

The Effect Of The Problem-Based Learning Model On Understanding Fraction Addition

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ABSTRACT

Background	This study was motivated by students' low understanding of fraction addition, as indicated by the number of students who had not achieved the Minimum Mastery Criteria.
Purpose	This research aimed to determine the effect of the Problem-Based Learning (PBL) model on fourth-grade students' understanding of fraction addition at UPTD SDN Mandung 3, Kokop District.
Research Methodology	This study employed a quantitative approach using a pre-experimental one-group pretest-posttest design. The research instrument consisted of a 20-item multiple-choice test that had been validated and tested for reliability. Data were analyzed using the Paired Sample t-Test with the assistance of SPSS software.
Result	The findings showed an increase in the average posttest score compared to the pretest score after implementing the PBL model. Hypothesis testing produced a significance value of $0.000 < 0.05$, indicating that the alternative hypothesis (H_a) was accepted and the null hypothesis (H_0) was rejected. It can be concluded that the Problem-Based Learning model has a significant effect on students' understanding of fraction addition among fourth-grade students
Conclusion	The PBL model was proven to improve student engagement and deepen students' understanding of fraction concepts.
Keywords	Problem-Based Learning, Understanding, Fraction Addition



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INTRODUCTION

Education is a deliberate and planned effort to influence individuals in order to improve students' achievements and provide benefits both for themselves and for society (Anugraheni, 2018). Education also plays an important role in improving the quality of human resources, particularly in producing high-quality students (Rahman et al., 2022). Based on this description, education can be understood as a systematic process designed to educate, guide, and develop individuals' abilities. Therefore, education holds a vital role in human life. Learning is a positive interaction between students and their environment that leads to changes in behavior toward a better direction (Gunawan et al., 2017). Teachers have the responsibility to manage the learning environment in order to support meaningful changes through the learning process (Ardianti et al., 2022). Learning can also be defined as a conscious effort by educators to provide knowledge, theories, and information to students so that they can learn according to their abilities, capacities, and needs (Kistian, 2019). Furthermore, learning is an activity aimed at implementing the curriculum of an educational institution so that educational objectives can be achieved according to predetermined standards (Aditya et al., 2023).

One of the subjects studied by fourth-grade students is mathematics, particularly the topic of fraction addition. Based on observations conducted at UPTD SDN Mandung 3, Kokop Subdistrict, fourth-grade students experienced difficulties in learning fraction addition and demonstrated a low level of understanding, especially in concepts that require a high degree of abstraction. Fraction addition is one of the essential competencies that must be mastered by fourth-grade students (Handayani & Koeswanti, 2021). However, based on field findings, this material is often considered difficult because it involves several abstract procedures, such as determining common denominators and solving fraction addition operations (Novianti et al., 2020). As a result, many students struggle to understand these procedures, which negatively affects their academic achievement.

Based on the results of daily evaluations, it was found that 23 out of 33 fourth-grade students scored below the Minimum Mastery Criteria (KKM), while only 10 students achieved the required standard. The KKM score for this class was 70. These findings indicate that most students' learning outcomes were still below the expected level. This condition was influenced by several factors, including limited conceptual understanding, lack of practice in real-life contexts, and teaching methods that did not actively involve students in the learning process. To overcome these problems, the researcher applied the Problem-Based Learning (PBL) model as an alternative solution (Pertiwi et al., 2023). Problem-Based Learning is an innovative learning model that emphasizes active student participation in solving problems (Nurlaelah & Sakkir, 2020). PBL is based on real-life problems that are relevant to students' daily experiences, thereby encouraging students to become more motivated and actively engaged in learning activities (Permatasari et al., 2019). In the PBL model, teachers act as facilitators who guide students in finding solutions to problems rather than merely delivering information. This approach has been shown to improve students' motivation and conceptual understanding (Qomariyah et al., 2019).

