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Improving Students' Multiplication Learning Outcomes Through the Implementation of PBL Model with P4 Basket Media

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ABSTRACT

Mathematics learning at the elementary school level has a crucial role in students' cognitive development. Although it is often perceived as a boring and difficult material, especially in understanding the concept of multiplication, this study aims to evaluate the effectiveness of the Problem Based Learning model (PBL) combined with the P4 basket media in improving students' problem-solving skills, understanding of mathematical concepts, and cognitive thinking skills. This study uses a quasi-experimental design by involving grade III students at SDN Kanigoro 03 Blitar Regency as a control and experimental group. The purposive sampling method was applied to select 26 students from class IIIA as the control group and 26 students from class IIIB as the experimental group. The instruments used in this study include observation sheets to monitor the learning process and cognitive ability tests consisting of 25 questions, consisting of 15 multiple-choice questions and 10 short-fill questions. The results show that the application of the PBL model supported by the P4 basket media can improve students' learning outcomes in multiplication materials, improve their understanding of mathematical concepts, and improve analytical thinking skills. These findings indicate that PBL can be an effective approach in teaching mathematics at the primary school level.

Informasi Artikel

Kata Kunci:
Hasil Belajar Perkalian; Model PBL; Keranjang P4; Sekolah Dasar

ABSTRAK

Pembelajaran matematika pada tingkat sekolah dasar memiliki peranan yang krusial dalam perkembangan kognitif siswa. Meskipun sering kali dipersepsikan sebagai materi yang membosankan dan sulit, terutama dalam memahami konsep perkalian, penelitian ini bertujuan untuk mengevaluasi efektivitas model pembelajaran berbasis masalah yang dipadukan dengan media keranjang P4 dalam meningkatkan kemampuan pemecahan masalah, pemahaman konsep matematika, serta keterampilan berpikir kognitif siswa. Studi ini menggunakan desain quasi-eksperimen dengan melibatkan siswa kelas III di SDN Kanigoro 03 Kabupaten Blitar sebagai kelompok kontrol dan eksperimen. Metode sampling purposive diterapkan untuk memilih 26 siswa dari kelas IIIA sebagai kelompok kontrol dan 26 siswa dari kelas IIIB sebagai kelompok eksperimen. Instrumen yang digunakan dalam penelitian ini mencakup lembar observasi untuk memantau proses pembelajaran serta tes kemampuan kognitif yang terdiri dari 25 butir soal, yang terdiri dari 15 soal pilihan ganda dan 10 soal isian singkat.

Hasil penelitian menunjukkan bahwa penerapan model ini didukung dengan penggunaan media keranjang P4 dapat meningkatkan hasil belajar siswa dalam materi perkalian, memperbaiki pemahaman konsep matematika mereka, serta meningkatkan keterampilan berpikir analitis. Temuan ini mengindikasikan bahwa model PBL berbasis media P4 dapat menjadi pendekatan yang efektif dalam pengajaran matematika di tingkat sekolah dasar.

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INTRODUCTION

Mathematics learning in elementary school plays an important role in students' cognitive development. Despite being a fundamental subject, mathematics is often seen as a difficult and less engaging subject for many students, especially in understanding the concept of multiplication (Farrow et al., 2024). Several factors such as lack of concentration, low interest, and inadequate motivation can affect their understanding (Saad & Zainudin, 2022). In addition, the physical challenges of unhealthy students and difficulty in reading well, experienced by some 3rd grade elementary school students, can also hinder their ability to understand written math clues or problems (Siregar, 2023).

Lestary et al. (2023) showed that students often have difficulty learning and solving multiplication problems. Some of the causes of this problem include ineffective and unengaging teacher teaching methods, which cause students to get bored during the learning process. Teachers usually only emphasize that multiplication is an addition that is done repeatedly. As a result, students tend to use the same repetitive summation method when working on assignments or tests, which can cause them to become saturated. This theory is in line with the opinion of experts who say that a poor understanding of the meaning of problems and an undeveloped understanding of basic mathematical concepts are the two main factors that cause difficulties in calculations (Nisa et al., 2023).

