	100	100
Average Score	36,33	84,66

Table 4. Control Class Pretest and Posttest Scores

Score Description	Classification	Level of Influence
	Pretest	Posttest
Lowest Score	23	71
Highest Score	70	85
Maximum Score	100	100

Average Score	36,55	76,00

The table above shows the score of students' understanding of triangle material. The test was given to grade IV students of SDN Pucangarum 1 as many as 12 students, 12 students were then divided into 2 groups, group 1 was the experimental group, group 2 was the control group, the two groups were given a Pretest test before being given a learning model, and the *Posttest* test was conducted after being given treatment. It can be explained in the table above that there is a difference between the Control *Posttest* and the experimental *posttest*, the highest average is obtained in the experimental *Posttest* test after being given the *Project Based Learning* model treatment.

2. Data Analysis of Research Results

Data analysis conducted by researchers based on research data includes N-Gain Test, Prerequisite Test, Hypothesis Test.

a. N-Gain Test

N-gain test is needed in this study to determine the average difference obtained from normally distributed research results or vice versa. (Wahab, 2015).

Table 5. Experimental Class Gain Normality Test Results

Students	Experiment Class	Control Class
	N-Gain Score (%)	N-Gain Score (%)
1	80,88	50,00
2	79,73	72,73
3	20,00	59,15
4	71,43	61,67
5	75,00	59,42
6	87,01	62,16
Average	69,0089	60,8552
Minimal	20,00	50,00
Maxsimal	87,01	72,73

Prerequisite Test Based on the data in table 4.7, namely Pretest data and Posttest data for class IV SDN Pucangarum 1. The results of data analysis of the class applied Project Based Learning model obtained Value < g> = 69.0089 or 0.69. the level of effectiveness of N-Gain of the class applied Project Based Learning model is categorized as quite effective with moderate classification. And it can be concluded that there is an influence between the Project Based Learning model compared to the Conventional learning model.

b. Prerequisite Test

1) Data Normality Test

This data normality test is used to determine whether the data that has been studied has normal or abnormal distribution. (Homogenitas & Uji,

2020). The data is said to be normal if the test results get a significant value> 0.1 or 10% in the results of *Kolmogorof-Smirnov*. The following are the results of the normality test.

Table 6. Results of Pretest and Posttest Normality Test for Experimental Classes

Test Of Normality							
	Kelas	**Kolmogorov-Smirnov**			**Shapiro-Wilk**		
		Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Student Learning Outcomes	Pre-test Experiment	,321	6	,125	,748	6	,019
	Post-test Experiment	,129	6	,200*	,991	6	,991
	Pre-test Control	,291	6	,123	,779	6	0,37
	Post-test Control	,269	6	,200*	,879	6	,266

Based on the table above, it shows that the normality data in the Pretest experimental class obtained a result of 0.125, the Posttest experimental class normality data obtained a result of 0.200, the Pretest control class normality data obtained a result of 0.123, the Posttest control class normality data obtained a result of 0.200, if the significant value of learning outcomes> 0.1, and the significant results of all the results of the normality data> 0.1 then all these samples come from a normally distributed population.

2) Homogenity Test

This homogeneity test is needed to see the research results obtained are homogeneous or inhomogeneous samples. (Usmadi, 2020). The data obtained is said to be homogeneous if the significance level is 10% or 0.1. The results of homogeneity testing using the *Bartlett* method can be seen as follows.

Table 7. Pretest Homogeneity Test Analysis Results with SPSS

Test Of Normality		
Box's M		0,300
F	Approx	0,273
	df1	1
	df2	300,000
	Sig.	0,602
Tests null hypothesis of equal population covariance matrices		

Based on the data analysis of the *Pretest* and *Posttest* homogeneous test on Box'M Test Results, it is obtained at 0.300 and has a significance of 0.602. If the Chi-Quadrat table with a significance level of 0.1 or 10%. The results of Box'M which obtained a significant level value of 0.602> 0.1 then the sample is homogeneously distributed. It can be concluded that the data is 0.602> 0.1, then H0 is accepted, and the results of the experimental *pretest* class and control class are both normally distributed or homogeneous.