Previous studies have shown that Problem-Based Learning (PBL) is an effective instructional model in improving students' understanding of mathematical concepts, particularly in fraction learning (Ningsih et al., 2019; Misnasanti et al., 2017). However, most of these studies focus on general learning outcomes without specifically examining students' understanding of fraction addition at the elementary school level within a contextual, problem-based learning environment that is closely related to students' daily lives (Sari et al., 2024). In addition, research on the implementation of PBL in elementary schools with diverse student characteristics remains limited. Several studies have also emphasized cognitive achievement, while students' active engagement and learning experiences have not been explored in depth (Chasanah & Fitriawati, 2023). Therefore, this study aims to address this gap by examining the effectiveness of PBL on fourth-grade students' understanding of fraction addition. The findings are expected to provide theoretical contributions to the

development of innovative learning models and practical contributions for teachers in improving mathematics instruction that is more active, meaningful, and student-centered (Harlinda & Widyastuti, 2025).

Previous studies have shown that the Problem-Based Learning (PBL) model can improve mathematics learning outcomes; however, research specifically examining its effect on elementary students' understanding of fraction addition in rural primary school contexts remains limited. Most prior studies focused on general mathematics achievement without deeply investigating conceptual understanding of fractions through contextual problem-solving activities. This gap highlights the need for further research on how PBL can support students in comprehending abstract fraction concepts at the elementary level. Therefore, this study offers novelty by applying the PBL model to fourth-grade students at UPTD SDN Mandung 3, Kokop Subdistrict, using real-life mathematical problems closely related to students' daily experiences. The purpose of this study is to analyze the effect of the PBL model on students' understanding of fraction addition and their engagement during mathematics learning. The findings are expected to contribute theoretically to the development of innovative mathematics instruction and practically provide teachers with an effective learning strategy to improve students' conceptual understanding, participation, and problem-solving skills in elementary mathematics learning.

The implementation of the Problem-Based Learning (PBL) model in this study has a positive impact on improving students' engagement, motivation, and understanding of fraction addition in elementary mathematics learning. By involving students in real-world problem-solving activities, PBL helps reduce learning difficulties related to abstract mathematical concepts and encourages active participation in the classroom. In terms of contribution, this research provides empirical evidence supporting the effectiveness of PBL in enhancing conceptual understanding at the elementary level, particularly in fraction learning. Theoretically, it enriches the literature on innovative instructional models in mathematics education. Practically, it offers teachers an alternative teaching strategy that is more interactive, student-centered, and meaningful. Furthermore, the results can serve as a reference for curriculum development and future educational practices aimed at improving learning quality. Thus, this study contributes to both improving classroom practice and supporting further research on effective learning models in elementary mathematics education.

RESEARCH METHODOLOGY

This study employed a quantitative experimental approach using a Pre-Experimental Design with the One Group Pretest-Posttest model. This design was chosen to determine the effect of the Problem-Based Learning (PBL) model on students' understanding of fraction addition. In this design, students were given a pretest before the implementation of the PBL model and a posttest after the learning process was completed. The comparison between the pretest and posttest results was used to identify whether there was an improvement in students' understanding after the application of the PBL model. The Pre-Experimental Design used in this study did not involve a control group and did not apply random sampling techniques. Therefore, the design is considered less controlled because external variables outside the treatment may influence the results of the experiment. Nevertheless, this design is suitable for preliminary educational research aimed at examining the effectiveness of a learning model in a real classroom setting.

This research was conducted at UPTD SDN Mandung 3, Kokop District. The population and sample of the study consisted of all fourth-grade students, totaling 33 students, including 15 female students and 18 male students. The researcher selected the entire class as the research sample because the number of students was manageable and represented the target population of the study. The instrument used in this research was an objective multiple-choice test consisting of 20 questions related to fraction addition material. Before being administered, the test instrument was first examined for validity and reliability using IBM SPSS Statistics version 21. The validity test was conducted to determine whether each test item accurately measured students'

understanding of fraction addition, while the reliability test aimed to ensure the consistency and stability of the instrument. Only valid and reliable test items were used in the research process.

