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The Effect of Problem-Based Learning Model on Junior High School Students' Self-Efficacy in Mathematics

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Abstract- Mathematics is an important part of science education and plays an important part in lots of aspects of life. However, students' low self-efficacy in mathematics is often an obstacle in learning. Low self-efficacy can inhibit students' confidence in solving problems and impact on their learning outcomes. One method that might be utilized to improve students' self-efficacy is the Problem-Based Learning (PBL) model. This search aims to analyze the impact of PBL models on their self-efficacy in learning mathematics. This research used quasi-experiment method with Nonequivalent Posttest Only Control Group design. The research sample consisted of fifty-two seventh grade students of SMP IT Madani Islamic School Payakumbuh who were divided into experimental and control groups. The experimental group was treated with PBL model, while the control group used conventional learning. Data was collected through self-efficacy questionnaire and analyzed descriptive and inferential statistical tests. The findings revealed that pupils who studied with PBL models had higher self-efficacy compared to students who used conventional learning models. In conclusion, the application of PBL can increase students' self-efficacy in learning mathematics because this method encourages active involvement, contextual problem solving, and reflection on the thinking process. This research shows the urgency of implementing PBL in mathematics learning to significantly improve students' confidence and learning outcomes.

1. Introduction

Mathematics is a critical component of scientific education and a fundamental discipline that develops logical reasoning, analytical thinking, and problem-solving skills, making it essential in various aspects of life (Doly & Ahmad, 2021). Early exposure to mathematics enhances students' cognitive abilities and fosters a structured way of thinking, which is crucial for academic success and future careers. Research has shown that integrating contextual and meaningful learning approaches in mathematics education can increase student motivation and engagement (Harefa, 2024). In particular, mathematics education should not be limited to theoretical instruction but should connect with students' real-life experiences to improve understanding and retention of mathematical concepts (Schukajlow et al., 2023). Additionally, the rapid technological advancements in the twenty-first century have influenced the Indonesian education system, creating new opportunities to enhance mathematics learning (Muthy & Pujiastuti, 2020).

Self-efficacy plays an influential part in the academic achievement of students and overall learning process. Research has shown that self-efficacy mediates the connection between instructional quality and mathematical success, show that students with higher self-efficacy tend to reach a greater academic outcome (Li et al., 2021). Additionally, students often lack confidence in their mathematical abilities, which affects their willingness to engage in complex reasoning tasks (Melhuish et al., 2020). A strong sense of self-efficacy enables students to persist in learning and overcome difficulties. Similarly, with high self-efficacy are more capable of managing learning problems and achieving better results (Ferrell & Barbera, 2015). In contrast, low self-efficacy is associated with dishonest academic behavior, highlighting the importance of fostering confidence in students to promote ethical learning practices (Alhadabi & Karpinski, 2020). Studies have clearly established that self-efficacy consistently influences learning engagement, motivation, and perseverance, all of which contribute to academic success (Luo et al., 2023).

Beyond individual learning outcomes, self-efficacy also affects broader educational experiences, including teacher effectiveness and classroom dynamics. Students with higher self-efficacy exhibit better self-management and academic performance, reinforcing the idea that self-regulation is essential for success (Al-Abyadh & Abdel Azeem, 2022). Furthermore, self-efficacy not only impacts individual motivation but also works as a major predictor of academic achievement across various subjects (Fakhrou & Habib, 2021). Self-efficacy plays a mediating role between emotional intelligence and academic success, further highlighting its importance in shaping students' learning behaviors (Chang & Tsai, 2022). Future educators' experiences significantly influence their beliefs about their own teaching abilities, suggesting that creating an engaging classroom environment is an effective way to boost graduates' confidence in their skills (Sahin-Taskin, 2018). Teachers' self-efficacy directly impacts students' learning experiences, indicating that a supportive learning environment can upgrade students' belief in their own abilities and lead to better academic performance (Ma, 2022). To further understand how self-efficacy affects students' academic achievement, the following presents the results of the Midterm Examination (UTS) in mathematics for students of SMP IT Madani Islamic School Payakumbuh. This data can provide an overview of the variations in student academic achievement in Table 1.

