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The Effectiveness of Project-Based Learning Model in Increasing Understanding of Mathematical Concepts in Fourth-Grade Elementary School Students

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ABSTRAK

Peserta didik kurang mampu mengoptimalkan model project based learning. Masih banyak peserta didik yang belum terlatih berfikir kritis dan kreatif terhadap pemahaman konsep matematika dan anak kurang mampu melakukan kerja sama dengan baik. Tujuan dari penelitian ini adalah untuk menganalisis efektifitas model Project Based Learning Penelitian ini menggunakan metode kuantitatif dengan jenis pre-eksperimen, dan desain one-group pretest-postest. Populasi dalam penelitian ini diambil dari kelas IV, yang terdiri dari 3 kelas. Sampel penelitian terdiri dari kelas IVC sebanyak 33 orang. Data penelitian dikumpulkan melalui metode tes. Teknik analisis data dalam penelitian menggunakan analisis deskriptif dan uji prasyarat dengan menggunakan SPSS release 24 for windows yakni r_hitung lebih dari 0,361 maka 10 item soal tes dinyatakan valid dan layak untuk digunakan peneliti. Berdasarkan kategori kemantapan alpha nilai 0,658 termasuk dalam kategori reliable dapat disimpulkan soal tes yang diajukan reliabilitas. Pada hasil uji Paired Sample t Test dengan nilai signifikan 0,000 kurang dari 0,05 yang menunjukan adanya perbedaan yang signifikan dalam penerapan model project based learning dalam meningkatkan pemahaman konsep matematika siswa kelas IV sekola dasar. Sehingga dapat disimpulkan bahwa perlakuan hasil posttest dengan menerapkan model project based learning efektif dalam meningkatkan pemahaman konsep matematika siswa kelas IV sekolah dasar.

ABSTRACT

Learners are less able to optimize the project-based learning model. Many students still have not been trained to think critically and creatively toward understanding mathematical concepts, and children are less able to cooperate. This study aimed to analyze the effectiveness of the Project Based Learning model. This research used quantitative methods with the type of pre-experiment and a one-group pretest-postest design. The population in this study was taken from class IV, which consisted of 3 classes. The research sample consisted of class IVC, as many as 33 people. Research data were collected through the test method. The data analysis technique in the study used descriptive analysis and prerequisite tests using SPSS release 24 for Windows, r_hitung more than 0.361, so the 10 test items were declared valid and suitable for researchers to use. Based on the alpha stability category, a score of 0.658 is included in the reliable category, so it can be concluded that the test questions submitted are reliable. In the Paired Sample, t-test results with a significant score of 0.000 less than 0.05 show a significant difference in applying the project-based learning model in improving the understanding of mathematical concepts of fourth-grade elementary school students. So, it can be concluded that the treatment of post-test results by applying the project-based learning model effectively improves the understanding of mathematical concepts of grade IV elementary school students.

1. INTRODUCTION

Education is important in shaping children to have skills that enable them to survive and adapt to the environment (Suryana et al., 2021). Preparing qualified students who have skills and can compete globally is challenging for educators (Junedi et al., 2020). One of the exact sciences that has a significant impact on everyday life is mathematics (Sylviani & Permana, 2019). Mathematics is a basic science that underlies the development of other sciences (Jeheman et al., 2019; Rahayu & Hidayati, 2018). Therefore, mathematics is an important subject and is always present at every level of education, from elementary school to university and even in kindergarten informally (Indriani, 2018; Saraswati & Agustika, 2020). Mathematics is a science that is taught gradually and uses the spiral method. Mathematics is taught starting from the concrete, semi-concrete, and abstract stages (Khairani & Roza, 2021). Mathematics is hierarchical, where students must understand concepts well to learn other concepts because

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understanding concepts is the most important part of mastering mathematics (Diana et al., 2020; Farida & Rahayu, 2017; Ula et al., 2019). The most important aspect of learning mathematics is conceptual understanding. After mastering the concept, it is followed by planning to solve problems so that students can overcome the difficulties encountered to achieve the expected goals. The next step is to carry out the plans made earlier. Finally, re-check the results and processes that have been carried out. Thus, a mindset is formed in students to solve the problems they encounter (Putri et al., 2019; Sri Wijayanti, 2023). The purpose of learning mathematics at school is for students to be capable and skilled while at the same time providing provisions to students so that students can apply mathematics in everyday life (Lestari & Putra., 2021).