The data collection process began with administering the pretest to measure students' initial understanding of fraction addition before the implementation of the Problem-Based Learning model. Afterward, the researcher conducted learning activities using the PBL approach, which emphasized student participation in solving contextual and real-life problems. At the end of the learning process, students were given a posttest to measure their understanding after receiving the treatment. Data analysis was carried out using IBM SPSS Statistics 21. First, a normality test was conducted using the Kolmogorov-Smirnov test to determine whether the data were normally distributed. After confirming the normality of the data, hypothesis testing was performed using the Paired Sample t-test. This test was used to determine whether there was a significant difference between the pretest and posttest scores. The hypothesis was accepted if the significance value (2-tailed) was less than 0.05, indicating that the Problem-Based Learning model had a significant effect on students' understanding of fraction addition. Through this analysis, the study aimed to identify the effectiveness of the PBL model in improving students' mathematical understanding, particularly in the topic of fraction addition.

RESULT AND DISCUSSION

Validity Test

The validity test was conducted to determine whether the instrument items were capable of accurately measuring students' understanding of fraction addition. The instrument trial involved 22 respondents and was analyzed using IBM SPSS Statistics 21. Based on the results of the validity test for the 20 multiple-choice items, all items were declared valid because each calculated correlation coefficient (r-count) exceeded the r-table value of 0.432. Therefore, all 20 items were retained and used in the research instrument.

Table 1. Results of the Validity Test of the Items

Item	R Table	R Calculate	Description
1	0.432	0.566	Valid
2	0.432	0.469	Valid
3	0.432	0.476	Valid
4	0.432	0.521	Valid
5	0.432	0.543	Valid
6	0.432	0.512	Valid
7	0.432	0.637	Valid
8	0.432	0.468	Valid
9	0.432	0.457	Valid
10	0.432	0.525	Valid
11	0.432	0.540	Valid
12	0.432	0.478	Valid
13	0.432	0.585	Valid
14	0.432	0.439	Valid
15	0.432	0.488	Valid
16	0.432	0.454	Valid
17	0.432	0.476	Valid
18	0.432	0.486	Valid
19	0.432	0.594	Valid
20	0.432	0.682	Valid

Reliability Test

The reliability test involves processing or analyzing the data from the instrument trial conducted with the test sample using IBM SPSS Statistics 21 for Windows. The instrument trial, consisting of 20 questions tested on 22 respondents, was analyzed as follows:

Table 2. Reliability Test

Cronbach's Alpha	N of Items
.739	20

Based on the reliability test in the table above, the Cronbach's Alpha value is 0.739. This indicates that the students' understanding has a reliable level, as the reliability test criterion is met where the alpha value (α) is greater than the table value (r table). Specifically, $0.739 > 0.432$. The calculation results from the test items and data processing using IBM SPSS Statistics 21 for Windows show whether an instrument is normally distributed, which is called the normality test. The significance level used is 0.05. If the significance obtained is greater than 0.05, the sample is assumed to come from a normally distributed population. However, if the significance is less than 0.05, the sample is assumed not to come from a normally distributed population.

Table 3. Normality Test

One-Sample Kolmogorov-Smirnov Test	
	Unstandardized Residual
N	33
Normal Parameters ^{a,b}	Mean
	Std. Deviation
Most Extreme Differences	Absolute
	Positive
	Negative
Kolmogorov-Smirnov Z	.594
Asymp. Sig. (2-tailed)	.872

Based on the table 3, the significance value of the influence of the Problem-Based Learning (PBL) model on the understanding of fraction addition by 4th-grade students at UPTD SDN Mandung 3, Kokop District, is obtained (Asymp. Sig = 0.872), which is greater than the table value (0.05). Therefore, the data from this variable are normally distributed.