Table 1. Results of Midterm Assessment of Class VII Participants of SMP IT Madani Islamic School Payakumbuh Academic Year 2024/2025

Class	The total number of learners	Average Score
VII.1	26	50,57
VII.2	25	47,67
VII.3	24	52,55
VII.4	26	50,38
VII.5	28	51,56
VII.6	25	53,67

Source: 7th grade Math teacher SMP IT Madani Islamic School Payakumbuh

Teachers play a vital role in fostering students' self-efficacy, which significantly influences their learning engagement, motivation, and academic success. One of the most effective strategies to enhance self-efficacy is providing mastery experiences, where students repeatedly engage in problem-solving tasks to build confidence through success (Hughes, 2009). Additionally, teachers can help students develop

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self-efficacy by setting attainable goals and offering constructive feedback that emphasizes growth and improvement (Hughes, 2009). Research indicates that with higher self-efficacy demonstrate greater perseverance and problem-solving ability, leading to better mathematical performance (Chiang et al., 2022). Peer modeling is another crucial element, as students observing their peers succeed in similar tasks can develop a stronger belief in their own abilities (Liu et al., 2020; Street et al., 2017). Moreover, teacher support and encouragement play a fundamental role in reinforcing students' confidence, particularly in mathematics, where anxiety often hinders performance. The importance of self-efficacy extends beyond individual learning, as students with strong self-efficacy are more likely to engage deeply in mathematical tasks, persist in the face of difficulties, and adopt effective learning strategies (Luo et al., 2023). By integrating these approaches, educators can make an environment that empowers students to believe in their abilities, succeeding in the long run and improving academic performance.

The following aspects are used to measure individual self-efficacy: (1) Magnitude, which refers to an individual's perception of task difficulty and their ability to overcome challenges (Alam et al., 2022; Mulu et al., 2023). (2) Strength, indicating the level of confidence an individual has in their skills and persistence in facing obstacles (Nurhayati et al., 2025; Zay & Kurniasih, 2023). (3) Generality, which reflects the extent to which self-efficacy beliefs apply across different tasks and contexts (Alam et al., 2022; Mulu et al., 2023). The self-efficacy indicators employed in this study include confidence in problem-solving abilities, the ability to remain persistent in challenging situations, belief in overcoming difficulties, readiness to engage in mathematical tasks, and a strong commitment to achieving academic success (Alam et al., 2022; Mulu et al., 2023; Nurhayati et al., 2025; Zay & Kurniasih, 2023). Individuals with higher self-efficacy demonstrate greater motivation, resilience, and performance in mathematical problem-solving, suggesting its crucial role in academic achievement (Alam et al., 2022; Nurhayati et al., 2025).

Employing a PBL model constitutes one method to achieve this. Consequently, the PBL model may correlate with self-efficacy to promote significant learning (Qarareh, 2016). Problem-based learning is an efficacious instructional method as it promotes critical thinking regarding real-world issues, facilitates the utilization of relevant learning resources, and enables the organization of knowledge into a coherent theory (Günter & Alpat, 2017). The five stages of the learning process in the problem-based model are as follows: Students participate in active learning by collecting data, performing experiments, and pursuing solutions and explanations through collaborative inquiries. They subsequently establish, present, and disseminate their findings to others. Finally, they assess and appraise their findings.

Both PBL and self-efficacy have the potential to boost students' motivation and confidence, which in turn can lead to more efficient problem-solving and assignment completion (Ramnarain & Ramaila, 2018). The teacher acts as an organizer in problem-based learning activities, according to Akinoglu, which involves dividing students into small groups (Kristinawati et al., 2018). The relationship between PBL and self-efficacy is shown in Table 2.

