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The Influence of Problem Based Learning Model on Cognitive Learning Outcomes of Mathematics in Grade V Elementary School Students

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ABSTRACT
Increasing the effectiveness of the learning process can be realized through the application of learning models that are in line with student characteristics. One approach that supports active student involvement is the Problem Based Learning model. This study aims to analyze the effect of the application of the Problem Based Learning model on the achievement of cognitive learning outcomes in mathematics subjects in grade V students at the elementary school level. This study uses a quantitative approach with a Pre-Experimental design, specifically the One-Group Pretest-Posttest Design type. The research subjects included all grade V students of SD Negeri 02 Amban, Manokwari Regency, West Papua Province as many as 32 students in the 2024/2025 academic year. Data analysis techniques involve normality tests, t-tests, and n-gain tests, with the help of SPSS software version 30. The results of the normality test show that the pretest value data (0,123 > 0,05) and posttest (0,105 > 0,05) are normally distributed. Meanwhile, the t-test showed a significant difference between the pretest and posttest scores with a significance value (2-tailed) of 0,001 (p < 0,05), indicating that there was a significant increase in cognitive learning outcomes after the implementation of the PBL model. Based on the significance value (0,001 < 0,05), the null hypothesis (H_0) was rejected and the alternative hypothesis (H_1) was accepted. In addition, the results of the n-gain analysis showed an increase in the average score from 64,44 to 84,09 with a difference of 19,66 points, and the average n-gain value was 0,56, which was categorized as quite effective. Thus,

the results of this study indicate that the implementation of the Problem Based Learning model has a positive effect on improving the cognitive learning outcomes of elementary school students in mathematics. ***Keywords****: Learning Model; Problem Based Learning; Cognitive Learning Outcomes*

ABSTRAK

Peningkatan efektivitas proses pembelajaran dapat diwujudkan melalui penerapan model pembelajaran yang selaras dengan karakteristik peserta didik. Salah satu pendekatan yang mendukung keterlibatan aktif peserta didik adalah model *Problem Based Learning*. Penelitian ini bertujuan untuk menganalisis pengaruh penerapan model *Problem Based Learning* terhadap pencapaian hasil belajar kognitif dalam mata pelajaran matematika pada peserta didik kelas V di tingkat sekolah dasar. Penelitian ini menggunakan pendekatan kuantitatif dengan desain *PreExperimental*, khususnya tipe *One-Group Pretest-Posttest Design*. Subjek penelitian mencakup seluruh peserta didik kelas V SD Negeri 02 Amban, Kabupaten Manokwari, Provinsi Papua Barat sebanyak 32 peserta didik pada tahun ajaran 2024/2025. Teknik analisis data melibatkan uji normalitas, uji-t (*ttest*), serta uji n-gain, dengan bantuan perangkat lunak SPSS versi 30. Hasil uji normalitas menunjukkan bahwa data nilai pretest (0,123 > 0,05) dan posttest (0,105 > 0,05) berdistribusi normal. Sementara itu, uji-t menunjukkan adanya perbedaan signifikan antara nilai pretest dan posttest dengan nilai signifikansi (2-tailed) sebesar 0,001 (p < 0,05), yang menandakan bahwa terdapat peningkatan signifikan dalam hasil belajar kognitif setelah penerapan model PBL. Berdasarkan nilai signifikansi tersebut (0,001 < 0,05), hipotesis nol (H0) ditolak dan hipotesis alternatif (H1) diterima. Selain itu, hasil analisis n-gain menunjukkan peningkatan rata-rata skor dari 64,44 menjadi 84,09 dengan selisih 19,66 poin, dan nilai rata-rata n-gain sebesar 0,56, yang dikategorikan sebagai cukup efektif. Dengan demikian, hasil penelitian ini menunjukkan bahwa penerapan model *Problem Based Learning* memberikan pengaruh positif terhadap peningkatan hasil belajar kognitif matematika peserta didik sekolah dasar.

