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Project-Based Learning Model on Mathematical Concept Understanding Ability in Mathematics Learning in Elementary Schools

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Abstract. This study seeks to assess the impact of the Project-Based Learning model on the mathematical comprehension skills of fifth-grade elementary students. This research methodology employs a quasi-experimental pretest-posttest group design. The study's population comprised fifth-grade children from SDN 60 Bengkulu City, with class VA serving as the control group of 22 individuals and class VB as the experimental group of 21 individuals. The research tool employed was a mathematics comprehension assessment. Analytical methods using descriptive statistics, prerequisite assessments, and t-tests. The study's results indicated a disparity in the average posttest scores, with the control class averaging 57.86 and the experimental class averaging 77.90, demonstrating that the mathematical comprehension of students in the experimental class exceeded that of the control class (77.90 > 57.86). The findings are derived from the table of distribution values for df = 41 (alpha = 5%) = 1.68. The computed t value exceeds the critical t value (5.786 > 1.68) and significance level. p-value (2-tailed) = 0.000 < 0.005. The null hypothesis (H0) is rejected, and the alternative hypothesis (H1) is accepted. The conclusion is that the Project-Based Learning model significantly influences the mathematical comprehension abilities of elementary school students.

Keywords: Project-Based Learning, Mathematical Concept, Understanding Ability

INTRODUCTION

The process of mathematics education is fundamentally a pedagogical endeavor designed by educators to cultivate students' creative thinking, enhance their cognitive abilities and comprehension of mathematical concepts, and enable them to generate new information, so fostering a robust mastery of mathematical content. Hartati & Indrawati (2019) assert that the objective of mathematics education is to equip the next generation to confront life's different changes with logic, rationality, caution, critical thinking, creativity, and efficiency.

In mathematics education, comprehending mathematical concepts is paramount; students must first grasp these concepts to effectively answer problems and apply their knowledge in real-world scenarios. Sukmawati (2017) defines the ability to understand concepts as an individual's capacity to grasp and accurately interpret an idea or concept without altering its meaning.

Students' mathematical conceptual comprehension necessitates their ability to comprehend the significance of the mathematical concepts being examined, both during the teacher's explanations and during solving mathematical problems. Yasmansyah and Sesmiarni (2022) contend that comprehending mathematical concepts is crucial for grasping mathematics. Fundamental mathematical principles must be comprehensively understood prior to advancing in mathematics. By comprehending the foundational principles initially, students will more readily assimilate following content. According to Supriatna et al. (2023), enhancing comprehension abilities is crucial in mathematics education, since a lack of understanding adversely impacts the conceptualization and communication of these ideas to others.

Experts assert that comprehending mathematical concepts is fundamental to learning mathematics and essential for cultivating pupils' critical thinking and communication skills. Consequently, enhancing conceptual comprehension should be a primary focus in the mathematics education process. Moreover, Supriatna et al. (2023) indicate that a student's prior mathematical knowledge significantly affects their capacity to acquire mathematics. The capacity of students to assimilate the presented material is significantly influenced by their prior knowledge. If this past knowledge is inadequate, students will encounter challenges in assimilating following content. Consequently, at the outset of the educational process, educators should initially assess students' existing mathematics knowledge to provide a more effective learning experience, so ensuring the attainment of the desired educational results.

Consequently, conceptual comprehension in mathematics education is essential for basic pupils, since it establishes the groundwork for the application of mathematical principles at advanced stages. Moreover, the acquisition of mathematical knowledge is essential at all educational stages, including basic education. The study of mathematics is essential in daily life, as it pertains directly to the environment, particularly concerning plane figures.

The challenges faced by students in comprehending various planar figures indicate a deficient grasp of fundamental geometric principles, which are essential for a solid foundation in mathematics education. If the comprehension of the attributes of plane figures, including side lengths, angle configurations, and other features, is not solidified early, pupils are likely to encounter challenges in grasping more intricate geometric ideas at advanced levels. This underscores the necessity for more effective and novel pedagogical methods to facilitate students' comprehensive understanding of planar figure ideas. Yusnia et al. (2024) assert that innovative learning is crucial for establishing an interesting and effective educational environment.

To tackle educational issues, it is imperative to create pedagogical approaches that foster active student engagement, such as the adoption of Project-Based Learning. The PJBL paradigm enhances teaching and learning through the promotion of effective interaction

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between students and educators. Thomas (in Winarni, 2018) asserts that PJBL is a student-centered educational model that encompasses project-based activities requiring students to tackle challenges, make decisions, do research, present findings, and produce outcomes.

In this setting, project-based learning fosters intellectual engagement among students while underscoring a contextual approach pertinent to real-life applications. Rahmadanti et al. (2022) assert that project-based learning necessitates students to engage in creative thinking to produce a product and collaborate in groups to generate innovative ideas, hence optimizing the outcomes achieved. This aligns with the perspective of Supriatna & Lusa (2020), who assert that educators' endeavors to cultivate an enjoyable learning atmosphere through diverse pedagogical models suitable for students can foster good mathematics attitudes among learners. Increased positive mathematical attitudes among pupils correlate with enhanced confidence in mastering and solving mathematical issues, leading to greater achievements. This study aims to furnish empirical data on the efficacy of the PjBL model in enhancing students' comprehension of mathematical ideas and facilitating a more profound understanding of the subject matter.

