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The Influence of Problem-Based Learning Model on the Improvement of Students' Critical Thinking Skills in IPAS Learning

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Abstract

Education plays an important role in shaping individuals to be critical, creative, and independent. However, the learning process in elementary schools is still dominated by conventional lecture methods that do not actively involve students, which affects their low critical thinking skills. This study aims to examine the effectiveness of the Problem-Based Learning (PBL) model in improving the critical thinking skills of fourth-grade students at SD Negeri 2 Kuanyar, Jepara. The method used is a quantitative approach with a one-group pretest-posttest design, involving 19 students as the research sample. The research instruments were tested for validity and reliability using SPSS version 25. The analysis results show a significant increase between the pretest and posttest scores (t-count = 7.833 > t-table = 2.110; sig. = 0.000 < 0.05), which proves that the PBL model is effective in enhancing students' critical thinking skills. The implementation of PBL also encourages active participation, group discussions, as well as the ability to solve problems independently and collaboratively. Therefore, the PBL model is a feasible alternative learning strategy to improve the quality of education, particularly in developing critical thinking skills at the elementary school level.

Keywords Critical Thinking, IPAS, Problem Based Learning

INTRODUCTION

Various efforts have been made by the government to improve the quality of learning in schools, such as the implementation of the 2013 Curriculum and the use of instructional media. However, the reality is that the learning process in many educational institutions still faces various challenges. One of the most common issues is the low level of active student participation in the learning process. Many teachers continue to use conventional, one-way teaching methods, where the teacher dominates the class and students only act as passive listeners. This leads to low student engagement, underdeveloped critical and creative thinking skills, and suboptimal learning outcomes (Manullang, 2021). This condition indicates the need for further innovation in the learning process to encourage student activity and provide meaningful learning experiences. One alternative that can be applied is the use of interactive, student-centered learning models supported by the use of relevant instructional media (Silaban, 2019). Therefore, this study was conducted to examine the effectiveness of specific models, methods, or media in improving the quality of learning and student achievement (Al-Tabany, 2017).

One of the learning strategies considered effective in increasing student engagement and learning outcomes is the implementation of student-centered learning models. In this approach, the teacher acts as a facilitator who guides students to explore the material through various challenging, enjoyable, and contextual activities. The use of engaging instructional media that aligns with children's developmental characteristics is also a crucial factor in creating an active and enjoyable learning environment (Nunchus & Gunansyah, 2016).

Instructional media not only serve as tools to assist teachers in delivering information, but also function as means to clarify concepts, stimulate interest in learning, and help students understand the material more deeply and concretely. This is especially important for elementary school students who are still in the concrete operational stage of development; visual or audio-visual media can help connect abstract content with real-life experiences they encounter in their daily lives.

Previous studies have also shown that the use of appropriate media can increase students' learning motivation, facilitate concept comprehension, and positively impact learning outcomes. For example, the use of picture story media, educational games, or interactive digital media has been proven to create a more engaging and enjoyable learning atmosphere (Fitriyani, 2022). Therefore, in this study, the researcher is interested in exploring the effectiveness of using specific instructional media as an effort to enhance student participation and learning outcomes.

Based on field observations and previous findings, many teachers have yet to fully utilize instructional media in a creative and innovative manner. The learning process is still largely dominated by lecture-based methods, which tend to make students passive, easily bored, and less able to deeply understand the material. This condition negatively affects students' learning outcomes, especially in subjects that require conceptual understanding and critical thinking skills.

Given these issues, there is a need for concrete and applicable solutions to improve the quality of learning in elementary schools. One viable alternative is integrating instructional media that aligns with the needs and characteristics of students. Well-designed instructional media can capture students' attention, boost their motivation to learn, and support their thinking processes and understanding of the subject matter (Rusmono, 2014).