Kata Kunci: Model pembelajaran; Problem Based Learning; Hasil Belajar Kognitif

INTRODUCTION

Education is the main element in forming a quality human life, because with a maximum education system, quality human resources can be realized. Education is a process that facilitates students in optimizing their potential so that they are able to think rationally and achieve superior academic achievement (Pranoto et al., 2023). Education includes the process of interaction between teachers and students who have the aim of achieving certain goals (Wati et al., 2024).

Evaluation plays a crucial role in improving the quality of the learning process, which ultimately contributes to improving the overall quality of education (Akmalia et al., 2023). Evaluation results are very useful, especially in providing important information to assist in decision making, consideration of determining policy direction, increasing understanding of certain conditions or phenomena, and can be used as problem solving (Maulani et al., 2023). Evaluation is a crucial component in learning because it functions to measure the level of mastery of the material by students (Asih et al., 2025). Learning outcomes are the abilities acquired by students after going through the learning process, and are an important indicator in assessing the level of achievement of learning objectives (Nurmawati, 2024). Achievement of learning outcomes can be classified into three main domains, namely cognitive,

psychomotor, and affective (Ramadani & Handayani, 2024). Cognitive learning outcomes are the results of learning activities that require intelligence and brain activity related to memory, intellectual thinking (Putri et al., 2024). Cognitive aspects that reflect high level thinking skills and deep understanding of the subject matter, including the ability to remember, understand meaning, apply concepts, analyze information, evaluate results, and create new things (Oktaviani et al., 2025). Previous research has shown that the application of the Problem Based Learning (PBL) model is effective in improving learning outcomes (Yeni et al., 2025).

Based on the results of observations at SD Negeri 02 Amban, it was found that the active involvement of students in mathematics learning in grade V was still minimal, so that it affected the low cognitive achievement of students. Various factors can cause low cognitive learning outcomes of students in mathematics (F. M. Putri & Safrizal, 2023). The causal factor is the limited active participation of students in learning activities. Several behaviors such as lack of focus on teacher instructions, friend disturbances, and conversations that are not related to the teaching material indicate a low level of student involvement that has not yet optimal learning outcomes.

Students success in solving mathematical problems is highly influenced by the teacher's ability to deliver mathematical instruction effectively (Firmansyah et al., 2024). Various strategies can be applied by teachers in the process of transferring knowledge (Siswanto et al., 2024). Achieving success in the activeness of mathematics learning can be created with the right learning model (Widyowati et al., 2023). The learning model acts as a reference for learning designers and educators in compiling and implementing learning activities (Hendracipta, 2021).

In the context of implementing the Independent Curriculum, the development of innovative learning models and strategies is a central aspect in creating a more interesting and meaningful learning experience for students (Rosa et al., 2024). The Problem-Based Learning Model has the potential to be an effective approach for educators to improve the quality of the learning process and encourage the achievement of learning objectives more optimally (Rasya et al., 2024). Learning using the Problem Based Learning model places students as active subjects in a student-centered learning process, encourages collaboration, and develops problem solving skills and learning independence that are essential to face various life challenges (Francisca et al., 2024). The Problem Based Learning model is a learning approach that directs students to be actively involved in the process of solving and resolving problems through the use of their knowledge and logical reasoning. (Nirwana et al., 2024). The PBL learning model is one of the many learning models that can motivate student learning so that it can improve student learning outcomes (Prabowo et al., 2024).

Problem Based Learning (PBL) has several advantages, including: 1) Encouraging students to develop their ability to solve problems related to real life. 2) Providing opportunities for students to build knowledge independently through learning activities. 3) Learning focuses on concrete problems, which reduces irrelevant material and lightens the burden on students in memorizing or storing information. 4) Facilitating scientific activities among students through group collaboration. 5) Accustoming students to accessing knowledge sources from various platforms, such as libraries and the internet (Rahmaniati et al., 2025).

