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THE EFFECT OF THE PROBLEM-BASED LEARNING MODEL ASSISTED BY QUESTION CARD MEDIA ON MATHEMATICS LEARNING OUTCOMES

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Abstract

This study aims to examine the effect of the Problem-Based Learning (PBL) model supported by question card media on students' mathematics learning outcomes. The research employed a quasi-experimental design involving fourth-grade students at SD Negeri Margajaya 4, with a total sample of 48 students selected through purposive sampling. Data on students' learning outcomes were collected using pre-tests and post-tests. To analyze the data, several statistical tests were conducted, including the N-Gain test, normality test, and homogeneity test as prerequisites before performing the hypothesis test (t-test). The average N-Gain score in the experimental class was 70, while the control class scored 59. Hypothesis testing using the t-test showed that the calculated tvalue (3.32929) exceeded the critical t_{value} (2.01290) at a 5% significance level. This result indicates that the null hypothesis (H0) is rejected and the alternative hypothesis (Ha) is accepted. Based on these findings, it can be concluded that the implementation of the Problem-Based Learning model assisted by question card media has a significant positive effect on students' mathematics learning outcomes. The integration of interactive media within a student-centered learning model enhances engagement and improves academic achievement in mathematics.

***Keywords**: Problem Based Learning; Question Card; Learning Outcomes*

Abstrak

Penelitian ini bertujuan untuk mengkaji pengaruh model Problem-Based Learning (PBL) yang didukung oleh media kartu pertanyaan terhadap hasil belajar matematika siswa. Penelitian ini menggunakan desain kuasi-eksperimen yang melibatkan siswa kelas IV SD Negeri Margajaya 4, dengan jumlah sampel sebanyak 48 siswa yang dipilih melalui teknik purposive sampling. Data mengenai hasil belajar siswa dikumpulkan melalui pretest dan posttest. Untuk menganalisis data, dilakukan beberapa uji statistik, termasuk uji N-Gain, uji normalitas, dan uji homogenitas sebagai prasyarat sebelum melakukan uji hipotesis (uji-t). Rata-rata skor N-Gain pada kelas eksperimen adalah 70, sedangkan pada kelas kontrol sebesar 59. Hasil uji hipotesis menggunakan uji-t menunjukkan bahwa nilai t_{hitung} (3,32929) > t_{tabel} (2,01290) pada tingkat signifikansi 5%. Hasil ini menunjukkan bahwa hipotesis nol (H0) ditolak dan hipotesis alternatif (Ha) diterima. Berdasarkan temuan tersebut, dapat disimpulkan bahwa penerapan model Problem-Based Learning yang didukung media kartu pertanyaan memberikan pengaruh positif yang signifikan terhadap hasil belajar matematika siswa. Integrasi media interaktif dalam model pembelajaran yang berpusat pada siswa meningkatkan keterlibatan dan prestasi akademik dalam mata pelajaran matematika.

Kata Kunci: *Problem Based Learning, Question Card*, Hasil Belajar

A. Introduction

The learning process is an interactive activity between teachers and students aimed at achieving optimal learning outcomes. The success of learning is greatly influenced by students' ability to meet predetermined competency standards, as well as the teacher's effectiveness in selecting strategies, approaches, and instructional models that are appropriate to the characteristics of the subject matter.

In the context of mathematics education which is widely recognized as abstract and challenging the selection of suitable learning models and instructional media becomes a crucial aspect. Conventional approaches, which are often monotonous and teacher-centered, tend to fall short in fostering students' active participation and engagement. As a result, students' academic performance may remain low.

One instructional model that has the potential to enhance mathematics learning outcomes is Problem Based Learning (PBL**)**. This model emphasizes the use of real-life problems that are relevant to students' everyday experiences, which in turn can increase their motivation and active involvement in the learning process., the implementation of the PBL model can help develop students' problem-solving abilities, foster critical thinking, and improve overall learning achievements especially in mathematics. According to research (Kaharuddin, 2019) It has been shown that the implementation of the PBL model can improve mathematics learning outcomes for sixth-grade elementary school students in Kendari. Furthermore, the use of innovative learning media can also support the effectiveness of the PBL model. One such tool is the question card media, which can be used to stimulate collaborative discussion and problem-solving. With this media, students become more active in exploring mathematical concepts and developing their critical thinking skills. The integration of the PBL model and question card media is expected to create a more dynamic and enjoyable learning environment. This, in turn, can enhance students' understanding of mathematical concepts and improve their overall learning outcomes (Darojad, 2021).