Science (IPA) is a subject that explores natural phenomena, both living and non-living. According to the Ministry of Education and Culture, science learning emphasizes active and direct involvement of students in learning concepts, skills, and principles. Through this learning process, students are able to discover concepts and principles on their own. Science education encompasses four main components: attitudes, processes, products, and applications (Sutria Amanda et al., 2018). Critical thinking is an organized process that involves mental activities such as problem-solving, decision-making, assumption analysis, and scientific inquiry. This way of thinking results in reasoning that is cohesive, logical, reliable, concise, and convincing.

The challenges in science education today have encouraged the government to implement various innovative efforts to improve the quality of education while strengthening character values. Since 2004, there have been significant curriculum changes, from the 1994 Curriculum to the current Merdeka Curriculum. These changes aim to shift the learning paradigm from a teacher-centered approach to a student-centered one. However, in practice, the learning process has not been fully optimized, as students still tend to be passive during lessons (Shoimin A, 2017). They often just sit and listen to the teacher's explanation, while teachers continue to rely heavily on expository teaching methods, which are predominantly teacher-centered. As a result, students' development of scientific attitudes and critical thinking skills remains suboptimal.

IPAS (Ilmu Pengetahuan Alam dan Sosial) learning is intended to equip students with critical thinking skills to solve problems related to natural and social phenomena. However, fourth-grade students at SD Negeri 2 Kuanyar still show learning outcomes below the expected standard, mainly due to the continued use of conventional teaching methods, such as lectures. Although the 2013

Curriculum and the Merdeka Curriculum have been implemented to encourage more interactive learning, the main challenge faced is the lack of active student participation, which negatively affects the development of their critical thinking skills.

The Problem-Based Learning (PBL) model offers an approach that allows students to take an active role in the learning process through the solving of practical problems (Hartati & Sholihin, 2015). Based on previous studies, this approach can enhance critical thinking skills as it encourages students to identify, analyze, and formulate solutions to problems. Therefore, this study aims to examine the impact of the Problem-Based Learning model on improving the critical thinking skills of fourth-grade students (Agnafia, 2019).

In addition, students have also shown low levels of engagement during learning activities. During lessons, many students remain passive, failing to actively participate when the teacher asks questions or reviews the material. Most students stay silent and do not respond. Student involvement in the learning process is key to achieving learning objectives. In this regard, teachers are also expected to foster students’ confidence so that they are not afraid to ask questions or respond to their classmates (Amanda, 2018). Therefore, students need to be encouraged to take the initiative in asking and answering questions, whether from the teacher or their peers. In doing so, everyone can actively participate in the learning process.

One of the proposed solutions to enhance students' thinking skills is the implementation of the Problem-Based Learning (PBL) model. As defined by Chaerul Abas and Deni Darmawan (Nisah et al., 2021), Project-Based Learning is a learning strategy that enables educators to design a learning framework by creating specific items within classroom learning experiences. The problem-based learning model presents students with practical problems as a foundation for learning through various challenges. According to Trianto (A. Octavia, 2020), a learning model is a plan or pattern used as a guide in organizing classroom learning. It refers to the learning approach applied, including learning objectives, stages, learning environment, and classroom management.

According to Beyer (Khairunnisa, 2016), critical thinking is a disciplined way of thinking used to evaluate the validity of statements, ideas, or arguments. It involves the ability to think logically, reflectively, and productively in order to assess situations and make sound judgments and decisions. Critical thinking also includes deep problem-solving and maintaining an open mind through various approaches and perspectives. The problem-based learning model is closely linked to critical thinking skills. This model emphasizes problem-solving through analytical activities

(Frasandy, R. N., & Septikasari, R., 2018). The analytical activities carried out by students require information from various sources. The ability to process such information is one of the key characteristics of critical thinking skills.

Therefore, the implementation of the problem-based learning model is expected to improve students' critical thinking abilities. This model has been tested and proven to enhance student independence, particularly in learning activities involving project completion, as supported by previous research (Irfana et al., 2022).