Table 2. The connection between PBL and self-efficacy

No	The PBL syntax (Arends, 2015)	Self-efficacy can be enhanced by:
1	Pupils have an orientation to the problems	Providing pupils with learning opportunities based on practical difficulties. (Backlund et al., 2008)
2	Pupils have the structure to study tasks connected with the problems	encouraging kids to participate actively in the process of learning activities (Widmer et al., 2014)
3	pupils are active by accumulating information, conducting experiments, and looking for solutions and explanations in group investigation	engaging students in investigation activities in the learning process (Britner & Pajares, 2006)
4	pupils establish, present, and share their outcomes with others	requiring pupils to construct, defend, and reflect their ideas. (Burton, 2004)
5	pupils analyze and evaluate their outcomes	

The availability of a problem-based learning approach is predicted to increase self-efficacy. Students' good conduct toward learning may have a beneficial impact on their self-efficacy. As a result, it is advised that students take responsibility for completing actions related to improving their academic self-efficacy. Furthermore, students in educational settings frequently examine their talents to those of their peers. These comparisons shape their perceptions of their own strengths. It indicates the way students' motivation might impact their self-efficacy. This strategy also helps them to implement their understanding in real-world circumstances and encourages collaborative projects. Before beginning, this strategy can boost instructor confidence and once implemented, promote student responsibility in the learning process (Balim et al., 2014). Based on the previously indicated difficulties, the the authors wanted to explore the consequences of a PBL Model on the Self-Efficacy of Junior High School Pupils in Mathematics Learning. This study will also look at how the use of PBL might boost students' self-efficacy in solving problems in mathematics.

Several studies have examined the impact of PBL on students' self-efficacy. PBL has been found to improve students' self-efficacy and problem-solving skills by encouraging active learning and deeper engagement with mathematical concepts (Taufiqurrahman & Hidayat, 2023). It also increases self-efficacy by allowing students to develop confidence through structured problem-solving experiences (Choi et al., 2022). Additionally, PBL plays a significant role in enhancing students' self-efficacy by fostering a more interactive and student-centered learning environment (Nofriyandi et al., 2024). While these studies highlight the benefits of PBL, they often focus on specific instructional variations. In contrast, this study examines the effect of PBL in its standard implementation on junior high school students' self-efficacy in mathematics. By maintaining a direct focus on the PBL model, this research aims to provide a clearer understanding of how it influences students' self-efficacy in solving mathematical problems.

2. Methods

(a) Settings

This study will be conducted on grade 7 at SMP IT Madani Islamic School Payakumbuh, West Sumatra Province, Indonesia, during the 2024/2025 academic year. This study will focus on mathematics and algebraic form material. During the study, the researcher observed both treatment groups. This investigation was conducted after gaining permission from the school administrator.

(b) Participants

This study's respondents were 52 SMP IT Madani Islamic School Payakumbuh students studying mathematics during the first semester of the 2024/2025 academic period. The experimental and control groups had twenty-six pupils each. It was mentioned that all the students took part in this study willingly. Table 3 shows descriptive statistics for the participants.

Table 3. Descriptive statistics about participants

Group	Gender		Total	Age range(years)
	Male	Female		
Experimental	12	14	26	12-14
Control	13	13	26	12-14
Total	25	27	52	12-14

(c) Design

This is a quasi-experimental study designed to investigate the retrieved from PBL strategy on junior high school self-efficacy in mathematical topics. The study design was the Nonequivalent Posttest Only Control Group Design. The research design is shown in Table 4.

Table 4. Research Design

Group	Treatment	Post-test
Experimental	X_1	O
Control	X_2	O

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Notes:
X_1 : treatment with PBL model;
X_2 : treatment with conventional learning model.
O : giving self-efficacy questionnaire test.