In addition to several advantages and benefits, the PBL model also has weaknesses. Some of the weaknesses of the Problem Based Learning model include: a) Not all learning topics can be applied effectively in this model, especially when there are limited facilities, infrastructure,

or learning support media; b) This model requires a relatively longer time than conventional learning methods; c) Learning activities tend to focus on problem solving, so that other aspects of the learning material are at risk of being less thoroughly explored (Triyatun, 2022).

In the application of the Problem Based Learning (PBL) model, there are five main syntaxes, namely: 1) Orienting students to problems; 2) Organizing students in learning activities; 3) Providing guidance during the investigation process individually or in groups; 4) Facilitating the development and delivery of work results; and 5) Conducting analysis and evaluation of the problem solving process (Prameswari et al., 2025). An educator is expected to be able to implement these steps optimally in the learning process.

The achievement of active learning success in mathematics subjects can be supported through the application of effective learning models that are in line with the characteristics and needs of students (Samara et al., 2024). This study aims to examine the significant influence of the implementation of the Problem-Based Learning model on the cognitive learning outcomes in mathematics of fifth grade elementary school students. It also seeks to analyze the differences in cognitive learning outcomes between students who are taught using the Problem Based Learning model and those who receive instruction through a conventional teaching approach. This study also aims to determine whether there is a significant influence of the implementation of the Problem Based Learning model on the cognitive learning outcomes in mathematics of fifth-grade elementary school students. Based on this background, the researcher conducted a study aimed at analyzing the effect of the problem-based learning model on cognitive learning outcomes in mathematics subjects in grade V elementary school students.

METHODS Type and Design

Research is a systematic process that aims to solve problems, investigate, and prove the truth based on a scientific approach, where the data collected is rational, empirical, and structured (Mulyana et al., 2024). This study uses a pre-experimental design with a one-group pretest-posttest design approach. This research design allows researchers to compare the results obtained before and after the treatment is applied to one group of subjects. This design can be illustrated as follows.

$$\mathbf{O_1\ X\ O_2}$$

Figure 1 Pre-Experimental One-Group Pretest-Posttest Design

Information:
O_1 = pretest value (before treatment)
X = teaching (implementation of problem based learning model)
O_2 = posttest value (after treatment)

The pre-experimental design was chosen in this study due to several practical and contextual considerations. Although this design does not involve a control group, which results in a relatively lower level of internal validity compared to a true experimental design, the pre-

experimental design still allows the researcher to observe the initial effect of implementing the Problem-Based Learning model on the cognitive learning outcomes in mathematics of fifth-grade elementary school students. Moreover, limitations in resources, time, and access to research subjects make the use of a pre-experimental design an appropriate choice to obtain an informative preliminary overview. The researcher also strives to minimize bias by using valid and reliable measurement instruments and applying systematic testing procedures, so that the data obtained can still provide meaningful indications regarding the effectiveness of the applied learning model.

This research was conducted in February 2025 in class V of SD Negeri 02 Amban with a focus on mathematics subjects. The subjects of the study included all students of class V of SD Negeri 02 Amban, totaling 32 students, consisting of 19 female students and 13 male students. SDN 02 Amban was selected purposively because it has characteristics that support the implementation of the research, such as the availability of teachers who are open to learning innovations, sufficient number of students, and facilities that allow the implementation of the PBL model optimally. In addition, the location of the school that can be reached by researchers makes it easier to monitor, collect data, and evaluate during the research. The limitation to one school also aims to maintain the consistency of the context and variables of the learning environment, so that the results obtained can focus more on the influence of the learning model itself without being disturbed by differences between schools.

The approach used in this study is a quantitative approach based on the positivist paradigm. In quantitative research, the delivery of hypotheses must be done clearly and in detail. This approach assumes that reality, symptoms, or phenomena can be observed, measured, and have cause and effect relationships that can be identified objectively. The purpose of this study is to analyze a specific population or sample. This experimental study used a census approach by involving all fifth-grade students at a school that was purposively selected based on specific criteria. Thus, all fifth-grade students at the selected school were included as the sample to observe the effect of the Problem-Based Learning model on cognitive learning outcomes in mathematics.