3) Hypothesis Test

This hypothesis test is used to review the average and influence between the *Project Based Learning* model and the conventional learning model. (Mufarrikoh, 2019). To see the effect on this hypothesis test using Anova 1 path technique or (One way Anova). Based on the analysis, the One Way Anova test data is obtained as follows:

Table 8. ANOVA (Student Learning Outcomes)

ANOVA

Student Learning Outcomes	Sum Of Squares	df	Mean Square	F	Sig.
Between Groups	4590,246	3	1530,082	2,592	,025
Within Groups	11215,667	19	590,298		
Total	15805,913	22			

Based on the table above, the acquisition of a significant value of 0.025. because the *probability value* (Sig) = 0.025> 0.1 then H_0 is rejected and H_a is accepted. So it can be concluded that there is an influence on the *Project Based Learning* model on student understanding so that it can improve student learning outcomes in mathematics class IV SDN Pucangarum 1. To find the average difference in the *Project Based Learning* model and the conventional learning model based on the hypothesis analysis of *One Way* Anova which is significant, the Descriptives data is obtained as follows:

Table 9. Results of SPSS Analysis of Descriptive Statistics Group Data

Descriptives of Mathematics Learning Outcomes

N		Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Min	Max
Pretest Exsperimen	6	36,33	22,259	9,087	12,97	59,69	20	80
Posttest Exsperimen	6	84,67	3,559	1,453	80,93	88,40	80	90

Pretest Control	6	36,50	17,398	7,103	18,24	54,76	23	70
Posttest Control	6	76,00	5,441	2,221	70,29	81,71	71	85
Total	24	58,38	26,375	5,384	47,24	69,51	20	90

Based on the table above shows that in the Mean column the data obtained that the average of the *Pretest* experimental class (carried out before being given the *Project Based Learning* model treatment) obtained an average of 36.33, in the *Posttest* experimental model (actions taken after being given the *Project Based Learning* model treatment) obtained an average of 84.67, while the Pretest control class (actions taken before being given the conventional learning model treatment) obtained an average of 36.50 and in the Posttest control class (actions taken after being given the conventional learning model treatment) obtained an average of 76.00. In the *One Way* Anova tenik hypothesis test, the *Project Based Learning* model treatment is predicted to have an influence on increasing student understanding with a significance level value of 0.1 or 10%. Thus it can be seen in the *One Way* Anova Hypothesis Test descriptively it can be concluded that the highest average student thinking ability is applied using the *Project Based Learning* model which is 84.67> 0.1, so there is an influence between the *Project Based Learning* model and the conventional learning model.

Based on the analysis obtained by researchers in conducting research, the application of the *Project Based Learning* model has a positive effect on class IV SDN Pucangarum 1. Based on field observations: 1) students are less active in the learning process, 2) students do not understand the material taught, 3) teachers still use conventional learning models, 4) student learning outcomes are still below the KKM score, 5) students are less creative and do not think critically. In the learning process of *Project Based Learning*, the achievement of this learning model makes students actively think creatively, students can operationalize the material independently, students can communicate among groups, discuss, can improve skills, and exchange ideas to be able to improve their cognitive knowledge, so that the classroom atmosphere becomes more active.

The application of the learning model using the *Project Based Learning* model succeeded in increasing good interaction in the learning environment. Mathematics learning is more effective or more meaningful by using the *Project Based Learning* model starting from the stage of determining the project and problem introduction, planning the steps for completing the project, preparing a project implementation schedule, the teacher monitors students in carrying out the project, compiling reports, presenting project results, and evaluating, so that students not only listen to the theory conveyed by the teacher but students gain a deep understanding obtained from making the real product, this makes students able to exchange information and find new ideas.