(d) Instrument

The research tool utilized in this study was a mathematics self-efficacy questionnaire. This questionnaire has twenty statement items that indicate three key components of self-efficacy: degree (level of task difficulty), strength (strength of belief), and generality (generalization of ability). This test is designed to assess students' confidence in performing arithmetic assignments, tackling academic hurdles, and overcoming problems in learning mathematics. Each statement in the questionnaire was scored on a 5-point Likert scale, with the following categories: one for extremely unsure, two for unsure, three for undecided, four for definite, and 5 for very sure. The results of this questionnaire will be statistically examined to specify the retrieved from the PBL model on self-efficacy in mathematics.

(e) Data Analysis

This study will collect data to use a Nonequivalent Posttest Only Control Group Design to investigate how the PBL model impact mathematical self-efficacy. A comparison of the post-test results of the two groups, one of which received PBL-based learning and the other more conventional instruction, is used to draw conclusions from the data. To ensure the data is suitable for parametric analysis, we will first run normality and homogeneity tests. Using the Independent Sample T-Test, we can determine if there is a significant difference between the two groups, assuming the data is homogeneous and distributed normally. But non-parametric tests like the Mann-Whitney U Test are used when the data is not homogenous or distributed normally. Research used SPSS to analyze the data.

3. Results and Discussion

To find out how the PBL model affected students' confidence in their mathematical abilities, we ran a battery of statistical tests, including a t-test, a normalcy test, and a homogeneity test. Table 5 shows the results of the test, which indicated the normally distributed; Table 6 shows the results of the Levene test, which indicated the homogeneous population.

Table 5. Normality Test Results

	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Self-Efficacy	Experiment Class	,137	26	,200*	,957	26	,343
	Control Class	,118	26	,200*	,953	26	,267

Table 6. Homogeneity Test Results

Self-Efficacy			
Levene Statistic	df1	df2	Sig.
3,366	1	50	,073

Table 5 shows the data normally distributed according to the Shapiro-Wilk test, and Table 6 shows that the data were from a homogeneous population according to the Levene test. Hence, the t-test was used to assess the data. Students' levels of self-efficacy were compared using a t-test in Table 6, with the groups that apply the PBL model and the group that applied conventional learning.

Table 7. Independent Samples Test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Sel Efficacy	Equal variances assumed	3,366	,073	2,599	50	,012	9,5769	3,6847	2,1760	16,9779
	Equal variances not assumed			2,599	43,682	,013	9,5769	3,6847	2,1493	17,0045

The "Equal variances assumed" section of the "Independent Samples Test" output table shows a Sig. (2-tailed) value of 0.012, which is less than 0.05. That H_0 is rejected it can be deduced from the decision-making criteria of the independent sample t-test. The results show that the Exp class that uses the PBL model had significantly higher average mathematics self-efficacy compared to the class that uses conventional learning. There was a statistically significant difference in mathematical self-efficacy in the PBL group compared to the conventional group. Students' confidence, openness to innovative approaches, and persistence in the face of mathematical challenges were all positively impacted by the PBL model of instruction.

The PBL learning model has proven to have a positive impact on students' self-efficacy in mathematics. PBL is an approach that encourages students to learn by solving relevant and challenging problems, which requires them to think critically and use the knowledge they have learned. In the context of mathematics, the application of PBL helps students face real problems related to mathematical concepts, so that they feel more competent in applying their mathematical skills to solve these problems.

The PBL process provides opportunities for students to work collaboratively, discuss with peers, and find solutions together, which increases their confidence in dealing with math problems. When students successfully solve problems or find solutions, they feel a sense of accomplishment that increases their confidence in their mathematical abilities. This positive experience leads to increased self-efficacy, which is confidence that they can complete similar tasks or challenges in the future.