Hypothesis Testing

The purpose of this hypothesis test is to determine whether there is an effect of the Problem-Based Learning model on the understanding of fraction addition by 4th-grade students at UPTD SDN Mandung 3, Kokop District. The hypothesis test used in this study is the Paired Sample T-test, which is employed to assess the effect of the PBL model on students' understanding of fraction addition. The criteria for hypothesis testing in this study are as follows: If the significance value (2-tailed) < 0.05 , it indicates a significant effect between the initial and final variables. In this case, H_0 is rejected and H_a is accepted. If the significance value (2-tailed) > 0.05 , it indicates no significant effect between the initial and final variables. In this case, H_0 is accepted and H_a is rejected. The hypothesis outlined in this study is that the Problem-Based Learning model has an effect on the understanding of fraction addition by 4th-grade students at UPTD SDN Mandung 3, Kokop District. The analysis results can be seen in the following table:

Table 4. Hypothesis Test (Paired Sample T Test)

		Paired Samples Test							
		t	df	Sig. (2-tailed)					
Paired Differences		Std.	Std. Error	95% Confidence Interval of the Difference					
Mean		Deviation	Mean	Lower	Upper				
Pair 1	Understanding of fraction addition - Understanding of fraction addition	-17.576	9.852	1.715	-21.069	-14.082	-10.248	32	.000

Based on the table above, the Paired Sample T-test shows a significance value (2-tailed) < 0.05 , or in other words, $0.000 < 0.05$. Therefore, H_0 is rejected and H_a is accepted, indicating that there is an effect of the Problem-Based Learning (PBL) model on the understanding of fraction addition among 4th-grade students at UPTD SDN Mandung 3, Kokop District. In the research conducted, the researcher selected 33 4th-grade students at UPTD SDN Mandung 3, consisting of 18 male students and 15 female students, as the research sample. The study used two measurements: a pretest and a posttest. The pretest was administered before the intervention, and the posttest was given after the intervention using the PBL model. The study focused on the subject of mathematics, specifically on fraction addition, with a test consisting of 20 multiple-choice questions administered to the 4th-grade students at UPTD SDN Mandung 3, Kokop District. After administering the test, the results showed that the PBL model significantly influenced students' understanding of fraction addition in mathematics. This was confirmed through the Paired Sample T-test, where the significance value was $0.000 < 0.05$, leading to the rejection of H_0 and acceptance of H_a . This suggests that the PBL model positively impacted students' understanding, as the significance value (2-tailed) was smaller than 0.05. This study provides insight into how the PBL model can be used as a reference for teachers to improve students' understanding, thus preventing boredom in learning and allowing students to respond more freely to lessons.

The Problem-Based Learning (PBL) model has been shown to be effective in enhancing students' understanding of fraction addition. A study in Demak District indicated that the implementation of PBL positively affected mathematics learning outcomes, with a t-test value of $2.199 > 2.000$ and an N-gain percentage of 61.73, indicating a relatively high level of effectiveness (Masriah et al., 2023). Furthermore, the application of Polya's problem-solving steps within PBL also significantly improved learning outcomes related to fraction addition. Observations and assessments demonstrated significant improvements in both teaching and student learning outcomes (Ningsih et al., 2019). A meta-analysis covering a 30-year period found that PBL has a greater effect on students' cognitive and affective learning outcomes compared to other methods, with an average effect size of $g = 0.726$ (Koçoğlu & Kanadlı, 2025). In addition, PBL contributed to improvements in student behavior, including increased discipline, cooperation, confidence, and enthusiasm (Sukmanasa et al., 2019).

The Problem-Based Learning (PBL) model has been proven effective in enhancing critical thinking skills, which are essential for the development of student competencies across various educational levels. Several studies have shown that PBL improves critical thinking processes from elementary to tertiary education (Bonafide et al., 2021). Moreover, PBL contributes to better academic achievement, with numerous studies indicating that students engaged in PBL environments achieve higher grades compared to those learning through traditional methods (Muerza et al., 2024). In this context, the application of PBL can enhance learning outcomes in various subjects such as genetics, biochemistry, and geography (Hincapié Parra et al., 2018). PBL not only focuses on academic achievement but also fosters the development of crucial skills such as problem-solving, teamwork, communication, and self-regulated learning (Wynn, 2022). These skills are highly relevant for future professional success and are often inadequately developed through traditional teaching methods (Wilder, 2015). Additionally, PBL has been shown to increase student motivation and engagement, largely due to the real-world relevance of the problems they address and the collaborative nature of the learning process (Maksum et al., 2025). However, the implementation of PBL also presents challenges, particularly in terms of the additional burden on instructors, who require significant preparation and facilitation skills (Gonzalez, 2019).