METHODOLOGY

This study employs quantitative research methodology. Winarni (2018) asserts that quantitative research is a methodology grounded on positivist philosophy, employed to investigate a particular population or sample. Data collecting employs research instruments and statistical analysis to evaluate established hypotheses. Hermawan (2019) asserts that quantitative research is an inductive, objective, and scientific methodology characterized by data represented as scores, which are subjected to statistical analysis.

This study employed a quasi-experimental method. Sugiyono (2023) asserts that quantitative approaches has distinct properties, notably the inclusion of control and experimental groups. This strategy seeks to assess the impact of the treatment on two groups: the experimental and the control.

The research design employed was a matching-only pretest-posttest control group design. Winarni (2018) characterized this design as the matching of subjects in the control and experimental groups.

Table 1. Research Design

Implementation in the experimental class	M	O1	X	O2
Implementation in the control class	M	O3	C	O4

Source: Winarni (2018)

Information:

M: Matching of experimental and control class subjects

O1 : Implementation of the initial test of the experimental class

O2: Implementation of the final test of the experimental class

O3: Implementation of the initial test of the control class

O4: Implementation of the final test of the control class

X : Treat with PjBL Model

C : Treat it with direct learning with lectures

RESULTS AND DISCUSSION

The post-test data analysis results for mathematical concept comprehension ability, derived from SPSS, indicate the following:

Descriptive statistics

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Posttest Experimental	21	35	58	93	1636	77.90	9.914	98.290
Posttest control	22	48	35	83	1273	57.86	12.571	158.028
Valid N (listwise)	21							

Picture 1. posttest output

The SPSS result indicates that the mean posttest score for the experimental group was 77.90, while the mean posttest score for the control group was 57.86. The standard deviation for the experimental group was 9.914, whereas the standard deviation for the control group was

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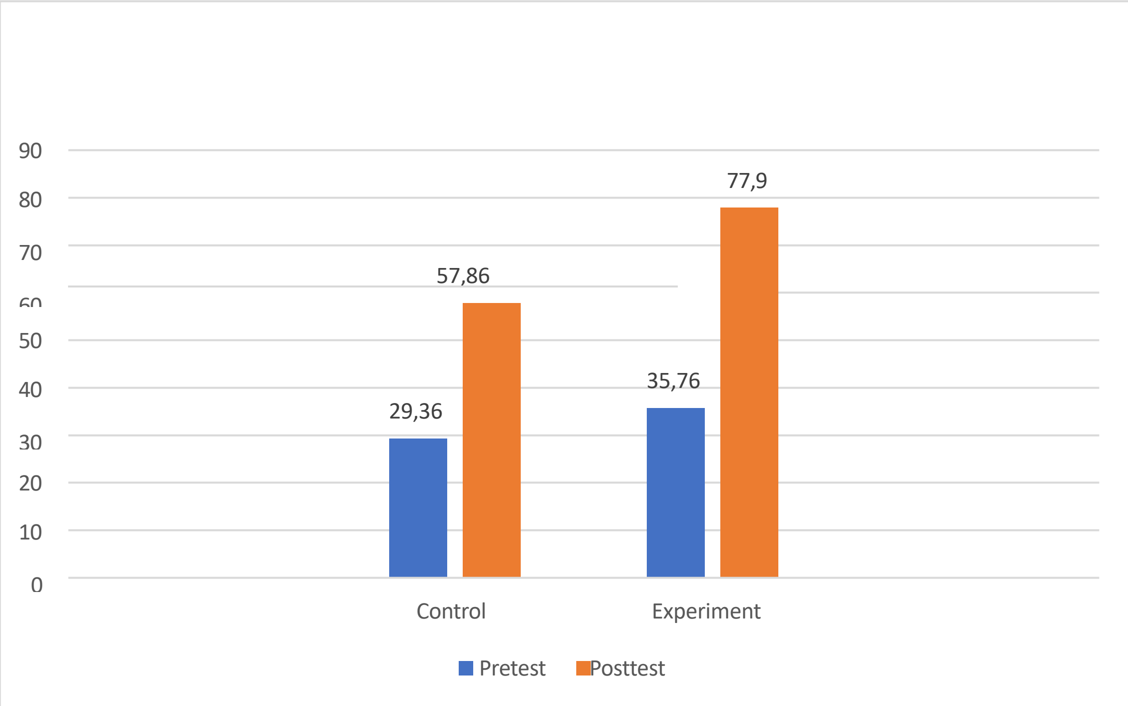
12.571. The variance of the experimental class was 98.290, while the variance of the control class was 158.028.

The subsequent graph illustrates the mean posttest scores for both the experimental and control groups.



Picture 2. Average scores for mathematical concept understanding

The data indicates a substantial disparity in the average scores between the experimental class and the control class, with scores of 77.90 and 57.86, respectively. This suggests that the PjBL paradigm positively influences students' comprehension of mathematical concepts.