In addition, PBL also encourages students to develop problem-solving strategies independently, which improves their ability to think analytically and creatively. In this case, students feel more confident in facing new challenges, as they feel they have mastered the processes needed to solve problems effectively. The syntax in PBL, such as problem identification, information gathering, data analysis, and solution implementation, helps students understand that they have control over their learning process, which in turn increases their self-efficacy. Relevant research supports this finding, as PBL can increase students' engagement in learning and improve their understanding of mathematical concepts in depth. In addition, PBL is effective in improving critical thinking skills and increasing students' confidence in facing math tasks (Maulidia et al., 2020). Thus, the application of PBL in mathematics learning can help students develop their self-efficacy, which contributes to improving their learning outcomes and academic achievement. Several studies have confirmed that students engaged in PBL exhibit greater confidence in their mathematical abilities, as they actively construct knowledge through meaningful problem-solving experiences (Nofriyandi et al., 2024; Nurlinda et al., 2024; Taufiqurrahman & Hidayat, 2023).

The syntax of PBL plays a very crucial role in fostering students' self-efficacy. The first stage, problem orientation, helps students build confidence by exposing them to real-world problems that require critical thinking and independent inquiry (Nurlinda et al., 2024). This exposure allows students to see

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the relevance of mathematics in everyday life, reducing anxiety and increasing their belief in their ability to tackle mathematical challenges (Nst et al., 2023). The second stage, organizing students to learn encourages collaboration, where students discuss ideas, exchange perspectives, and develop solutions together. Such interactions create a supportive environment that enhances self-efficacy by providing opportunities for students to articulate their thoughts and receive feedback (Nofriyandi et al., 2024; Taufiqurrahman & Hidayat, 2023).

During the investigation phase, students actively explore problem-solving strategies, test hypotheses, and engage in reasoning. This hands-on approach allows them to experience mastery learning, which is a key factor in self-efficacy development (Nurlinda et al., 2024). According to Bandura's self-efficacy theory, repeated successful experiences reinforce students' confidence in their abilities. Research has shown that who engage in self-directed exploration during PBL demonstrate stronger perseverance, motivation, and resilience in mathematical problem-solving (Nofriyandi et al., 2024; Nst et al., 2023).

The final stages, developing and presenting solutions, followed by evaluation and reflection, further strengthen students' self-efficacy. Presenting their findings boosts confidence, as students take ownership of their learning and validate their understanding through structured reasoning (Taufiqurrahman & Hidayat, 2023). Additionally, reflecting on the problem-solving process allows students to recognize their growth and identify areas for improvement, fostering a mindset of continuous learning and self-improvement (Nst et al., 2023; Nurlinda et al., 2024).

Overall, PBL enhances self-efficacy by providing structured problem-solving experiences, promoting mastery learning, fostering collaboration, and encouraging perseverance. By continuously engaging with complex mathematical challenges, students develop confidence in their abilities, leading to improved academic performance and a more positive attitude toward learning mathematics. This approach aligns with research findings that highlight the effectiveness of PBL in developing self-efficacy, motivation, and resilience among students (Nofriyandi et al., 2024; Nst et al., 2023; Taufiqurrahman & Hidayat, 2023).

4. Conclusion

Finally, the t-test, normality test, and homogeneity test results show that the PBL model significantly improves students' self-efficacy in learning mathematics. A valid t-test analysis was possible because the data was homogeneous and normally distributed, and the results demonstrated a significant difference in self-efficacy scores between the sample groups. Students in the PBL-taught group exhibited higher self-efficacy, greater persistence in solving mathematical problems, and a stronger willingness to engage with complex problem-solving tasks. These findings suggest that implementing the PBL model in mathematics education can effectively enhance students' self-efficacy, ultimately leading to better learning outcomes and performance. However, this research has several limitations. First, the research was conducted within a limited timeframe, making it difficult to assess the long-term effects of PBL on students' self-efficacy. Second, the study focused on a specific sample of students, meaning the findings may not be generalizable to different educational levels or learning environments. Additionally, external factors such as teacher expertise, student motivation, and classroom dynamics may have influenced the results but were not explicitly controlled. Future research could explore how PBL impacts self-efficacy across different student demographics, extended periods, and varied instructional settings to render a fuller comprehension of its efficacy.

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