However, in reality, students tend to master less material in learning mathematics (Khotimah & Yuliastuti, 2019; Safithri et al., 2021; Saputro & Rahayu, 2020). Based on the results of interviews with fourth-grade teachers at SDN 112 Pekanbaru. Students are less able to optimize the project-based learning model. Many students still have not been trained to think critically and creatively in understanding mathematical concepts, and children cannot work together well. This is because learning in schools is still monotonous and conventional. In education at school, teachers generally only direct conventional material, prioritizing memorization skills and not building students' creativity and problem-solving abilities (Sari et al., 2023). Teachers still use learning as before, question and answer learning while playing. The teacher also never gave assignments like a project in learning. Which project tasks are carried out in groups. Making students passive and lacking variation in learning causes boredom in the learning process (Hamzah & Mentari, 2017; Nuswowati et al., 2017).

One way to overcome monotonous and conventional education is to apply the Project Based Learning model. Project Based Learning is a learning model that provides opportunities for educators to manage classroom learning by involving project work (Agitsna et al., 2019; Nurlaily et al., 2019; Oktaviani & Marliana, 2021; Tri Pudji Astuti, 2019). Project learning activities carried out by children can inspire children to contribute and make an impact on the surrounding environment (Nurhadiyati et al., 2020). In mathematics, project-based learning is considered appropriate. To absorb and enter new information depending on experience in real activities (Fauzia & Kelana, 2021; Logan et al., 2021). The Project Based Learning model is a learning process to raise students' awareness regarding real-world problems, discuss problems that arise individually and collectively, and enable them to present their work. Developing interests and choosing tasks, the stages in using PjBL are asking questions, designing product plans, assessing products and conducting assessments in observing when children do projects (Ringotama et al., 2022). Looking into the process of creating or completing a project is an important milestone in learning, therefore, one that is relevant to students in elementary school (Mariskhantari et al., 2022; Siti Suryaningsih & Ainun Nisa, 2021; Yus et al., 2020).

Previous research findings state that project-based learning can create learning in a fun, meaningful, curious, and critical-thinking atmosphere while at the same time encouraging students to become more active, independent, and creative in solving a problem (Safitri et al., 2018). In addition, this model can also improve children's cognitive abilities, skills to work together in groups, learning motivation, teamwork, and children's creativity (Ayuningsih et al., 2022). Students can also solve problems that exist in themselves or problems that exist in their environment (Aisyah Aini et al., 2019; Nofziarni et al., 2019). Research related to the Project-based Learning model has been carried out a lot, but this research examines the Project-based Learning model for understanding mathematical concepts. This research aims to analyze the effectiveness of the Project Based Learning model to improve students' understanding of mathematical concepts. Hopefully, the Project Based Learning model can improve students' understanding of mathematical concepts.

2. METHODS

This type of research uses a quantitative method with a pre-experimental type and a one-group pretest-posttest design, which aims to determine the ratio of post-test scores to pre-test scores after treatment. The population in this study was taken from the fourth grade, which consisted of 3 classes. The research sample consisted of the IVC class as the experimental class. The number of IVC classes is 33 people. Research data were collected through pre-test and post-test tests. Data analysis techniques in this study were carried out using descriptive analysis and prerequisite tests, the normality and homogeneity tests. Descriptive analysis was carried out to describe the situation before and after being given treatment for understanding mathematical concepts. Furthermore, the normality test is used to see whether the data distribution in the experimental group is normal. The normality test in this study used the Kolmogorov-Smirnov test technique with SPSS release 24 for Windows. At the same time, the homogeneity test is used to determine whether the sample in the experimental class has the same variation. After carrying out

prerequisite tests with normality and homogeneity tests, a hypothesis test was carried out with the Paired Sample T-Test and NGain data analysis.

3. RESULT AND DISCUSSION

Results

The results of the validity test on the instrument that will be used for the pre-test and post-test are tested using the SPSS release 24 tool, which shows that of all the statement item's ten statements, the results show all are valid. Then, the ten statements are feasible and can be used to obtain research data. It is by Table 1.

Table 1. Question Validation

Question Number	r count	r table	Description
1	0.662	0.361	Valid
2	0.584	0.361	Valid
3	0.566	0.361	Valid
4	0.433	0.361	Valid
5	0.422	0.361	Valid
6	0.411	0.361	Valid
7	0.451	0.361	Valid
8	0.406	0.361	Valid
9	0.583	0.361	Valid
10	0.478	0.361	Valid

Based on the results of the pre-test and post-test calculation trials in fourth grade at SD Negeri 112 Pekanbaru above using SPSS release 24 for Windows, which has been presented in the table if $r_{count} \geq r_{table}$, $r_{count} \geq 0.361$ then all 10 test item items are declared valid and feasible for use by researchers. After testing the validity, the test instrument is also tested for reliability. The results of the reliability test are presented in Table 2.

