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The Impact of the Problem-Based Learning Model on The Mathematical Problem-Solving Skills of Students

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Abstract: This study aims to determine the effect of the Problem-Based Learning (PBL) model on the mathematical problem-solving ability of fifth-grade students at SD Negeri 3 Balerejo, Central Lampung. The research method used was a quasi-experimental design with a non-equivalent control group design. The study involved 60 students divided into two groups: an experimental class that used the PBL model and a control class that used conventional learning methods. The research instrument was an essay test on mathematical problem-solving ability. The data analysis results showed a significant difference between the mathematical problem-solving abilities of students taught using the PBL model and those taught using conventional methods. Thus, the PBL model has a positive effect on improving elementary school students' mathematical problem-solving abilities.

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Introduction

In today's technological era, technology is widely used across various industries and levels of society. One field that is closely related to the use of technology is education. In the field of education, technology is utilized to support students' learning facilities (Fatmawati, 2022) . It is hoped that through the use of technology, education can progress, and both teachers and students become more open-minded to the developments of the times. Technology in education greatly influences the learning process. Innovations and developments in the world of education continue to be made as efforts to improve the quality of learning and to address various challenges that arise during the teaching and learning process, including in mathematics education (Mahmudi & Martha, 2025). The learning process is expected to explore and develop students' potential so that they are prepared to face future changes and challenges.

One essential potential that can be developed through learning activities is thinking ability (Djidu & Jailani, 2017; Djidu & Retnawati, 2018). Mathematics is one of the subjects considered very important in the education system because the skills developed in mathematics learning have broad applications in daily life-from financial planning to solving technical problems. However, despite its importance, many students find mathematics difficult and uninteresting. This is often

Juli 2025. Vol. 10 No. 3
E-ISSN: 2656-1417
P-ISSN: 2503-0602
pp. 538-546

due to teaching approaches that are monotonous and unrelated to students' daily experiences. For example, mathematics teaching in many elementary schools tends to focus on theory and formulas without linking them to real-world problems students face. As a result, many students perceive mathematics as a boring and difficult subject to understand. Mathematics is one of the subjects that plays an important role in developing students' logical, systematic, critical, and creative thinking skills (Zulkarnaen, 2021). In both the *Merdeka Curriculum* and previous curricula, problem-solving skills are considered one of the core competencies that elementary school students must possess. These skills are not only needed to solve mathematical problems but are also essential in everyday life, where rational thinking and sound decision-making are required. However, the reality in the field shows that students' mathematical problem-solving abilities remain relatively low. Initial observations at SD Negeri 3 Balerejo, Central Lampung, indicated that many students struggled to comprehend word problems, identify important information, and choose appropriate solution strategies. This is supported by the results of daily tests and assignments, which showed that most students could only solve routine procedural problems but failed when faced with reasoning-based or contextual problems. One contributing factor to this low ability is the use of conventional, teacher-centered instructional models.

Mathematics instruction tends to be one-way, where the teacher explains concepts, provides examples, and students imitate without being given opportunities to construct understanding through direct experience. As a result, students become passive, are less actively engaged in thinking processes, and are not accustomed to facing intellectual challenges (Liu, Y., & Pásztor, 2022). To address this issue, a learning approach that can stimulate students' higher-order thinking skills is needed. One relevant learning model is *Problem-Based Learning* (PBL) (Warr, M., Dicochea, L., Alvarez Flores, S. M., Holmes, T., O'Connor, B. H., Garcia, D., & Orozco, 2025). This model places problems at the center of learning, challenging students to analyze, develop strategies, and find solutions to the given problems. PBL encourages active student participation, group collaboration, and the development of critical thinking and problem-solving skills (Aini, 2022).

The low academic achievement of students is also due to their lack of interest in learning mathematics (Aisyah, N., & Hartati, 2021). Several factors have been recognized by teachers as obstacles. First, students are not actively involved in mathematics lessons. Teachers have made efforts to apply various methods in delivering material, including ice-breaking activities and educational math games. However, these efforts have not yet succeeded in fostering students' interest in learning. The current assessment of learning outcomes tends to focus on cognitive aspects only, while non-cognitive aspects are rarely assessed (Aisyah, N., & Hartati, 2021). Teachers are aware of the issue with students' interest, but they lack data on how many students have high learning interest and how many have low interest.