Thinking is an inseparable part of human activity, as it is a defining trait that distinguishes humans from other living beings. Critical thinking is one of the higher-order thinking skills that is essential for every individual, as it has a positive influence on the direction of one's life in achieving goals and aspirations. Individuals who lack critical thinking skills will face challenges in solving the problems they encounter in life. Critical thinking involves reasoning and reflective thinking focused on decision-making about what to believe or do (Mustiaji in Surip, 2014). Critical thinking skills involve the process of thinking about ideas or concepts related to specific issues or problems. This includes analyzing ideas more specifically, sharply distinguishing them, selecting, identifying, reviewing, and developing them to a more refined level (Susanto, 2018). It is a systematic way of thinking with structured steps, including analyzing and solving problems to reveal the clarity of the information conveyed, eventually arriving at the truth of that information.

Critical thinking is one of the higher-order thinking skills frequently applied in daily life. Therefore, learning critical thinking skills for students—or teaching these skills to educators is highly important. Critical thinking involves evaluating conclusions based on the examination of issues, events, or problems through logical and systematic problem-solving (Surip, 2014).

In the field of education, critical thinking can help individuals improve their understanding of the material being studied by critically evaluating arguments found in textbooks, journals, peer discussions, and even those presented by instructors during the learning process. Thus, critical thinking in education is both a competency to be achieved and a tool necessary for building knowledge. The thinking involved in critical thinking is structured and systematic. Critical thinking skills are essential for success in both education and social life, and these skills can be developed or strengthened through the learning process.

Problem-Based Learning (PBL) is an educational innovation, as it fully optimizes students' critical thinking abilities through a systematic group or team work process. This approach enables students to utilize, refine, test, and continuously develop their thinking skills (Tan in Rusman, 2019). During the learning process, students are required to think critically and express their ideas, both individually and in groups. Problem-Based Learning (PBL) is a learning model that engages students in solving a problem through stages of the scientific method, enabling them to learn knowledge related to the issue while also acquiring the skills needed to resolve it (Fathurrohman, 2015).

Problem-Based Learning (PBL) is a learning model characterized by real-world problems that serve as the context for students to develop critical thinking and problem-solving skills while acquiring knowledge (Shoimin, 2019). In the learning process, students are presented with problems they have previously encountered or issues that exist in their surroundings, and they are actively involved in finding solutions to these problems. Through this approach, students are not merely memorizing concepts, but are also trained to think logically and creatively.

The purpose of this study is to determine the effect of implementing the Problem-Based Learning model on improving students' critical thinking skills and learning outcomes. This research is expected to provide insights into the extent to which PBL is effective in creating meaningful learning experiences and empowering students both cognitively and affectively.

METHOD

This study employed a quantitative approach using a descriptive-analytical method. This approach was chosen because it aligns with the characteristics of the problem being investigated. According to (Sugiyono, 2018), research methodology is a scientific method used to obtain data for specific purposes and benefits. This research is classified as quantitative research with a one-group pretest-posttest design. This method involves initial measurement (pretest) before the intervention and final measurement (posttest) after the intervention to observe the effect of the intervention. The quantitative approach focuses on collecting numerical data, which is then statistically analyzed.

The study was conducted at SD Negeri 2 Kuanyar, located in Mayong District, Jepara Regency, Central Java. The research population consisted of all fourth-grade students at SD Negeri 2 Kuanyar in the academic year 2024/2025, totaling 19 students. The school was selected based on the fourth-grade students' mathematics learning outcomes, which were below the minimum mastery criteria (KKM), indicating a need for intervention to improve academic performance.

In quantitative research, a sample is drawn from a portion of the population that shares similar characteristics with the overall population. If the population is too large to study in its entirety due to limitations in budget, manpower, or time, a representative sample is selected. The results obtained from this sample are then generalized to the population. The sampling technique used was Simple Random Sampling, where sample members are selected randomly without considering any stratification within the population (Sugiyono, 2018). The research sample consisted of students from class IV B at SD Negeri 2 Kuanyar.