Table 2. The Results of the Reliability Test of the Concept Understanding Instrument

Cronbach's Alpha	N of Items
0.658	10

Based on the essay test reliability test results, the Cronbach Alpha's score is 0.658 or if ≥ is 0.658 ≥ 0.361. Based on the stability category, the alpha score of 0.658 is included in the reliable category. So, it can be concluded by the researcher that the 10 test items proposed are reliable and feasible to use. The application of the project-based learning model in increasing students' understanding of mathematical concepts has been implemented. A total of 33 students were involved in this study. The results of this study are data on understanding mathematical concepts obtained through research instruments in the form of essay questions consisting of 10 items. The average results of the post-test showed that students' understanding of mathematical concepts after being applied to the project-based learning model increased after being given treatment. The average post-test result for the experimental class was 87.12, while the pre-test average was 64.39, which means the post-test average is greater than the pre-test. Post-test results showed the highest mean score (87.12). It shows that understanding mathematical concepts from the post-test results is better than the pre-test results in Table 3.

Table 3. Data Description of Pre-Test and Post-Test Understanding of the Concept

Group	Mean	Median	Variance	Std. Deviation	Minimum Score	Maximum Score
Pre-test	64.39	65	57.434	7.57850	55	85
Posttest	87.12	85	53.172	7.29194	70	100

Based on Table 3, the student's conceptual understanding of pre-test data obtained a mean score of 64.39, a median of 65, a variance of 57.434, std. deviation of 7.57850, the lowest score is 55, and the

highest is 85. At the same time, the post-test data of students' understanding of the concept obtained a mean score of 87.12, a median of 85, a variance of 53.172, std. deviation of 7.29194, the lowest score is 70, and the highest is 100. The data description is presented as a histogram of the pre-test and post-test scores of understanding the concept in Figure 1.

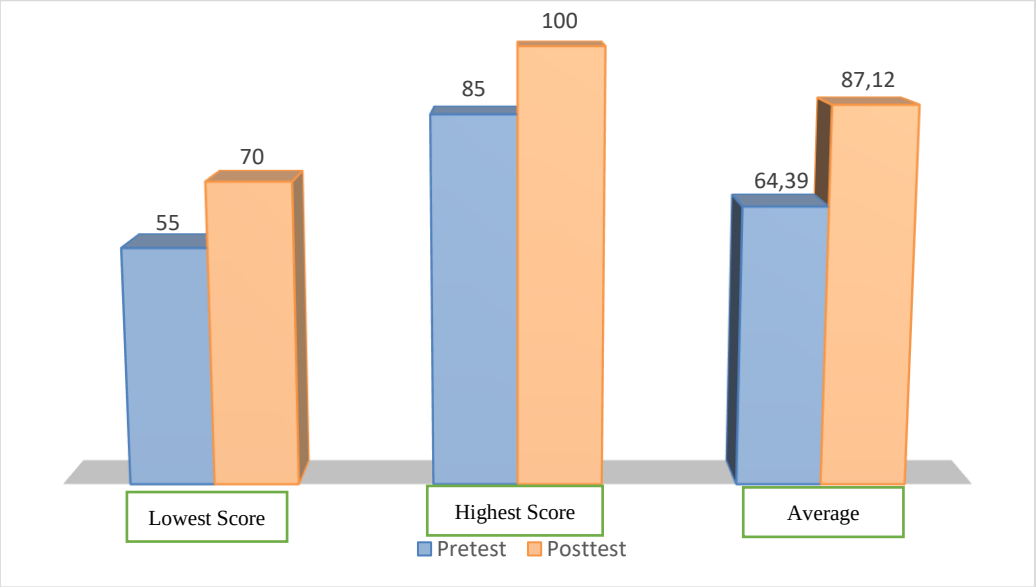

Figure 1. Comparison of Pre-Test and Post-Test Scores for Understanding Mathematical Concepts

The results shown in the understanding of mathematical concepts data show that the post-test results are better than the pre-test results. However, this basic assumption cannot be proven if hypothesis testing and N-Gain have not been carried out. Before testing the hypothesis, the normality and homogeneity tests as prerequisite tests must be fulfilled. The results of the data normality test for understanding mathematical concepts can be seen in Table 4.

Table 4. Output normality test

Variable	Class	Kolmogorov-Smirnov			Assumption	Description
		Statistic	df	Sig.		
Concept understanding	Pre-test	0.139	33	0.107	p > 0.05	Normal Distribution
	Post-test	0.143	33	0.084		Normal Distribution

Based on Table 4, it can be seen that the pre-test significance score (0.107). While the significance score of the experimental group post-test (0.084). All data has a sig score > 0.05, so the pre-test and post-test data for understanding mathematical concepts are declared to be normally distributed. After the normality test is fulfilled, the homogeneity test is carried out; the results for understanding mathematical concepts are presented in Table 5.