Therefore, in the preliminary study, student interest in learning mathematics in grade V will be measured using a previously developed learning interest questionnaire. The identified problems are also due to the lack of adequate learning media to support the learning process (Sanjaya, 2023). Based on the initial needs analysis and the low student learning outcomes, the author is interested in developing a mathematics learning media to enhance students' learning interest using the *Problem-Based Learning* model (Slameto, 2022). One possible solution is to change the instructional approach, including the implementation of the *Problem-Based Learning* (PBL) model ((Bana, K. F. M., Shamim, M. S., & Shahid, 2022). PBL is a learning model that places

Juli 2025. Vol. 10 No. 3
E-ISSN: 2656-1417
P-ISSN: 2503-0602
pp. 538-546

students at the center of the learning process by providing real-world problems that must be solved (Fitriyani & Kurniawan, 2023). PBL enables students to develop critical thinking and problem-solving skills. Therefore, PBL is considered effective in increasing students' interest and understanding in mathematics.

Problem-Based Learning (PBL**)** is a learning model that shifts the traditional approach from being teacher-centered to focusing on student activities and engagement (Huda, 2020). In its implementation, learning begins with a problem that has been designed in advance, so that students not only learn to understand relevant concepts and apply scientific methods to solve problems, but also simultaneously build character. Therefore, PBL has become one of the learning models integrated into the *Merdeka Curriculum*. Through this approach, learning is expected to be more contextual, meaningful, and provide real benefits for students in their daily lives (Effendi, A., Rahmawati, D., & Yuliana, 2021).

The research question in this study is: Does the Problem-Based Learning model have an effect on the mathematical problem-solving ability of fifth-grade students at SD 3 Balerejo, Bandar Lampung? The aim of this study is to determine the effect of the Problem-Based Learning model on the mathematical problem-solving ability of fifth-grade students at SD 3 Balerejo, Bandar Lampung. Based on this, the researcher is interested in conducting a study titled "The Effect of the Problem-Based Learning Model on the Mathematical Problem-Solving Ability of Students at SD 3 Balerejo, Bandar Lampung." This study is expected to make a real contribution to improving the quality of mathematics learning in elementary schools, especially in equipping students with better problem-solving abilities. Problem-Based Learning (PBL) is a learning model that shifts the traditional approach from being teacher-centered to focusing on student activities and engagement (Huda, 2020). In its implementation, learning begins with a problem that has been designed in advance, so that students not only learn to understand relevant concepts and apply scientific methods to solve problems but also simultaneously build character. Therefore, PBL has become one of the learning models integrated into the *Merdeka Curriculum*. Through this approach, learning is expected to be more contextual, meaningful, and provide real benefits to students in their daily lives (Effendi, A., Rahmawati, D., & Yuliana, 2021).

Research Method

This study employs a quantitative approach with a quasi-experimental method. The research design used is the Non-Equivalent Control Group Design, which involves two groups (an experimental group and a control group) that are not randomly selected but are given different treatments. The experimental group receives treatment using the Problem-Based Learning (PBL) model, while the control group receives conventional teaching methods.

The population in this study consists of all fifth-grade students at SD Negeri 3 Balerejo, Central Lampung, in the 2024/2025 academic year. The sampling technique used is purposive sampling, considering the equivalence of initial abilities and ease of access. The sample consists of two classes: class VA as the experimental group and class VB as the control group, with 30 students in each class.

Data were collected using the following instruments:

Jurnal Teknologi Pendidikan:
Jurnal Penelitian dan Pengembangan Pembelajaran
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Juli 2025. Vol. 10 No. 3
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P-ISSN: 2503-0602
pp. 538-546

- A Mathematical Problem-Solving Ability Test, in the form of essay questions developed based on Polya's problem-solving indicators (understanding the problem, planning the solution, carrying out the plan, and reviewing the result).
- Observation of the learning implementation, used to ensure the learning model was implemented according to the designed plan. Before being used, the instruments were tested for validity and reliability to ensure accurate measurement (Sugiyono, 2021).

Data were analyzed quantitatively through the following steps:

1. Normality and Homogeneity Tests, to ensure the data met the assumptions for parametric statistical analysis.
2. t-Test (independent sample t-test), to determine the difference in post-test mean scores between the experimental and control groups.
3. Gain Score Calculation, to examine the improvement in problem-solving abilities before and after treatment (M Guntur dan Dina Martha dkk, 2023).