Data collection was conducted using objective tests in the form of descriptions. This test was given before and after the treatment, known as the pretest and posttest. The comparison between the pretest and posttest results was used to measure the improvement in learning outcomes achieved by students.

Data collection technique

The stage that determines the implementation of research is the data collection stage because this is where researchers obtain reliable results. The data collection techniques used in this study are tests and observation.

1. Test

A test is a series of questions, exercises, or an assessment tool designed to measure an individual's knowledge, skills, or innate abilities. The data collection technique in the form of tests serves as a tool to assess students learning achievements in mathematics. The test administered was a written assessment in the form of essay questions, consisting of 5 items focused on fraction material, used for both the pretest and posttest.

2. Observation

Observation is a data collection method used to evaluate the extent to which the implemented treatment has achieved the intended objectives. This technique is employed to assess the

researcher's activities while acting as the teacher during the learning process. Observation is carried out by an observer, focusing on the researcher's teaching performance and students engagement during the implementation of the Problem Based Learning model.

Data analysis

The data analysis technique in this study employs a quantitative approach aimed at examining the effect on the dependent variable. Descriptive statistical analysis is a method used to describe collected data using specific techniques, without aiming to draw generalizable conclusions. This analysis involves statistical measures such as the mean, standard deviation, maximum, and minimum values. To simplify the data processing, IBM SPSS Statistics Version 30.0 was utilized. Individual learning mastery is achieved when a student's score meets or exceeds the minimum mastery criteria set by the school. Meanwhile, classical mastery is considered achieved if at least 75% of the students obtain a minimum score of 75. The standard categories of cognitive learning mastery for fifth-grade students at SD Negeri 02 Amban are defined as follows.

Table 1. Criteria for Completion of Cognitive Learning Outcomes

Learning Outcome Value	Learning Outcome Completion Criteria
$75 \leq x < 100$	Completed
$0 \leq x < 74$	Not Completed

Based on table 1, individual learning completion is achieved if students obtain a score that at least meets the completion criteria set by the educational unit. Classical completion is stated to be achieved if at least 75% of the total students achieve a minimum score of 75 (Karimah et al., 2024). The instruments used in this study were analyzed through several stages, namely descriptive analysis, normality test, t-test, and N-gain test using the IBM SPSS Statistics Version 30.0.

RESULTS AND DISCUSSION

Based on the results of data processing and analysis that have been carried out, pretest and posttest data were obtained related to the application of the Problem Based Learning learning model to the cognitive learning outcomes of mathematics subjects of grade V students at SD Negeri 02 Amban. Before the implementation of learning, comprehensive planning has been carefully prepared. The planning is adjusted to the steps in the Problem Based Learning (PBL) model which are considered relevant to be applied to Mathematics subjects, especially in learning Fraction material. In this study, the implementation of learning uses the PBL model which follows the following steps:

1. Students orient themselves to problems in everyday life related to fractions. After that, students are asked to provide responses to the problems that have been presented.
2. Students are divided into several groups to facilitate understanding of the steps for completing the Student Worksheet. The teacher conveys the procedure for completing the

Student Worksheet to students so that they understand the steps that need to be followed.

3. The teacher provides investigation guidance both individually and in groups. In this case, the teacher acts as a guide who helps students solve problems, as well as provides support to groups or individuals who are facing difficulties.
4. Each group develops and presents solutions to the problems faced. The groups will take turns presenting the results of their discussions in front of the class.
5. The analysis and evaluation process is carried out on the progress of the process and the results of the problem solving that has been carried out. At this stage, other groups provide opinions in the form of responses or objections to the group that is presenting the results of the discussion, while the teacher provides reinforcement for the learning process that has been carried out.