Learning outcomes are a primary indicator for assessing the effectiveness of the learning process. In the context of primary education, achieving optimal learning outcomes is highly expected, especially in mathematics, which is known to be complex and challenging. Learning outcomes not only reflect students' understanding of the material taught but also serve as the foundation for teachers to design appropriate instructional interventions.

According to (Pundi Aprillia et al., 2021), mathematics learning outcomes refer to the new abilities or achievements acquired by students after undergoing the mathematics learning process, measured in the form of scores or grades based on the attainment of learning objectives within a certain

timeframe. Similarly, (Artati Iriana & Safrudin, 2020) emphasize that mathematics learning outcomes are benchmarks of students' success in understanding mathematical material after experiencing learning activities, typically evaluated through tests.

Several factors influence students' learning outcomes, including intelligence level, readiness to learn, interest, motivation, teaching methods, and the competence and attitude of the teacher. Teachers play a central role as facilitators of learning. According to (Fety Pratiwi et al., 2023), teachers are not only responsible for delivering material but are also required to create a conducive learning environment that encourages students to be more active and engaged in the learning process. A supportive atmosphere motivates students to better comprehend the material and improve their academic achievements.

Thus, achieving optimal mathematics learning outcomes depends not only on students' cognitive abilities but also on the teaching strategies applied by teachers and the learning environment fostered throughout the learning process.

Today's learning process must enhance students' abilities to think logically and creatively to achieve optimal learning outcomes. One effective learning model that develops both of these skills is Problem Based Learning (PBL). The PBL model positions students as active participants in the learning process by presenting real-world problems relevant to their daily lives. This approach encourages students to think critically, creatively, and logically in seeking solutions to the problems they face. According to (Aqila Zahra Latifa et al., 2024), PBL helps students develop problem-solving skills, improve understanding and knowledge, and foster active engagement in acquiring knowledge. Similarly, (Arif Maulana et al., 2023) state that PBL presents real or life-related problems, enabling students to gain new knowledge by searching for solutions to resolve those problems.

Meanwhile, (Haryanto et al., 2023) demonstrated that the implementation of the PBL model can enhance students' creative thinking skills in science learning. Similarly, research by (Masitoh, 2023) revealed that PBL is effective in improving students' creative thinking abilities in mathematics. Additionally, a study by (Wulandari & Arsyad, 2021) showed that integrating brainstorming methods within PBL can further enhance students' creative thinking skills. Therefore, the application of the PBL model not only improves students' logical and creative thinking abilities but also prepares them to face real-world challenges through an active and contextual learning approach.

Current learning processes must be able to enhance students' abilities to think logically and creatively in order to achieve optimal learning outcomes. One effective learning model for developing these skills is

Problem Based Learning (PBL). The PBL model positions students as active participants in the learning process by presenting real-world problems that are relevant to their daily lives. This approach encourages students to think critically, creatively, and logically as they seek solutions to the problems they face. According to Latifa et al. (2024:1347), PBL helps students develop problem-solving skills, improve understanding and knowledge, and promote active engagement in acquiring knowledge. Similarly, Maulana et al. (2023:12) state that PBL presents real-life problems, enabling students to acquire new knowledge by finding solutions to these problems.

Research by Haryanto et al. (2023) shows that the implementation of the Problem Based Learning (PBL) model can improve students' creative thinking skills in science learning. Similarly, research by Masitoh (2023) revealed that PBL is effective in enhancing students' creative thinking abilities in mathematics. Furthermore, a study by Fatmawati and Wulandari (2023) demonstrated that integrating brainstorming methods within PBL can further improve students' creative thinking skills. Thus, the application of the PBL model not only enhances students' logical and creative thinking abilities but also prepares them to face real-world challenges through an active and contextual learning approach.