Table 5. Output of the Homogeneity Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Concept Understanding	Based on Mean	0.003	1	64	0.954
	Based on Median	0.000	1	64	1.000
	Based on the Median and with adjusted df	0.000	1	64.000	1.000
	Based on trimmed mean	0.024	1	64	0.876

Table 6 shows that the significance score of the homogeneity test results for the mathematical concept understanding variable is 0.954. The significance score is greater than 0.05, so it can be concluded that the data is homogeneous. Furthermore, hypothesis testing is done with parametric statistics because the pre-test and post-test data are normally distributed and homogeneous. Hypothesis testing aims to

determine differences in understanding pre-test and post-test mathematical concepts. The following is the data from the calculation of the paired sample t-test on the pre-test and post-test in Table 6.

Table 6. T-Test Output (Paired Sample T-Test)

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Concept Understanding Pretest-Concept Understanding Posttest	-22.727	9.022	1.570	-25.926	-19.528	-14.471	32	.000

Based on the calculation results in Table 6, it can be seen that the sig score is 0.000. The sig score is less than 0.05. Thus, it is proven that there are differences in the understanding of mathematical concepts post-test and pre-test. Furthermore, finding the effective or ineffective interpretation of the project-based learning model in increasing students' understanding of mathematical concepts can be seen from the results of the N-Gain test. The results of statistical descriptions are presented in Tables 7 and 8.

Table 7. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
NGain	33	-0.250	1.000	0.632	0.231
Valid N (listwise)	33				

Table 8. Criteria for the N-Gain Score

Criteria	Gain Point
High	$g > 0{,}7$
Medium	$0{,}3 < g \leq 0{,}7$
Low	$g \leq 0{,}3$

Based on the gain score criteria, project-based learning can effectively increase understanding of mathematical concepts by obtaining an n-gain score > 0.3 or a score of 0.6 ≤0.7 with moderate criteria.

Discussion

It has been carried out Based on research on applying the project-based learning model in increasing students' understanding of mathematical concepts. The results of this study are data on the understanding of mathematical concepts obtained through the test instrument pre-test and post-test essay questions, as many as ten questions. The average result of the post-test showed that students' understanding of mathematical concepts after being applied to the Project Based Learning model increased after being given treatment. It shows that understanding mathematical concepts from the post-test results is better than the pre-test results. Increasing students' understanding of mathematical concepts by applying the Project Based Learning model is in the medium category. It shows that the Project Based Learning model effectively increases understanding of mathematical concepts. This model causes students' motivation and curiosity to increase. The PBL model is also a place for students to develop critical thinking and higher thinking skills (Karjiyati et al., 2018; Pan et al., 2021). By applying the Project Based Learning learning model, teachers are not only based on student books, but teachers can also learn from everyday problems experienced by students (Fitriyah & Ramadani, 2021; S Suryaningsih & Nisa, 2021). The Project Based Learning (PJBL) model gives freedom to explore various learning content from various media to be able to answer guiding questions and can actively promote independent learning by giving projects to students, such as making scientific papers. These results are by previous research explaining that the Project Based Learning model is proven to be an efficient method for ensuring that students understand the subjects provided through distance learning (Nisa et al., 2021). The Project Based Learning model increases students' understanding and creativity (Widiyanti et al., 2021).

Evaluation of project-based learning in mathematics uses building material for class five at SDN 250 Sinar Gading II with the CIPP evaluation approach. The instructor's facilities and mandate are more than sufficient considering the carrying capacity of project-based learning institutions for fifth-grade students in geometric materials (Wibowo et al., 2022). Judging from the process, the teacher completes assignments according to process standards and uses project-based learning phases and terminology. Project-based learning model learning has proven successful based on the findings of the output/product test and the results of student projects. As a result, the learning material for grade five at SDN 250 Sinar Gading II was rated as good based on the CIPP exam. The compatibility of this research with previous research shows that it is true that the project-based learning model can improve students' understanding of mathematical concepts when working together to complete a learning project. The better the implementation, the better the students' understanding of mathematical concepts will be.

4. CONCLUSION

The study showed significant differences in the effectiveness of post-test and pre-test results on elementary school students' understanding of concepts. It is based on the Paired Sample t-test results, which show a significant difference in applying the project-based learning model in increasing the understanding of mathematical concepts in fourth-grade elementary school students. Furthermore, the percent N-Gain test was carried out to see the level of effectiveness in the experimental group in the moderately effective category. So, the treatment of post-test results by applying the project-based learning model effectively increases the understanding of mathematical concepts in fourth-grade elementary school students.

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