Before the data were analyzed, prerequisite tests were conducted, including validity and reliability tests of the test instruments. Once the instruments were confirmed to be valid and reliable, hypothesis testing was carried out to determine whether there was a significant difference between the pre-test and post-test results. The test used in this study was the paired sample t-test. The paired sample t-test was used to compare the mean scores of the pre-test and post-test within the same group—namely, the fourth-grade students of SD Negeri 2 Kuanyar—in order to measure the effectiveness of the Problem-Based Learning (PBL) model in improving students' critical thinking skills. Data analysis was performed using statistical software such as SPSS.

The decision-making criteria in the paired t-test are as follows: if the significance value (p-value) is less than 0.05, then H_0 is rejected and H_1 is accepted. This indicates that there is a significant difference between the pre-test and post-test mean scores, which implies that the intervention using the Problem-Based Learning model had a positive impact on enhancing students' critical thinking skills and learning outcomes.

FINDINGS AND DISCUSSION

Findings

A. Instrument Testing

1. Validity Test

The validity test is used to measure whether an instrument accurately assesses what it is intended to measure. The r table value in the validity test is determined using the formula n - 2, where n is the number of respondents. In this study, with n = 19, the degrees of freedom (df) is 19 - 2 = 17. Using a significance level of 0.05, the corresponding r table value is 0.455. The results of the validity test calculations in this study are as follows:

Table 1. Validity Test Result

Correlations			
		Pre Test	Post Test
Pre Test	Pearson Correlation	1	.885**
	Sig. (2-tailed)		.000
	N	19	19
Post Test	Pearson Correlation	.885**	1
	Sig. (2-tailed)	.000	
	N	19	19

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Output SPSS 25

Based on the data above, it can be seen that 0.885 > 0.455, thus it can be concluded that the Pre-test and Post-test scores in this study are valid and appropriate to be used as research instruments.

2. Reliability Test

Reliability testing is used to examine the consistency of the measuring instrument—whether the instrument used can be relied upon and remains consistent if the measurement is repeated (reliable). A variable is considered reliable if it yields a Cronbach's Alpha value greater than 0.60. The results of the instrument reliability test in this study can be seen in the following table:

Table 2. Reliability Test Result

Reliability Statistics	
Cronbach's Alpha	N of Items
.936	2

Source: SPSS 25 Processing Results

Based on the table, it can be concluded that the pre-test and post-test in this study are reliable. This is indicated by the Cronbach's Alpha value of 0.936, which is greater than 0.60.

B. Classical Assumption Test

The classical assumption test is carried out to ensure that the data used in the statistical analysis meets the basic assumptions required for valid inference. In this study, the classical assumption tests include normality test and homogeneity test.

1. Normality Test

Uji normalitas data bertujuan untuk menguji apakah dalam model regresi antara variabel independen dan variabel dependen mempunyai distribusi normal atau tidak dengan menggunakan uji kolmogorof sminorv test. Uji kolmogorof sminorv test memiliki ketentuan apabila nilai Asymp sig > 0,5 maka dapat dinyatakan bahwa data tersebut berdistribusi normal, namun sebaliknya apabila nilai Asymp sig < 0,5 maka data tidak normal. Hasil uji normalitas dalam penelitian ini adalah sebagai berikut:

Table 3. Normality Test Result

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		**19**
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	1.92222463
Most Extreme Differences	Absolute	.140
	Positive	.113
	Negative	-.140
Test Statistic		.140
Asymp. Sig. (2-tailed)		.200[c,d]

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

Source: SPSS 25 Processing Results

Based on the table above, the value of Asymp. Sig. (2-tailed) is 0.200, which is greater than 0.05. Therefore, it can be concluded that the data in this study are normally distributed. In addition, the normality test was also conducted using the P-P Plot, as shown in the figure below. The plot indicates that the data are normally distributed because the data points closely follow the diagonal line.