Based on previous research by Juwanti et al. (2024), the implementation of the Problem Based Learning (PBL) model assisted by flashcard media showed a significant increase in students' mathematics learning outcomes. The average pretest score in the experimental group was 57.4, which increased to 82.6 after the PBL model was applied. This research indicates that the combination of an active learning model with appropriate visual media can improve student learning effectiveness, especially in mathematics.

The success of the PBL model in improving mathematics learning outcomes is also supported by other studies. Putri et al. (2023) found that applying the PBL model to the topic of the perimeter of plane figures improved student learning outcomes. Data analysis showed a t-count value of 8.77770, which is greater than the t-table value of 2.00172 at a 5% significance level, indicating a positive effect of the PBL model on students' learning outcomes.

The novelty of this research lies in the integration of the PBL model with question card media for the topic of measuring area and volume using standard and non-standard units. Previous research by Putri et al. (2023) discussed the implementation of PBL on the perimeter of plane figures without using media. By combining the PBL approach with question card media, it is expected to create a more active, engaging,

and effective learning environment that improves mathematics learning outcomes for elementary school students.

Therefore, the integration of the PBL model and question card media is expected to be an innovation in mathematics learning, especially in the topic of measuring area and volume, which not only improves students' learning outcomes but also fosters their critical and creative thinking skills.

Based on initial observations conducted together with the fourth-grade teacher at SD Negeri Margajaya 4, it was found that many students still experience difficulties in understanding mathematics material. This is reflected in the results of the End-of-Semester Assessment (Penilaian Akhir Semester, PAS), where approximately 40% of students scored below the Minimum Competency Achievement Criteria (Kriteria Ketercapaian Tujuan Pembelajaran, KKTP). This low achievement indicates that the ongoing learning process has not optimally enhanced students' comprehensive understanding of mathematical concepts. Teacher-centered learning, minimal active student involvement, and the lack of contextual learning media are among the main contributing factors.

To address this issue, an innovation in learning strategies is needed to activate students and increase their engagement in the learning process. One approach considered effective is the Problem Based Learning (PBL) model, which places students as active subjects in facing and solving real problems. To make it more interesting and facilitate interaction among students, this study combines the PBL model with question card media, which consists of cards containing contextual questions designed to stimulate discussion and critical thinking.

This study is designed using an experimental method with two classes: class IV-A as the experimental group and class IV-B as the control group. Based on this background, the researcher is interested in conducting a study titled: "The Effect of Problem Based Learning Model Assisted by Question Card Media on the Mathematics Learning Outcomes of Fourth Grade Students at SDN Margajaya 4, Bogor City, Even Semester of Academic Year 2024/2025."

B. Research Method

This study uses a quantitative approach with a quasi-experimental method employing a Pretest-Posttest Control Group Design. This design involves two groups: the experimental class, which receives treatment using the Problem Based Learning (PBL) model assisted by question card media, and the control class, which receives conventional learning through a cooperative model as practiced by the teacher in daily teaching activities. According to (Hastjarjo, 2019)

The quasi-experimental design is very suitable for application in the educational

context because it is often difficult to conduct full randomization of subjects; however, it still allows researchers to measure the impact of the treatment in a controlled manner.

The PBL model is a learning approach that encourages students to actively solve contextual problems independently and collaboratively (Ariswati et al., 2018)

It states that the implementation of PBL assisted by question card media can significantly improve learning outcomes compared to conventional learning. Meanwhile, question card media are cards containing contextual questions designed to stimulate student discussion and critical thinking. (Dewi Ratnawati et al., 2020) demonstrated that this media positively contributes to enhancing students' critical thinking skills, especially in mathematics subjects.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experiment (KE)	O1	X	O2
Control (KK)	O1	_	O2

The subjects of this study were all fourth-grade students at SDN Margajaya 4, Bogor City, Academic Year 2024/2025. The sampling technique used was purposive sampling, involving two classes: Class IV A (25 students) as the experimental group, and Class IV B (23 students) as the control group. The total number of participants was 48 students.