Several previous studies have demonstrated that the Problem-Based Learning (PBL) model is effective in improving students' understanding of fraction concepts in mathematics learning. PBL significantly enhanced elementary students' conceptual understanding of fractions compared to conventional teaching methods (Cahyaningsih et al., 2025). The implementation of PBL in teaching fraction addition with different denominators also helped students better understand mathematical concepts through active problem-solving activities

(Poluakan et al., 2024). Furthermore, PBL was found to improve students' problem-solving abilities and mastery of fraction concepts in mathematics learning (Qudwatullathifah et al., 2019). Research also revealed that the use of PBL positively influenced students' learning outcomes in fraction operations and increased their engagement during classroom activities (Sukmanasa et al., 2019). In addition, combining PBL with manipulative media effectively improved students' conceptual understanding and participation in mathematics learning (Husna, 2025). These findings indicate that PBL is an innovative and interactive learning model capable of enhancing students' critical thinking, engagement, and mathematical understanding.

CONCLUSION

Based on the data analysis and discussion, it can be concluded that the Problem-Based Learning (PBL) model has a significant impact on the understanding of fraction addition among 4th-grade students at UPTD SDN Mandung 3, Kokop District. This impact is supported by the results of the Paired Sample T-test, where the obtained significance value (2-tailed) is 0.000, which is smaller than 0.05. This indicates that the PBL model has a positive effect on enhancing students' understanding of fraction addition. The results of the Paired Sample T-test show a significant difference between the pretest and posttest scores after the PBL model was applied. Therefore, it can be concluded that the implementation of the PBL model successfully improved students' understanding of fraction addition, demonstrating the effectiveness of problem-based learning in helping students comprehend more complex mathematical concepts. This study also highlights the importance of using more interactive and applied methods, such as PBL, to improve the quality of learning in elementary schools, especially in mathematics. The PBL model encourages students to be more active in learning, think critically, and engage directly in problem-solving, which ultimately leads to improved learning outcomes.

This study contributes to the development of innovative mathematics learning strategies, particularly in elementary education, by providing empirical evidence that the Problem-Based Learning (PBL) model can effectively improve students' understanding of fraction addition. Nevertheless, this research has several limitations, including the limited number of participants, the use of only one school as the research setting, and the short duration of the implementation, which may affect the generalizability of the findings. Therefore, future researchers are encouraged to conduct studies involving larger samples, different educational levels, and longer implementation periods to obtain more comprehensive results. Further studies may also examine the effect of PBL on other mathematical topics and students' higher-order thinking skills. Overall, the findings confirm that the PBL model is an effective and engaging learning approach that can enhance students' mathematical understanding and support more meaningful learning experiences in elementary school classrooms.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to all parties who have supported and contributed to this research. This study would not have been possible without the invaluable guidance and direction of my supervising lecturers, whose motivation and insights were truly beneficial. I also extend my thanks to the 4th-grade students at UPTD SDN Mandung 3, Kokop District, who participated enthusiastically in the trial of the Problem-Based Learning (PBL) model. This research is expected to have a positive impact on the quality of education in elementary schools, particularly in improving students' understanding of fraction addition. I hope the results of this study will serve as a useful reference for educators in implementing more effective and engaging teaching methods in the classroom. My sincere thanks also go to all those who have provided moral and material support.

AUTHORS' CONTRIBUTION

- Author 1 : Conceptualized the study, designed the research methodology, conducted data collection, analyzed the data using statistical procedures, and prepared the original manuscript draft.
- Author 2 : Contributed to the development of the research instrument, validated the research procedures, assisted in data interpretation, and reviewed the manuscript critically for important intellectual content.
- Author 3 : Assisted in the implementation of the Problem-Based Learning (PBL) intervention, coordinated the field research activities, and contributed to data organization and documentation.
- Author 4 : Supervised the overall research process, provided methodological guidance, verified the statistical analysis, and finalized the manuscript for publication.

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