Results and Discussion

Results

This study was conducted to determine the effect of the Problem-Based Learning (PBL) model on the mathematical problem-solving abilities of fifth-grade students at SD 3 Balerejo, Bandar Lampung. The research was carried out in two classes: Class VA as the experimental group, which received instruction using the PBL model, and Class VB as the control group, which was taught using conventional learning methods. The instrument used was an essay-type test measuring mathematical problem-solving ability, administered before (pretest) and after (posttest) the treatment.

Pretest and Posttest Results

The following are the average pretest and posttest scores for both groups:

Table 1. Pretest and Posttest Results

Group	Average Pretest	Average Posttest	Average Gain
Experimental (PBL)	56.2	82.7	26.5
Control (Conventional)	55.8	68.4	12.6

The data above shows that both groups had relatively similar initial (pretest) scores. However, after the treatment, there was a more significant improvement in the experimental group compared to the control group.

The normality test was conducted using the Kolmogorov-Smirnov test to determine whether the data is normally distributed.

Table 2. Results of the Normality Test

Group	Pretest Sig.	Posttest Sig.	Description
Experimental	0.118	0.094	Normal
Control	0.132	0.110	Normal

Normality testing was conducted to determine whether the data in each group (experimental and control) follows a normal distribution. This test commonly uses the Kolmogorov-Smirnov or Shapiro-Wilk method.

Jurnal Teknologi Pendidikan:
Jurnal Penelitian dan Pengembangan Pembelajaran
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Juli 2025. Vol. 10 No. 3
E-ISSN: 2656-1417
P-ISSN: 2503-0602
pp. 538-546

- If the significance value (Sig.) > 0.05, the data is normally distributed.
- If the significance value (Sig.) ≤ 0.05, the data is not normally distributed.

A significance value greater than 0.05 indicates that the data in both groups is normally distributed. Based on the table, the experimental group has a Sig. value of 0.118 (pretest) and 0.094 (posttest). The control group has a Sig. value of 0.132 (pretest) and 0.110 (posttest). All values are greater than 0.05, indicating that both pretest and posttest data in each group are normally distributed.

The homogeneity test was conducted using Levene's Test to ensure that the variances of the two groups are homogeneous.

Table 3. Results of the Homogeneity Test

Variable	Sig. Levene's Test	Description
Posttest Mathematical Problem Solving Ability	0.217	Homogeneous

A significance value greater than 0.05 indicates that the data variances are homogeneous, allowing the t-test to be performed. Since the significance value is 0.217, which is greater than 0.05, it can be concluded that the data has homogeneous variances, thus fulfilling the requirements for conducting the independent samples t-test. This means that the differences between the experimental and control groups can be tested using the independent samples t-test without concern for bias due to data heterogeneity.

The t-test is used to determine the significant difference between the posttest results of the experimental group and the control group.

Table 4. t-test Results

Group	N	Average	SD
Experimental (PBL)	30	82.7	7.43
Control (Conventional)	30	68.4	8.26

Table 5. t-test Results

Statistic	Value
t-value	6.989
df	58
Sig. (2-tailed)	0.000
Criteria	Sig < 0.05
Conclusion	There is a significant difference

The significance value of 0.000 < α = 0.05 indicates that there is a significant difference between the mathematical problem-solving abilities of students who participated in the Problem Based Learning (PBL) model and those who followed conventional learning. Therefore, it can be concluded that the PBL model has a positive effect on improving students' mathematical problem-solving abilities.

The results of this study show that the implementation of the Problem Based Learning (PBL) model significantly influences the improvement of mathematical problem-solving abilities in 5th-grade students at SD 3 Balerejo Bandar Lampung. This is demonstrated by the significant

Juli 2025. Vol. 10 No. 3
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P-ISSN: 2503-0602
pp. 538-546

difference in posttest scores between the experimental group (which used the PBL model) and the control group (which used conventional learning). The average posttest score of the experimental group reached 82.7, while the control group scored only 68.4. This difference is also reinforced by the t-test results, which show a significance value of 0.000 ($< \alpha = 0.05$), meaning that this difference did not occur by chance.