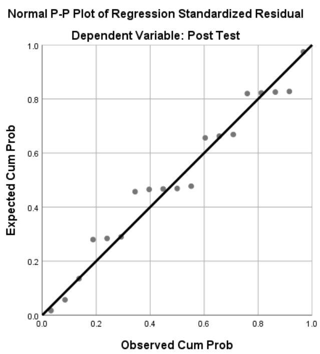

Figure 1. P-Plot Test Result

2. Heteroscedastisity Test

The purpose of the heteroscedasticity test is to determine whether there is a similarity in the variance of residuals from one observation to another within the regression model. In this study, the heteroscedasticity test was conducted using the Glejser test. The Glejser test is a hypothesis test used to detect indications of heteroscedasticity in a regression model by regressing the absolute value of residuals. According to this test, if the significance value is greater than 0.05, it indicates no heteroscedasticity symptoms, and the data are considered homoscedastic. The results of the heteroscedasticity test in this study are shown in the following table:

Table 4. Heteroscedastisity Test Result

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.417	5.789		.245	.810
	Pre Test	.000	.081	.001	.004	.997
a. Dependent Variable: Abs_RES						

Source: SPSS 25 Processing Results

Based on the data in the table, it can be seen that the significance value for the Pre-test variable is 0.997, which is greater than 0.05. Therefore, it can be concluded that the data in this study is homoscedastic, indicating that there are no symptoms of heteroscedasticity. The results of the heteroscedasticity test are also presented in the following figure:

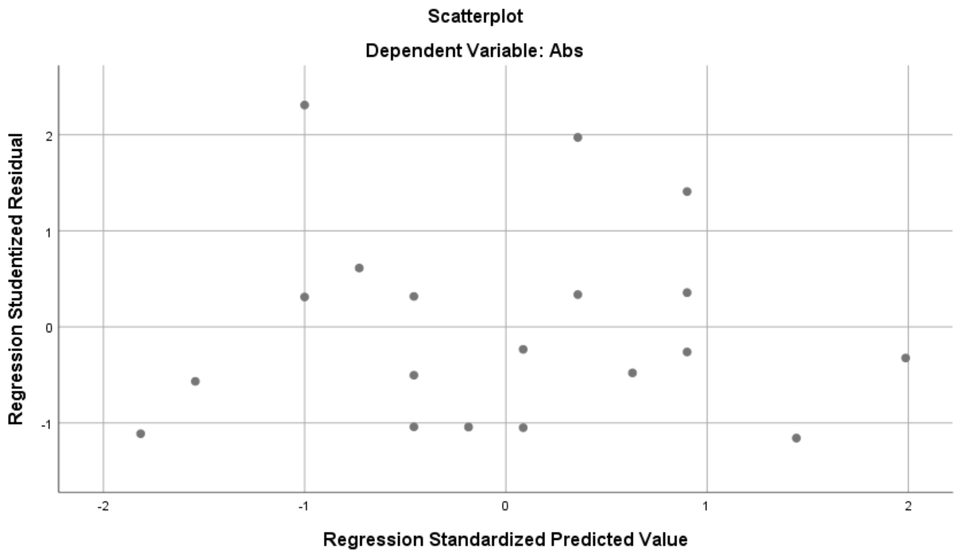

Figure 2. Scatterplot Test Result

The image above supports the Glejser test, indicating that the residual data distribution exhibits homoscedasticity or homogeneity. The figure also shows that the residuals are evenly spread and do not form a specific pattern. Therefore, both graphically and statistically, the data from the regression model is homogeneous and free from heteroscedasticity issues.

C. Hypothesis

1. t-Test (Individual/Partial Test)

The t-test aims to determine the significance level of the individual or partial effect between the independent and dependent variables. The t-test follows the criteria that if the significance value < 0.05 and the t-count > t-table, then the hypothesis is accepted. Conversely, if the significance value > 0.05 and the t-count < t-table, then the hypothesis is rejected. The t-table value can be calculated using the formula: t (α/2 : n - k - 1) with α = 5%, thus: t (0.05/2 : 19 - 1 - 1) = t (0.025 : 17), resulting in a t-table value of 2.110. The results of the t-test in this study can be seen in the following table:

Table 5. T-Test Result

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	8.761	9.086		.964	.348
	Pre Test	.992	.127	.885	7.833	.000
a. Dependent Variable: Post Test						

Source: SPSS 25 Processing Results

Based on the table above, it can be seen that the Pre-test variable has a t-count value of 7.833, which is greater than the t-table value of 2.110, and a significance value of 0.00, which is less than 0.05. Therefore, it can be concluded that the Pre-test variable in this study has a positive and significant effect on the Post-test.