Through observations, interviews, and questionnaires, it was found that most students (around 78%) admitted that they had difficulty understanding calculation operations, especially in multiplication stories. Siems-Muntoni et al. (2024) also mentioned that mathematical concepts are often difficult to apply in real-life contexts. For example, when calculating grocery prices, students often face difficulties in applying the concept of multiplication correctly. This shows the importance of innovative learning approaches that can encourage students to be more active and involved in the learning process, reduce boredom, and improve their understanding of the material.

Teachers can use a variety of approaches to address this issue. One of them is by giving examples of questions that are relevant and easy to understand, such as counting the number of oranges given by friends or the number of chickens put in the cage. This model is expected to provide students with a better understanding of the concept of multiplication and the ability to use it in real-world situations (Desnatalia, 2022; Yu, 2024). In addition, the Problem Based Learning (PBL) model supported by the P4 (Addition, Subtraction, Multiplication, and Division) basket media is an example of interactive and engaging teaching materials that can be used by teachers.

The PBL model is a learning approach that presents challenges and problems to be solved by students, encouraging them to be active in finding solutions. This can indirectly improve students' scientific skills, such as gathering information, conducting research, discussing, and others (Lestari & Winanto, 2022). On the other hand, P4 basket media is a tool used in the student-teacher interaction process. They use games to hone cognitive abilities and improve focus to achieve success (Sapoetra & Hardini, 2020).

The combination of the PBL model with the P4 basket media as an alternative to learning visual media has the potential to be an effective strategy in improving mathematics learning outcomes. PBL provides a challenging learning experience by presenting relevant problems and requiring students to be actively involved in the problem-solving process (Hidajat, 2023). Meanwhile, this visual media is interactive which can increase student engagement, improve memory (Nakamori et al., 2024), and facilitate a better understanding of mathematical concepts (Ati & Setiawan, 2020; Niu et al., 2024).

It is hoped that the integration of PBL and P4 basket media can change students' views on mathematics, which is often considered boring and difficult. This model can also help students think critically and relate what they learn to everyday life. The purpose of this study is to improve mathematics education at the elementary school level, especially by improving the understanding of mathematical concepts and cognitive thinking skills, as well as problem-solving skills.

Through PBL, students can develop logical, analytical, systematic, critical, and creative thinking skills, as well as the ability to work in groups to find the right solutions. Meanwhile, P4 basket media, with its interactive approach, can increase student engagement and improve memory, making it easier for students to understand mathematical concepts.

The combination of the PBL model and the P4 basket media is expected to overcome negative perceptions of mathematics, stimulate students' critical thinking, and make it easier for them to apply the knowledge gained in real-life contexts. Therefore, this study aims to explore the potential of the PBL model supported by the P4 basket media as an effective alternative in improving the cognitive learning outcomes of grade III elementary school students, especially in understanding the concept of multiplication. By focusing on the development of problem-solving skills, understanding of mathematical concepts, and improving cognitive thinking skills, it is hoped that this research can make a positive contribution to mathematics teaching at the elementary school level.

The PBL model has been widely researched and proven to be effective in improving students' critical thinking skills, problem-solving skills, and analytical skills. Research conducted by Rochani (2016) shows that PBL can help students develop logical and critical thinking skills by allowing them to be actively involved in the challenging learning process.

Other studies, such as those conducted by Abidin (2020), reveal that PBL strengthens students' systematic thinking skills because the learning process is based on real-world problem scenarios, encouraging them to find integrated solutions. In this regard, the PBL approach has been shown to facilitate effective group work, allowing students to discuss with each other and work together in finding solutions.

Although the PBL model has many advantages, some studies show that using PBL in mathematics learning often faces problems related to student engagement and understanding of more abstract concepts. According to Widyastuti & Airlanda (2021), the success of PBL implementation is highly dependent on the teacher's ability to support the learning process and design relevant problems. As a result, additional support is needed, such as learning media that can help students understand mathematical concepts.