The Problem Based Learning model places students at the center of the learning process, where they are challenged to solve contextual problems related to real-life situations. As a result, students are not only required to memorize formulas but must also be able to analyze, plan strategies, apply mathematical concepts, and reflect on the solutions they produce. This is in line with the indicators of problem-solving ability according to Polya, which include: (1) understanding the problem, (2) planning the solution, (3) carrying out the plan, and (4) evaluating the results. This type of learning approach provides students with space to think critically and creatively. Group discussions in PBL also help students develop communication skills, teamwork, and responsibility. With this active involvement, students tend to better understand the material and feel more confident in solving complex mathematical problems (Putra, A. R., & Sulastri, 2023).

This result is in line with previous research findings, such as those by Djidu & Retnawati (2018), who stated that Problem-Based Learning (PBL) can enhance students' higher-order thinking skills, including critical, analytical, and reflective thinking. In the context of mathematics learning, higher-order thinking skills are essential because students are not only required to memorize formulas, but also to understand, analyze, and apply mathematical concepts in complex real-life situations. Research by Effendi et al. (2021) also supports this finding, explaining that the PBL model provides a more meaningful learning experience because it begins with real-world situations or problems that are close to students' daily lives. With this approach, learning is no longer abstract or disconnected from context, but rather provides direct relevance that students can feel. This indirectly enhances learning motivation because students feel that what they are learning has practical use, not just for exams.

Moreover, problem-based learning does not only focus on mastering academic content, but also plays a role in shaping students' character. In the problem-solving process, students are encouraged to discuss, listen to others' opinions, express ideas openly, and make decisions together. This activity fosters important values such as responsibility, cooperation, tolerance, independence, and leadership (Yu, 2023). Therefore, PBL is effective not only in the cognitive aspect but also in the affective and social dimensions. Consequently, the implementation of the Problem-Based Learning model is highly aligned with the direction of the Merdeka Curriculum, which emphasizes student-centered learning, develops holistic competencies (cognitive, affective, and psychomotor), and encourages project-based and real-world problem learning (Dwi Yulianti & Herpratiwi, 2024). This makes PBL one of the strategic and relevant learning models for improving education quality, especially in mathematics education at the elementary school level (Susanto, 2021).

Conventional learning, which tends to be lecture-based and teacher-centered, often provides limited opportunities for student exploration and participation (Sagala, 2020). This results in students being more passive in learning, focusing only on the final outcome (correct answers), rather than the thinking process or problem-solving strategies. As a result, students' ability to solve non-routine problems or problems based on real-life contexts remains underdeveloped. Therefore, the findings of this study provide evidence that the Problem-Based Learning model is effective in

Juli 2025. Vol. 10 No. 3
E-ISSN: 2656-1417
P-ISSN: 2503-0602
pp. 538-546

mathematics learning at the elementary school level, particularly in improving students' problem-solving abilities. The success of PBL implementation depends on the quality of the problem designs used, the teacher's skills in facilitating discussions, and students' readiness to actively engage in the learning process.

Conclusion

Based on the research conducted at SD Negeri 3 Balerejo, it can be concluded that the Problem-Based Learning (PBL) model significantly influences the mathematical problem-solving abilities of 5th-grade students. Students who participated in PBL learning showed higher improvements in understanding, planning, solving, and evaluating mathematical problems compared to students who followed conventional learning. The statistical test results show a significant difference in posttest scores between the experimental and control groups, indicating that PBL is effective in developing students' critical and strategic thinking skills in the context of mathematics learning. Thus, the PBL model not only improves students' cognitive aspects but also encourages them to be active, independent, collaborative, and able to relate the subject matter to real-life situations.

Recommendations

1. **For Teachers:** It is recommended to implement the Problem-Based Learning model regularly in mathematics lessons, as it has been proven to significantly improve students' problem-solving skills. Teachers should also design contextual problems that are appropriate for the students' developmental level to ensure that the PBL process is effective.
2. **For Schools:** Schools should provide training and support for teachers in implementing innovative learning models such as PBL, especially in designing problem scenarios and guiding student discussions. Schools should also support the provision of teaching resources and media that facilitate the implementation of PBL.
3. **For Future Researchers:** It is recommended to conduct further research at different grade levels or in other subjects to assess the broader effectiveness of PBL. Future studies could also be developed using a mixed-methods approach to obtain a more comprehensive understanding, both quantitatively and qualitatively, of the impact of PBL.

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Juli 2025. Vol. 10 No. 3
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pp. 538-546

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