2. F-Test (Simultaneous Test)

The simultaneous F-test aims to determine the extent to which the independent variables, simultaneously or collectively, influence the dependent variable. The criteria for the F-test are as follows: if the significance value is less than 0.05 and the calculated F-value is greater than the F-table value, then the hypothesis is accepted. Conversely, if the significance value is greater than 0.05 and the calculated F-value is less than the F-table value, the hypothesis is rejected. The F-table value is calculated using the formula n - k - 1 = 19 - 1 - 1 = 17, which gives an F-table value of 3.592. The results of the simultaneous F-test in this study can be seen in the following table:

Table 6. F-Test Result

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	240.017	1	240.017	61.349	.000[b]
	Residual	66.509	17	3.912		
	Total	306.526	18			

a. Dependent Variable: Post Test
b. Predictors: (Constant), Pre Test

Source: SPSS 25 Processing Results

Based on the data in the table, it can be seen that the significance value is 0.000 < 0.05 and the calculated F-value is 61.349 > 3.592. This indicates that the Pre-Test and Post-Test variables in this study simultaneously have a positive and significant effect.

Discussion

Based on data analysis results, this study shows that the implementation of the applied learning model has a significant influence on improving student learning outcomes in Mathematics. This is evidenced by the validity test, which shows a correlation coefficient between the pre-test and post-test results of 0.885, which is higher than the r table value of 0.455, indicating that the instrument used in this study is valid. In addition, the reliability test results showed a Cronbach's Alpha value of 0.936, far above the minimum threshold of 0.60, indicating that the instrument is reliable and trustworthy in measuring student learning outcomes.

Furthermore, classical assumption tests were carried out prior to hypothesis analysis, including normality and heteroscedasticity tests. The normality test using the Kolmogorov-Smirnov method resulted in an Asymp. Sig value of 0.200, which is greater than 0.05, indicating that the data is normally distributed. The P-P plot graph also supports this result, showing that the data points follow the diagonal line. Meanwhile, the heteroscedasticity test using the Glejser test showed a significance value of 0.997 > 0.05, indicating no symptoms of heteroscedasticity, meaning the data is homogeneous. The scatterplot graph showed that the residuals are randomly distributed and do not form a specific pattern, further confirming that the regression model meets the homoscedasticity assumption.

The hypothesis testing results indicate that the applied learning model significantly affects the improvement of student learning outcomes. The t-test resulted in a t-count value of 7.833, which is greater than the t-table value of 2.110, and a significance value of 0.000 < 0.05, indicating a significant difference between the students' pre-test and post-test scores. This shows that the implementation of the problem-based learning model is effective in improving students' understanding and skills. The F-test also supports this finding, with an F-count of 61.349 greater than the F-table value of 3.592 and a significance value of 0.000 < 0.05, indicating that the independent variables collectively have a significant influence on students' learning outcomes.

These findings align with the theory proposed by Duch in Shoimin (2019:130), stating that Problem-Based Learning (PBL) is a learning model that places real-world problems as the context of learning. Through this approach, students are encouraged to think critically, analyze, and seek solutions to the problems they face. In the context of this study, the learning model proved to be effective in enhancing students' learning outcomes, as they were not just passively receiving material but actively exploring information, engaging in discussions, and making decisions based on their own understanding (Abidin, 2015).

Students' active involvement in the learning process allows them to construct knowledge independently. PBL promotes meaningful learning because it is directly related to students' everyday experiences and lives. This is reflected in the significant increase in post-test scores compared to pre-test scores. Critical thinking processes and group collaboration during learning are also key factors in the success of this model.