One possible solution to complement the implementation of the PBL model is the P4 basket media. This medium serves as a visual and interactive tool that allows students to see mathematical concepts and relate them to the real world. A study by Nuralfiani & Zanthy (2023) shows that the use of visual media can help students better understand what they are learning as well as improve their ability to remember what they are learning.

However, the incorporation of this media with the PBL model specifically in mathematics learning, especially on the concept of multiplication, is still not widely researched thoroughly. Studies related to the application of interactive-based media in PBL in the field of mathematics education are rarer, so it provides a research gap that can be filled by this research.

Although previous research has shown the effectiveness of PBL in developing students' critical thinking and cooperative skills, there are still some shortcomings, such as the lack of interactive media integration to improve understanding of specific mathematical concepts. Research on the influence of P4 media in the context of PBL to study mathematics, especially in multiplication materials, is still limited. The use of this

interactive media has the potential to solve challenges in the implementation of PBL, such as lack of student involvement and difficulties in understanding abstract concepts.

On the other hand, although previous studies have revealed the benefits of using visual media in learning, the emphasis on the integration of P4 basket media in PBL to teach mathematics at the elementary level has not been widely researched. This creates a significant research gap, where further exploration is needed on how effective the combination of PBL and P4 basket media is in improving students' understanding of the concept of multiplication and strengthening their cognitive thinking skills.

The contribution of this study aims to fill this gap by exploring the potential use of the PBL model supported by the P4 basket media. Thus, it is hoped that more effective approaches can be found in improving students' cognitive learning outcomes, which not only help them understand mathematical concepts, but also develop critical thinking skills and the application of knowledge in daily life.

METHOD

The study used a quantitative approach and used a quasi experimental experimental design with a disproportionate control group. This study involved all grade III students at SDN Kanigoro 03 Blitar Regency. The experimental group was class IIIA students, and the control group was class IIIB students, each with 26 students. Purposive sampling, which is based on special considerations, is the method of sample selection used.

The research process began with the provision of pretests to both groups to measure cognitive learning outcomes before the treatment was carried out. The control class (IIIA) follows conventional learning, while the experimental class (IIIB) receives treatment in the form of PBL Model supported by P4 basket media. After the treatment was completed, a posttest was given to both groups to evaluate the difference in learning outcomes resulting from the treatment.

The observation sheet used to supervise the learning process and the test consists of 25 questions, consisting of 15 multiple-choice questions and 10 short-fill questions, which are used to measure students' cognitive abilities. The validity of the test instrument is checked through the validity of the content and construction with the help of experts and then tested empirically with Pearson correlation. The test results show that the test tool is very valid. Cronbach's Alpha method is used to evaluate the reliability of test instruments; It resulted in a high score (0.961), indicating that the test tool had remarkable consistency in determining the variables studied.

Table 1. Reliability Test Results

Reliability Statistics	
Cronbach's Alpha	N of Items
.961	25

Data was collected during three meetings at SDN Kanigoro 03 during the first semester of the 2023/2024 academic year. The meeting took place from December 18, 2023 to January 11, 2024. In data analysis, prerequisite tests such as normality test (Kolmogorov-Smirnov and Shapiro-Wilk) and homogeneity test (Levene Statistic) were used. Then, to evaluate the difference between the pretest and posttest results in the two groups, a hypothesis test was carried out using a divided T sample test. The data were evaluated using SPSS 21.0 for Windows with a significance level of 0.05.

RESULTS AND DISCUSSIONS

A. Results

This research was carried out at UPT SD Negeri Kanigoro 03, taking place from December 18, 2023 to January 11, 2024, with two meetings every week. The research design used is an experiment, where class IIIA acts as a control group that accepts conventional learning, while class IIIB as an experimental group uses PBL model assisted by P4 Basket media.