Data were collected through learning outcome tests in the form of multiple-choice questions. The tests consisted of a pretest (initial test before treatment) and a posttest (final test after treatment). Initially, there were 40 questions, which were then selected down to 27 valid questions after instrument testing. The instrument underwent validity testing using the Point Biserial Correlation formula, resulting in 27 valid items (67.5%) and 13 invalid items (32.5%).

Data analysis was conducted in several stages as follows: calculating the normalized gain (N-Gain) to determine the improvement in students' learning outcomes. The interpretation criteria for N-Gain are shown in the following table:

Table 2. N-Gain Criteria

No.	N-Gain Score (G)	Criteria
1	$G \geq 0.70$	High
2	$0.30 \leq G < 0.70$	Medium
3	$G < 0.30$	Low

Normality test was conducted using the Liliefors test to determine whether the data are normally distributed. The decision criterion is: the data are considered normal if the calculated L value (Lcount) is less than the critical L value (Ltable) at a 5% significance level.

Homogeneity test was performed using the Fisher test to ensure equality of variances between groups. The data are considered homogeneous if the calculated F value (Fcount) is less than the critical F value (Ftable).

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Hypothesis testing was conducted using the Z-test for two means, with the following hypotheses:

H0: μ0 = μ1 — There is no effect of applying the Problem Based Learning model assisted by question card media on mathematics learning outcomes.

Ha: μ1 > μ0 — There is an effect of applying the Problem Based Learning model assisted by question card media on mathematics learning outcomes.

C. Research Results and Discussion

In the experimental group, the pretest scores showed an average of 51.06 with a minimum score of 29.6 and a maximum score of 70.3. After the treatment, the average posttest score increased significantly to 84.17, with a minimum score of 66.6 and a maximum of 100. The N-Gain score in this group showed an average of 70, with a range from 50 to 100. This indicates an improvement in learning achievement classified as high based on the N-Gain classification (Harahap et al., 2022).

Table 3. Frequency Distribution of N-Gain Scores in the Experimental Group

Class Interval	Class Limits	Midpoint (xi)	Frequency (fi)	xi.fi	Relative Frequency (%)
50 - 58	49.5 - 58.5	54	6	324	24%
59 - 67	58.5 - 67.5	63	5	315	20%
68 - 76	67.5 - 76.5	72	7	504	28%
77 - 85	76.5 - 85.5	81	3	243	12%
86 - 94	85.5 - 94.5	90	3	270	12%
95 - 103	94.5 - 103.5	99	1	99	4%
Total			25	1755	100%

Table 3 presents the frequency distribution of N-Gain scores in the experimental group, showing that the highest concentration of frequencies falls within the score range of 68–76.

In contrast, in the control group, the pretest scores showed an average of 48.10 (min: 25.9; max: 70.3), which increased to 77.86 (min: 59.2; max: 92.5) in the posttest. The average N-Gain score was 59, with a score range between 37 and 78, classified as moderate. The data above indicate that the concentration of student scores in the control group is within the moderate interval, particularly between 55 and 63.

A comparison between the two groups is presented in Table 5, which shows that the average N-Gain of the experimental group is higher (70) compared to the control group (59). The learning completeness rate also shows a significant difference, with 88% in the experimental class and 71% in the control class.

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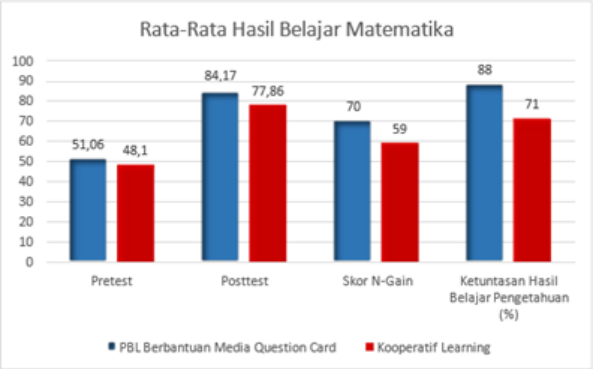
Table 5. Recapitulation of Average Scores for the Experimental and Control Groups

Score Recapitulation	Class Group
	Problem Based Learning Model Assisted by Question Card Media
Lowest Score	
Pretest	29.6
Posttest	66.6
N-Gain	50
Highest Score	
Pretest	70.3
Posttest	100
N-Gain	100
Average Score (Mean)	
Pretest	51.06
Posttest	84.17
N-Gain	70
Learning Mastery Percentage (%)	88%

Figure 1 shows a histogram comparing the average learning outcomes between the two groups, reinforcing the conclusion that the use of the PBL model assisted by question card media results in a more significant improvement in students' mathematics achievement.