Teachers must be selective in choosing the learning model applied in schools because there is an interaction or relationship between the learning model and learning outcomes (Sartika et al., 2022). By integrating real world contexts into the learning process, the Problem-Based Learning (PBL) approach encourages students to participate actively and improves their ability to work together in groups (Mallu et al., 2024). The following is a description of the results of the descriptive analysis of the pretest and posttest data of students.

Table 2. Results of Descriptive Analysis of Pretest and Posttest

	N	Minimum	Maximum	Sum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Pretest	32	50	75	2062	64.44	.770	4.355
Posttest	32	75	95	2691	84.09	.769	4.350
Valid N (listwise)	32						

Table 2 displayed through SPSS output shows that the number of respondents (N) in this study was 32 students. The lowest (minimum) pretest score obtained by students was 50, while the highest (maximum) score reached 75. As for the posttest, the lowest (minimum) score obtained by students was 75, while the highest (maximum) score reached 95. The total number of pretest scores (Sum) obtained from 32 students was 2,062, while the total number of posttest scores was 2,691. The average (mean) pretest score obtained by students was 64,44 with a standard deviation of 4,355. Meanwhile, the average posttest score reached 84,09 with a standard deviation of 4.350.

The data obtained were analyzed using the normality test with the Kolmogorov-Smirnov method to determine whether the data has a normal distribution or not. In this test, the hypothesis used is: Conversely, if the p-value is greater than 0,05, then there is no significant difference, so the data can be assumed to be normally distributed. Based on the test results, if the p-value < 0,05, then the data does not follow a normal distribution; whereas if p > 0,05, then the data follows a normal distribution.

Table 3. Data Normality Test Results

	Pretest	Posttest

N		32	32
Normal Parameters[a,b]	Mean	64.44	84.09
	Std. Deviation	4.355	4.350
Most Extreme Differences	Absolute	.123	.105
	Positive	.082	.105
	Negative	-.123	-.090
Test Statistic		.123	.105
Asymp. Sig. (2-tailed)[c]		.200[d]	.200[d]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. This is a lower bound of the true significance.

Based on the calculation results, it was obtained that the p-value for the pretest data was 0,123, which is higher than the significance level of α (0,05). Therefore, it can be concluded that the pretest data is normally distributed. The same thing also applies to the posttest data, where the p-value is 0,105, which also exceeds α (0,05), so that the posttest data also meets the assumption of normal distribution. Thus, both data sets, both pretest and posttest, can be said to be normally distributed. Based on these results, further hypothesis analysis was carried out using the Paired Samples t-test.

Table 4. Paired Samples T-Test Results

	Paired Differences					t	df	Significance	
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				One-Sided p	Two-Sided p
				Lower	Upper				
Pretest Posttest	-19.656	1.658	.293	-20.254	-19.058	-67.064	31	.001	.001

Based on Table 4 above, the results of the paired sample t-test on the pretest and posttest scores analyzed using the SPSS 30 application show that the significance value is 0,001. In the paired sample t-test, if the sig. value is greater than 0,05, then there is no significant difference between the pretest and posttest scores. However, because the test results show a sig. value (2tailed) of 0,001 which means 0,001 < 0,05, it can be concluded that there is a significant difference between the cognitive learning outcomes of students in mathematics before and after the implementation of the Problem Based Learning (PBL) model.

In addition, the results of the normality test conducted using the One-Sample Kolmogorov-Smirnov Test showed that the data had a normal distribution. This is indicated by the pretest significance value of 0,123 and the posttest of 0,105, both of which exceed the

significance limit of 0,05. Furthermore, the results of the paired sample t-test showed that the average difference between the pretest and posttest values was -19,656 with a significance value of 0,001. Because the significance value is less than 0.05, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. Thus, it can be concluded that there is a significant increase in cognitive learning outcomes in mathematics after the application of the Problem Based Learning model.

After conducting the t-test, the next step is to conduct a normalized gain (n-gain) test which aims to determine the level of improvement in students Mathematics learning outcomes. This test is conducted by comparing the n-gain values between the pretest and posttest. The results of the n-gain test analysis of the pretest and posttest data are presented in the following table.