The results of observations and interviews showed that students had poor multiplication calculation skills. Therefore, it is necessary to make efforts to improve their cognitive learning outcomes. Given that the PBL model emphasizes on solving real problems, which helps students relate mathematical concepts to everyday situations, and the P4 Basket media is used as a tool to provide concrete experience and help students understand the concept of multiplication as repetitive addition. At the beginning of the study, students were given a pre-calculation test to evaluate their initial ability in multiplication. Prior to the implementation of the P4 Basket media and the PBL model, this pretest was designed to evaluate students' understanding. The results of the question validity test showed that every twenty-five questions had a significant positive correlation, with a Pearson correlation value (r) between 0.590 and 0.814. The significance level p of all is 0.001. This suggests that the instrument as a whole can be considered valid, although there are differences in the correlation between the questions. For 25 question items, the data reliability test with SPSS produced a Cronbach's Alpha value of 0.961.

This value, which is close to 1, indicates a very high level of reliability, indicating that the data has good consistency between the items being measured. Based on these results, the data is considered valid and reliable to evaluate the relationship between the variables studied. Significance (Sig.) on the reliability test is not required in the context of the Cronbach's Alpha test to determine the validity of the data.

The treatment in the experimental class using the PBL model assisted by the P4 Basket media was carried out in two different meetings. At the first meeting, the activity began with an orientation on the concept of ordinary number multiplication, student readiness checks, pretest, and the use of P4 Basket media to solve multiplication problems. Although some students show excessive activeness, this approach has succeeded in creating an interactive and immersive learning experience.

In the second meeting, orientation was carried out by emphasizing the importance of multiplication in daily life, followed by the use of P4 Basket media to visualize and solve contextual multiplication problems. Despite some challenges in setting up classroom discipline, students showed great enthusiasm in using the P4 Basket for learning, which helped improve their understanding of the material. The PBL model has proven to be effective in mathematics learning because it can develop students' thinking skills and their ability to communicate and solve problems (Aryani et al., 2023).

Students showed a very positive response during the implementation of the PBL model supported by the P4 Basket media. Students seem more interested and enthusiastic about following the learning process because this model involves them in activities that are interactive and relevant to daily life. The use of P4 Basket media provides a more real learning experience and helps students understand the concept of multiplication through concrete objects. Because of their involvement in everyday situations, students are more involved in group discussions, help each other solve problems, and feel more motivated to learn. In contrast to conventional learning approaches, which are often passive, the learning atmosphere created is also more cooperative and fun.

Figure 1. P4 Learning Media

The PBL model, powered by the P4 Basket media, challenges students to solve problems related to their daily lives so that they not only memorize ideas, but also understand and use those ideas. The use of concrete media such as the P4 Basket helps students understand the multiplication of natural numbers better. The results showed that the PBL model assisted by the P4 Basket media was effective in improving the cognitive learning outcomes of students in class IIIB, or the experimental class, including the ability to remember (C1), understand (C2), apply (C3), and analyze (C4) multiplication concepts.

This is in line with Boom-Cárcamo et al. (2024)'s opinion which highlights the advantages of the PBL model, among others encouraging students to develop problem-solving skills in real contexts, building their own knowledge through learning activities, and focusing on problems so that irrelevant material is not learned. In addition, students engage in scientific activities through group work and are accustomed to using various sources of knowledge, such as libraries, the internet, interviews, or observation (Bicer et al., 2024).

In line with that, Ates & Aktamis (2024) revealed that (a) the problem-solving provided in the PBL model can stimulate students' critical thinking skills as well as provide satisfaction in discovering new knowledge, (b) the PBL model is more fun and preferred by students, (c) this model increases student engagement in the learning process, and (d) provides opportunities for students to apply their knowledge to real-world situations.

Table 1. Test of Normality

	Classes	*Kolmogorov-Smirnov*[a]			*Shapiro-Wilk*		
		Statistic	*Df*	*Sig.*	*Statistic*	*df*	*Sig.*
Students Learning Outcomes	*Pre-test Experiment*	.119	26	.200*	.971	26	.658
	Post-test Experiment	.129	26	.200*	.943	26	.160
	Pre-test Control	.125	26	.200*	.938	26	.120
	Post-test Control	.121	26	.200*	.945	26	.172

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

The results of the normality test of the Shapiro-Wilk method showed that each data group including the experimental group (Eksp.) and the control group had a Shapiro-Wilk statistical value greater than 0.05. The p-value (Sig.) for all data groups was above the significance level of 0.05, which was 0.658 for the experimental group, 0.160 for the post-experimental group, 0.120 for the control group, and 0.172 for the control post-test group. These results suggest that the null hypothesis (H0), which assumes that normally distributed data is acceptable, is reasonable.