Students' good response to the *Project Based Learning* model is evidenced according to the results of student comprehension tests on the *Pretest* and *Posttest* tests in the experimental and control classes. On the Pretest, the experimental class obtained an average score of 36.33, with the lowest score of 23 and the highest score of 80. In the *Posttest* the experimental class obtained an average score of 84.66, with the lowest score of 82 and the highest score of 90. In the *Pretest* the control class obtained a score of 36.55 with the lowest score of 23 and the highest score of 70. While in the Posttest class the control class obtained an average score of 76.00, with the lowest score of 71 and a value spread of 85. It can be concluded that in the *Posttest* value of the experiment, namely the treatment with the application of the *Project-based Learning* model, the highest score was compared to the *Posttest* of the control class which was applied with a conventional learning model, so the application of the *Project Based Learning* model had a positive effect on grade IV math lessons at SDN Pucangarum 1.

Based on this explanation, the *Project Based Learning* model has a significant effect on students' thinking skills so that students' understanding increases. In analyzing the test, this research uses the normality test of gain, prerequisite test, and hypothesis test.

In testing the normality test of this gain is needed to determine the difference in the average data on the *Pretest* and *Posttest* of the experimental class and the control class is normally distributed or vice versa. And the results analyzed through the normality test of the gain data obtained on the Pretest and Posttest results of this experimental class obtained a significant value of 0.69. The level of effectiveness of the gain in the class that applied the *Project Based Learning* model was categorized as quite effective with a moderate classification. While the analysis of the normality test results of the control class gain obtained a significant value of 0.61. At the level of effectiveness of gain in the class applied conventional learning model is categorized as quite effective with moderate classification. It can be concluded from the results of the normality test of this gain that both data are normally distributed, but the results of the class applied to the *Project Based Learning* model get a significantly higher value compared to the class that is only applied using a conventional learning model.

In the second test, namely the prerequisite test which consists of data normality test and homogeneity normality test. In this data normality test it is used to see the data obtained is normally distributed or vice versa. in the experimental *Pretest* class obtained a significant result of 0.125> 0.1, so the sample was normally distributed. In the *Posttest* data, the experimental class obtained a significance result of 0.200> 0.1, so the sample was normally distributed. The control class *Pretest* data obtained a significance result of 0.291> 0.1, so the sample was normally distributed. And the control class *Posttest* data obtained a significance result of 0.200> 0.1, so the sample was normally distributed.

In this homogeneity test it is used to see the data sample obtained is homogeneous or inhomogeneous. The data from this homogeneity test is said to be a homogeneous sample if the significance level is> 0.1 or 10%. the results of the

Pretest homogeneity test were obtained from the *test result* of 0.300. The result of Box'M in this homogeneity test is 0.602> 0.1, so the sample is homogeneously distributed. And the results of the *Posttest* homogeneity test were obtained from the *Test Result* of 0.875. The result of Box'M signified 0.373> 0.1, then the sample was homogeneously distributed. It can be concluded that the *Pretest* results have a significance of 0.602> 0.1, and the *Posttest* results have a significance of 0.373> 0.1, so H0 is accepted, and the Pretest and Posttest results of the experimental class and control class are both normally distributed or homogeneous.

In the third test, hypothesis testing was carried out with the aim of seeing the effect of the Project Based Learning model and the conventional learning model applied to improve student understanding and student thinking skills. This hypothesis testing uses the One Way Anova technique. The hypothesis is said to have a significant effect if the significant level is 0.1 or 10%, and H0 is rejected if the probability value <0.1 and H0 is accepted if the probability value> 0.1.

The results of testing this hypothesis are significant 0.025> 0.1 then H0 is rejected and Ha is accepted, so it can be concluded that there is an effect on the Project Based Learning model on student understanding of class IV SDN Pucangarum 1 triangle material.

Conclusion

Based on the results of research that has been conducted by researchers, it can be concluded that there is a significant effect on the *Project Based Learning* model assisted by manipulative learning media on student understanding of class IV SDN Pucangarum 1 triangle material that has been applied. These results are proven through the N-Gain test to see that the data is normally distributed, and the homogeneity test to see that the data obtained is homogeneously distributed, and in the hypothesis testing technique. Anova obtained the results of *Probability Value* (Sig) of 0.025> 0.1, it can be concluded that there is an influence on the *Project-based Learning* model on student understanding so that it can improve student learning outcomes in mathematics class IV SDN Pucangarum 1 triangle material.

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