Table 5. N-Gain Score Test Results

Criteria	**Value**
Pretest	64,44
Posttest	84,09
Average Difference	19,66
N-Gain Class	0,56
Criteria	Quite Effective

Based on the analysis results in Table 5, it can be concluded that there is an increase in the average cognitive learning outcomes of students, where the pretest score increased from 55,22 to 82,61 in the posttest. The average difference of 27,39 indicates a significant increase. In addition, the average N-Gain value of 0,56 indicates that the increase is in the fairly effective category. These findings indicate that the application of the Problem Based Learning (PBL) model has had a positive impact on improving the cognitive learning outcomes of fifth grade students at SD Negeri 02 Amban in Mathematics. This result is in line with the study by Wiastrini et al., (2024) which showed a significant improvement in students mathematics learning outcomes after the implementation of the Problem-Based Learning model.

Analytically, this improvement can be explained through the mechanism of ProblemBased Learning (PBL), which facilitates active student engagement in the learning process. By presenting real-world problems as a starting point, students are not merely passive recipients of information but are encouraged to identify problems, gather data, and critically reflect in search of solutions. This process aligns with constructivist theory, which emphasizes that knowledge is constructed through active experience and social interaction. Furthermore, PBL provides students with opportunities to develop higher order thinking skills such as analysis, evaluation, and synthesis, which are essential in mathematics learning. This is important because cognitive learning outcomes are not only measured by the ability to memorize formulas but also by deep understanding and meaningful application of concepts in relevant contexts.

In the context of the Kurikulum Merdeka (Independent Curriculum), these results reflect the compatibility between the PBL model and the learning principles that encourage

independence, creativity, and problem-solving. The Kurikulum Merdeka emphasizes learning that is relevant to the needs and experiences of students, which is directly accommodated by PBL through case studies and contextual situations. Therefore, the success of the PBL model in improving cognitive learning outcomes can also be seen as evidence of the effective implementation of the Kurikulum Merdeka in mathematics education.

However, this improvement in learning outcomes must also be considered alongside other factors such as student motivation, the quality of teacher facilitation, and the availability of learning resources. Observations during the learning process indicated that teachers who effectively guided students through each stage of PBL played a crucial role in fostering student engagement and the success of the learning process. This suggests that the success of PBL depends not only on the model itself but also on teacher competence and the context of implementation. Overall, the findings of this study reinforce the argument that problem-based learning is an effective approach to enhancing cognitive learning outcomes in mathematics and is highly relevant to the vision of the Kurikulum Merdeka in shaping students who are active, creative, and independent.

Based on the results of the analysis, the application of the Problem Based Learning model has proven to be effective in improving the cognitive learning outcomes of grade V students. This increase is shown through a comparison of the average posttest score which is higher than the pretest score. The significant improvement in students average scores reflects the effectiveness of the Problem-Based Learning model in enhancing learning outcomes (Sumarsih et al., 2024). This finding is in line with the results of previous studies which show that the application of the Problem Based Learning (PBL) model can significantly improve student learning outcomes (Ningsih et al., 2024). In line with that, based on the results of the study, it can be concluded that the Problem Based Learning (PBL) learning model is effective in improving student learning outcomes in Mathematics (Triandani & Fajrin, 2024). The results of other studies conclude that the application of problem-based learning (PBL) is not only able to improve student learning outcomes, but also encourage active participation and develop students' abilities in communicating student ideas effectively (Aprina et al., 2024).

CONCLUSION

Based on the results of the research and discussion that have been conducted, it can be concluded that the application of the Problem Based Learning (PBL) learning model has a significant influence on improving students cognitive learning outcomes in mathematics subjects in grade V of Elementary School. Learning activities that emphasize the active involvement of students during the learning process have been proven to contribute to improving their cognitive achievements. Therefore, the use of the PBL model that encourages active participation of students is highly recommended as an alternative learning strategy to improve cognitive learning outcomes at the elementary school level.

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