Table 2. Test of Homogeneity of Variance

		Levene Statistic	**df1**	**df2**	**Sig.**
Students Learning Outcomes	*Based on Mean*	1.223	3	100	.306
	Based on Median	1.241	3	100	.299
	Based on Median and with adjusted df	1.241	3	96.444	.299
	Based on trimmed mean	1.218	3	100	.307

The results of the variance homogeneity test with the Levene statistical approach showed that the significance values (Sig.) for all variance measurement methods were above the significance level of 0.05, namely 0.306; 0.299; 0.299; and 0.307 for methods based on mean, median, median with degrees of freedom adjusted, and trimmed mean respectively. Based on these results, the null hypothesis (Ho) is acceptable, which means that the population variance of student learning outcome data in the experimental group

and the control group is the same or homogeneous. Therefore, the variance in the two groups is not different at all.

Table 3. N-Gain Score Test Results

No.	Experiment Scores (III A) *N-Gain Score* (%)	No.	Control Scores (III B) *N-Gain Score* (%)
1.	83.87	1.	65.91
2.	74.47	2.	87.50
3.	90.00	3.	46.88
4.	78.13	4.	28.57
5.	76.47	5.	47.50
6.	51.52	6.	65.85
7.	16.67	7.	56.00
8.	6.25	8.	40.00
9.	61.29	9.	50.00
10.	85.71	10.	46.43
11.	46.43	11.	53.13
12.	20.00	12.	32.26
13.	61.76	13.	40.00
14.	25.93	14.	44.12
15.	38.46	15.	15.38
16.	41.67	16.	32.00
17.	16.67	17.	51.52
18.	60.00	18.	35.00
19.	69.44	19.	38.46
20.	16.67	20.	29.03
21.	65.79	21.	48.00
22.	72.50	22.	20.00
23.	52.00	23.	56.25
24.	51.61	24.	31.03
25.	97.44	25.	51.52
26.	84.62	26.	.00
Average	**55.5904**	**Average**	**42.7820**
Minimum	**6.25**	**Minimum**	**0.00**
Maximum	**97.44**	**Maximum**	**87.50**

Similar research in third grade students using the Rainbow Egg Rack media also showed an improvement in the ability to count, multiply, and divide operations (Boye & Agyei, 2023). Based on the results, it can be concluded that the multiplication calculation operation ability of grade III A students and their cognitive learning outcomes can be improved by applying the PBL Model assisted by the Media of Addition, Subtraction, Multiplication, and Division (P4) Basket Media.

Table 4. Anova Test (Paired Sample Statistics)

		Mean	N	*Std. Deviation*	*Std. Error Mean*
Pair 1	*Pre-test Experiment*	69.35	26	6.609	1.296
	Post-test Experiment	87.50	26	5.887	1.155
Pair 2	*Pre-test Control*	69.38	26	6.469	1.269
	Post-test Control	83.04	26	4.634	.909

Table 5. Paired Samples Correlations

		N	*Correlation*	Sig.
Pair 1	*Pre-test Experiment & Post-test Experiment*	26	-.350	.080
Pair 2	*Pre-test Control & Post Test-Control*	26	.185	.366

Table 6. Paired Samples T-Test

		Paired Differences					t	df	*Sig. (2-tailed)*
		Mean	*Std. Deviation*	*Std. Error Mean*	*90% Confidence Interval of the Difference*				
					Lower	*Upper*			
Pair 1	*Pre-test Experiment – Post-test Experiment*	-18.154	10.275	2.015	-21.596	-14.712	-9.009	25	.000
Pair 2	*Pre-test Control – Post-test Control*	-13.654	7.227	1.417	-16.075	-11.233	-9.633	25	.000

The results of the data analysis can be concluded that the implementation of PBL with P4 Basket media has succeeded in increasing student involvement through stages such as orientation, investigation, solution development, presentation, and evaluation. Despite some challenges such as varying levels of student activity and group settings, the model has succeeded in creating an interactive and immersive learning environment. Teachers are able to guide students to work together, solve problems, and stimulate their creativity in applying the concept of multiplication into real-life contexts.