Moreover, the improvement in learning outcomes can also be linked to increased student motivation due to the contextual and relevant approach used. When students feel that the learning material is directly related to their real-life situations, they become more interested and enthusiastic in participating in the learning process. This is supported by the observation results during the study, which showed an increase in students active participation in group discussions and problem-solving activities.

Overall, the implementation of the Problem-Based Learning model has a positive impact on students learning outcomes, in terms of conceptual understanding, critical thinking skills, and active participation in the learning process. This study provides empirical evidence that problem-based learning strategies are highly relevant to be implemented at the elementary school level, especially in Mathematics, which is often perceived as difficult by many students. It is hoped that the results of this study can serve as a reference for teachers in designing more effective and innovative learning strategies.

The successful implementation of the PBL model in grade IV at SDN 2 Kuanyar confirms its effectiveness in improving students' learning outcomes and overall learning experience. This active, reflective, and collaborative approach not only enhances students' understanding of the subject matter but also helps them develop critical thinking, problem-solving, and teamwork skills. Based on the results of this study, educators are encouraged to apply the PBL model to other learning topics to create a more interactive and student-centered learning environment, thereby improving overall educational quality.

In addition, the implementation of the Problem-Based Learning (PBL) model shows that problem-based learning can be an effective alternative to address the challenges of conventional learning. By placing students at the center of the learning process, PBL provides experiences that are relevant to real life, which not only enhances conceptual understanding but also trains students to think critically and creatively. In this approach, students are faced with situations that require analysis, evaluation, and decision-making, making them actively involved in finding solutions to the problems encountered (Rusman, 2015).

Beyond academic benefits, the application of the PBL model also has positive impacts on students’ non-academic aspects. Group discussions and collaborative work help students develop interpersonal skills such as communication, cooperation, and tolerance. Students learn to respect others' opinions, express their ideas confidently, and work effectively in teams. These skills are essential for students in facing future challenges, both academically and in daily life (Trianto, 2017).

This study also reveals that the key to successful PBL implementation is careful planning and effective facilitation by educators. Teachers do not only serve as information providers but also as facilitators who guide students throughout the learning process. By providing contextual and relevant problems, teachers can help students build understanding gradually and motivate them to continue learning (Rohman, 2019).

Based on the findings of this study, several practical implications can be applied. First, educators are encouraged to continue exploring the PBL method across various subjects, both at elementary and advanced education levels. Second, teacher training on the implementation of PBL should be conducted to enable them to manage problem-based learning optimally. Third, schools should support the implementation of PBL by providing adequate resources and facilities, such as relevant learning materials, discussion spaces, and learning aids.

In conclusion, the PBL model not only improves student learning outcomes but also equips them with 21st-century skills, such as critical thinking, problem-solving, and collaboration. Thus, the implementation of PBL can be an innovative strategy to enhance educational quality and create a more engaging, interactive, and student-centered learning environment (Kemendikbud, 2020).

CONCLUSION

Based on the research results and discussion, it can be concluded that the implementation of the Problem-Based Learning (PBL) model is effective in improving the mathematics learning outcomes of fourth-grade students at SD Negeri 2 Kuanyar. This is evidenced by the increase in student learning scores from the pre-test to the post-test after the application of the PBL model. This model encourages students to think critically, actively engage in discussions, and solve real-world problems relevant to their lives, making the learning process more meaningful and engaging. Therefore, the objective of this research—to determine the effectiveness of the PBL model on students' mathematics learning outcomes—has been successfully achieved.

The implications of this study suggest that teachers should consider using learning models that emphasize active student engagement, such as PBL, in order to enhance students' conceptual understanding and motivation to learn. This research also recommends that schools and teachers more frequently apply problem-based learning approaches, not only in Mathematics but also across other subjects. Furthermore, this study can serve as a foundation for future research to test the effectiveness of the PBL model at different grade levels or in other subjects, as well as to integrate this model with technology or other learning media for more optimal outcomes.

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