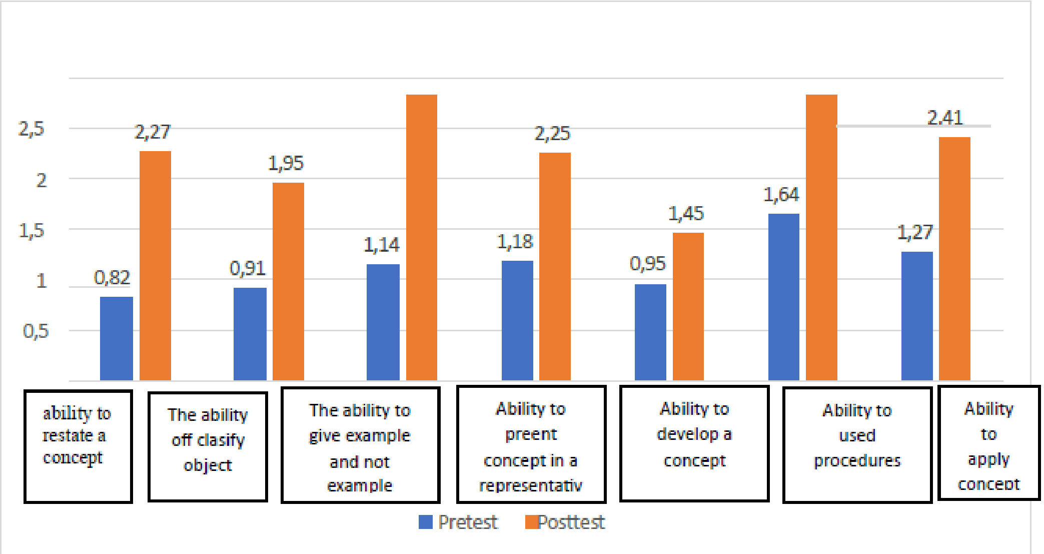


Figure 3. Average indicators of mathematical concept understanding ability in the experimental class

The data presented indicates a notable disparity between the pretest and posttest scores regarding students' comprehension of mathematical concepts in the experimental class.

Independent sample t tes

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Nilai	Equal variances assumed	.335	.566	5.786	41	.000	20.041	3.464	13.046	27.036
	Equal variances not assumed			5.819	39.620	.000	20.041	3.444	13.078	27.005

Figure 4. Posttest hypothesis t-test

The SPSS output indicates a calculated t-value of 5.786 and a two-tailed significance value of 0.000. The t-table value for df = 41 at a 5% significance level is 1.683. Consequently, the computed t-value exceeds the t-table value (5.786 > 1.683), leading to the rejection of H0 and

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the acceptance of H1. The introduction of the PjBL paradigm significantly affects elementary school students' understanding of mathematical concepts.

The findings of this study demonstrate that the PjBL model is efficient in enhancing overall conceptual comprehension, while also exhibiting differential impacts based on the specific competency indicators evaluated. The results demonstrate that PjBL effectively enhances students' general comprehension of mathematical concepts. This aligns with the findings of Ghaira and Vebrian (2024), who asserted that the PjBL learning model is more effective in enhancing mathematical concept comprehension.

The study's results indicate that the implementation of the PJBL model markedly enhances students' comprehension of mathematical ideas in contrast to the traditional lecture method. The average post-test score of pupils in the control class was 57.86, significantly lower than the experimental class, which had an average post-test score of 77.90. This enhancement demonstrates that project-based learning is more efficacious since it fosters student engagement, creativity, and direct participation in the educational process.

The implementation of the PjBL model may serve as a more effective technique for enhancing students' comprehension of mathematical concepts, particularly in geometry education at the primary school level. Nevertheless, both the control and experimental groups exhibited deficiencies in conceptual understanding, particularly regarding the ability to articulate mathematical representations and formulate necessary and sufficient conditions. This underscores the necessity to enhance instruction in these areas to deepen and broaden students' comprehension of mathematical concepts.

This aligns with the assertion of Pusvita et al. (2024), who indicated that the PjBL model markedly enhances students' understanding of mathematical concepts, particularly about specific indications. Moreover, study conducted by Komarudin et al. (2020) demonstrates a beneficial impact of the PjBL model on students' conceptual comprehension capabilities. This aligns with the perspective of Siregar et al. (2025) that the implementation of the PjBL model fosters interaction, critical thinking, and the application of innovative concepts in practical contexts.

This PJBL learning strategy has demonstrated superior efficacy compared to traditional lecture-based tactics, which are often passive, in enhancing students' comprehension of mathematical ideas.

CONCLUSION

The results of this study can be concluded that the application of the PjBL model in mathematics learning has a significant influence on students' mathematical concept understanding abilities. This conclusion is based on the results of the post-test analysis using the t-test, where the t-value = 5.786 > 1.68 from the t-table. In addition, the average post-test score of the experimental class of 77.90 is higher than the average score of the control class of 57.86. So there is an average difference between the control class and the experimental class. Then there is a significant influence between the results of students' mathematical concept understanding abilities in the experimental class that received the PjBL model treatment and the control class that received treatment with lectures.

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