Figure 1. Histogram of Mathematics Learning Outcomes for the Experimental and Control Classes



Before conducting the hypothesis test, normality and homogeneity tests as prerequisites for parametric statistical analysis were performed. The results of the normality test using the Liliefors method indicated that both groups had normal distributions. In the experimental class, the calculated L value was 0.136, which is less than the table value of 0.173, while in the control class, the calculated L was 0.067, less than the table value of 0.184.

The homogeneity test using Fisher's test also showed that the data from both groups had homogeneous variances, with an F calculated value of 1.157 less than the table value of 2.028. These results strengthen the validity of the subsequent hypothesis testing using the t-test.

The t-test was conducted to compare the average N-Gain between the experimental and control groups. The calculated t_{value} was 3.32929 with degrees of freedom (df) = 46. This value was compared to the t_{table} value at a significance level of α = 0.05, which is 2.01290. Since the calculated t-value is greater than the table value ($t_{calculated}$ > t_table), the null hypothesis (H_0) was rejected

and the alternative hypothesis (H_a) was accepted.

The results indicate that the use of the Problem Based Learning (PBL) model assisted by question card media significantly improves students' mathematics learning outcomes. The average N-Gain of the experimental group reached 70, indicating a high category of learning achievement improvement, while the control group only reached a moderate category. After conducting the t-test, the average N-Gain values of both groups showed t_calculated > t_table, namely 3.32929 > 2.01290. The null hypothesis is accepted if the t_calculated value falls within the interval -2.01290 to 2.01290, and rejected if $t_{calculated}$ < -2.01290 or $t_{calculated}$ > 2.01290. This indicates that there is an effect of the Problem Based Learning model assisted by question card media on mathematics learning outcomes.

The findings of this study show that mathematics learning outcomes using the Problem Based Learning model assisted by question card media are more effective compared to conventional learning models (cooperative learning) used in the control class.

D. Conclusion

This study demonstrates a significant effect of the Problem Based Learning (PBL) model assisted by question card media on students' mathematics learning outcomes. This is evident from the comparison of the average N-Gain scores between the experimental and control classes. The experimental class, which applied the PBL model with question card media, achieved an average N-Gain of 70, whereas the control class, which used conventional learning methods, only reached an average N-Gain of 59. To test the significance of this difference, a hypothesis test using a t-test was conducted. The results showed that the calculated t-value ($t_{calculated}$) was 3.32929, which is greater than the critical t-value (t_{table}) of 2.01290. Therefore, the null hypothesis is rejected and the alternative hypothesis is accepted, indicating that the PBL model assisted by question cards has a significant impact on improving mathematics learning outcomes.

Based on the results of this study, several recommendations can be made to improve the quality of mathematics learning in elementary schools. First, teachers are encouraged to implement the Problem Based Learning (PBL) model more widely in the learning process. The use of PBL combined with visual learning media such as question cards has been proven to enhance students' learning outcomes and promote their active engagement in learning activities. This model can serve as an effective alternative for delivering abstract materials, such as area and volume measurements.

Second, students are expected to become more active and enthusiastic in participating in the learning process, especially when working in heterogeneous groups to solve contextual problems. Active student involvement not only improves conceptual understanding but also fosters critical thinking and collaborative skills.

Third, future researchers are advised to expand the scope of the variables studied and increase the sample size so that the findings can have greater generalizability. In addition, the use of more varied

experimental methods—such as mixed design or long-term experiments—should also be considered in order to obtain more comprehensive and applicable results in various educational contexts.

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