B. Discussions

The use of the PBL model assisted by P4 basket media has an important role in making mathematics learning more interesting and relevant for students. In more conventional learning approaches, many students tend to consider mathematics to be a difficult and boring subject (Hidayah & Sugiarto, 2015; Li et al., 2023). However, with the implementation of the PBL model supported by the P4 basket media, mathematics learning is expected to become more interactive, contextual, and interesting for students.

This model allows students to understand the connection between mathematical concepts and everyday life situations, which in turn can increase their motivation to learn and master the concept of multiplication (Ding & Navarro, 2024; Yang, 2014). Thus, the main goal of this approach is to improve students' cognitive learning outcomes and make mathematics learning in grade 3 elementary school more effective and meaningful.

This statement is in line with the findings of Affandy et al. (2024) who explain Among the many advantages of the PBL model is that it helps students acquire problem-solving skills in a real-world context. The PBL model also helps students build knowledge independently through learning activities and ensures that the material studied focuses on relevant issues, which helps students avoid learning irrelevant material (Annetta et al., 2024; L. Zhao et al., 2024). Media use, on the other hand, can show increased student interaction and activity.

The research of Safitri & Iswari (2024) supports this by showing that P4 basket media as an effective visual medium for PBL learning in grade III. The advantages of this media include: 1) making learning not boring for students; 2) Students can increase their interest in learning in a more engaging and fun way. It can also make the learning process more interactive and incorporate elements of the game; 3) encourage students to think actively and effectively; 4) training students' memory; and 5) help students memorize calculations faster. Therefore, the application of the visual media-assisted PBL model can activate student involvement in learning, deepen the understanding of concepts through real experiences, and increase student motivation to participate (Gever et al., 2021; Y. Zhao, 2024). Collaboration between students can also enrich discussions and develop social skills. With this approach, students are encouraged to think critically, find solutions, and present the results of their work, which has the potential to improve their problem-solving skills.

Integrating the PBL model with the P4 basket media is a strategic approach in improving students' multiplication skills. By using PBL model, students' logical, analytical, systematic, critical, and creative thinking skills can be developed. By using this learning model, students are exposed to real problem situations that encourage them to work together in groups to find solutions to problems and gain a deeper understanding of the concepts. It is an important component in improving problem-solving and critical thinking skills.

Meanwhile, the use of interactive tools such as the P4 basket can increase student engagement in the learning process. This interactive tool helps students understand abstract concepts such as multiplication by visualizing those concepts and relating them to a more real and easy-to-understand context (Hao et al., 2024; Yan et al., 2024). The use of this media can also improve students' memory, thus helping them remember and understand the material more effectively.

CONCLUSIONS

The PBL model combined with the P4 basket media has been shown to improve the ability of grade III students to solve problems, especially in terms of multiplication calculation operations in the cognitive field. The results of the study show that this model improves students' cognitive learning outcomes. Based on these findings, it can be concluded that, compared to the conventional learning model, the application of the PBL model supported by the P4 basket media significantly improves students' cognitive learning outcomes. The PBL model and P4 basket media offer a promising way to improve

math learning, especially students' understanding of the concept of multiplication in grade 3. The PBL model encourages students to develop critical, analytical, and creative thinking skills through a real problem-solving process, and P4's basket media offers interactive tools that increase student engagement and improve the quality of their day. This model not only makes learning more engaging and relevant, but it also encourages students to actively participate in learning and understand how mathematics is used in everyday life, leading to better cognitive learning outcomes. The recommendation for the next study is to extend the duration of the study to evaluate the long-term impact of the implementation of the PBL model and conduct a more in-depth analysis of the visual and interactive elements in the P4 basket media. For teachers, it is important to plan time management more carefully, especially in classes with a large number of students, so that all students can be actively and deeply involved in the learning process.

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