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# THE EFFECT OF SCAFFOLDING STRATEGY ON MATHEMATICAL PROBLEM-SOLVING ABILITY REGARDING LINEAR EQUATIONS

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**Abstract**

*This study aims to determine the effect of the scaffolding strategy on students' mathematical problem-solving abilities and to examine these abilities before and after the implementation of the strategy in an eighth-grade class at an MTs (Islamic Junior High School). The study employs a pre-experimental design specifically, a one-group pretest-posttest design using a quantitative approach. The sample consists of eighth-grade students at MTs Al-Washliyah Pasar Miring. Statistical analysis was used to assess the impact of the scaffolding strategy on the students' mathematical problem-solving skills. The analysis results indicate a positive effect of the scaffolding strategy on the students' mathematical problem-solving abilities.*

***Keywords**: Scaffolding Strategy, Problem Solving, Linear Equations.*

**Abstrak**

*Penelitian ini bertujuan untuk mengetahui pengaruh strategi scaffolding terhadap kemampuan pemecahan masalah matematis siswa dan juga melihat bagaimana kemampuan pemecahan masalah matematis sebelum dan sesudah menggunakan strategi scaffolding di kelas VIII MTS.Jenis penelitian ini adalah Pre Experimental design dengan pendekatan kuantitatif dengan desain One-Group Pretest-Posttest design.Sampel pada penelitian ini adalah kelas VIII di Mts.S Al Washliyah pasar miring. Analisis data penelitian ini menggunakan analisis statistik dimana untuk mengetahui pengaruh strategi scaffolding dengan kemampuan pemecahan masalah matematis siswa. Berdasarkan hasil analisis,terdapat pengaruh positif dari strategi scaffolding terhadap kemampuan masalah matematis siswa.*

**Kata Kunci**: *Strategi Scaffolding, Pemecahan Masalah, Persamaan Linear.*

## INTRODUCTION

Mathematics education contributes significantly to the development of students' logical, analytical, critical, and systematic thinking skills. Among the essential competencies students need to acquire is mathematical problem-solving ability, as it is closely linked to conceptual mastery and the application of knowledge in various real-life situations. According to Polya (1973), problem-solving ability is the capacity to resolve a problem through four stages: understanding the problem, devising a plan, carrying out the plan, and looking back (reviewing the solution). This aligns with the stance of the (*National* Council of Teachers of Mathematics, 2000), which asserts that problem-solving is at the heart of mathematics education; through problem-solving, students learn to understand concepts, develop

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strategies, and apply mathematical knowledge in diverse contexts. This process demonstrates that problem-solving focuses not merely on the final answer, but also on how students employ their thinking skills at each stage of the resolution process.

Meanwhile, according to (Root et al., 2017), problem-solving lies at the heart of mathematics learning because it confronts students with the questions of when and why to apply the mathematical knowledge they have acquired, rather than simply focusing on how to perform calculations by following learned algorithms. Hudojo (2005) further notes that mathematical problem-solving ability refers to a student's capacity to utilize mathematical concepts, principles, and skills to address both routine and non-routine problems. This ability requires students to interpret problems, select appropriate strategies, and communicate their solutions in a logical and systematic manner.

Research by Rahmi et al., (2022) indicates that mathematics plays a role in enhancing conceptual understanding; by studying mathematics, individuals develop the ability to think logically and meticulously, as well as the capacity to solve complex problems. Lubis et al., (2021) further suggest that the mathematics learning process is closely linked to problem-solving skills.

However, findings indicate that problem-solving skills among students in Indonesia remain low. This low level of mathematical problem-solving ability is evidenced by various international surveys conducted by organizations such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS). Survey results show that Indonesia’s standing is low and unsatisfactory compared to other participating nations. PISA assessments place Indonesian students' mathematical literacy at Level 1 with a score of 379 well below the international standard average of 500 ranking Indonesia 72nd out of 78 participating countries. Muhtadi et al., (2022) also found Indonesia ranked 64th out of 72 countries, a low standing corroborated by Pebrianti et al., (2023), who observed that students struggle to comprehend problem information, formulate mathematical models, and interpret solution results.

Based on observations, students' mathematical problem-solving abilities remain low. Out of 25 students, 14 (56%) were able to understand the given problem, while only 11 (44%) were able to formulate an appropriate solution plan. At the plan implementation stage, 10 students (40%) successfully solved the problem according to their planned steps. The weakest stage was reviewing the answer, with only 8 students (32%) checking their work. Overall, the observations indicate that the majority of students still struggle to fully apply the problem-solving stages.

Several studies report similar findings; for instance, research by Fauziah & Kurniasih, (2022) indicates that students' mathematical problem-solving abilities remain low. This is evident from the average scores on the Junior High School Computer-Based National Exam (UNBK): the average was 52.96 in 2018 and 53.18 in 2019, representing an increase of only 0.22. These figures highlight the students' limited proficiency in mathematical problem-solving. This situation is further reflected in the large number of students who struggle to translate problem statements into mathematical expressions. Additionally, some students are unable to comprehend problems presented in the form of word problems. Furthermore, Haryati & Warmi, (2021) explain that students' mathematical problem-solving proficiency is classified as low. This is demonstrated by the errors students continue to make regarding key indicators such as understanding the problem, planning the solution, executing the solution steps, and verifying the obtained answers.

Based on the aforementioned views, improvements are necessary and warrant significant attention within the education sector; for instance, findings by Meika et al., (2021) indicate an urgent need for improvements to enhance students' problem-solving abilities. Similarly, Rambe & Afri, (2020) note that students' mathematical problem-solving skills remain at a merely adequate level, signaling a need for further improvement, while Himawan et al., (2021) demonstrate that students' creative thinking skills in solving problem-based questions remain suboptimal.

Linear equations are a topic closely linked to problem-solving skills and serve as the foundation for various advanced algebraic concepts. However, numerous studies indicate that students frequently struggle to understand variables, coefficients, equation structures, and the process of translating contextual problems into mathematical forms. Sundari & Wulantina, (2022) explain that algebraic difficulties often arise from students' inability to translate between verbal and symbolic representations. Prabandari et al., (2022) also found that students commonly make errors when working with linear equations due to a lack of precision in reading problem statements and a failure to grasp the underlying concepts. Furthermore, students often neglect to state a final conclusion when solving linear equations with one variable a habit stemming from a lack of familiarity with proper conventions and frequently lack mastery of the prerequisite material; consequently, they attempt to solve these problems using their own idiosyncratic approaches rather than applying the correct mathematical concepts.

To address this issue, a learning strategy is required that provides gradual assistance tailored to students' needs. One strategy considered effective is scaffolding. Scaffolding is an instructional approach that can be used to enhance students' mathematical understanding Khairunnisa et al., (2022). According Wood et al., (1976), scaffolding refers to temporary support provided by a teacher or a more knowledgeable individual to help learners complete tasks they cannot yet accomplish independently. This concept is grounded in the Zone of Proximal Development (ZPD) theory proposed by Vygotsky (1978), which defines the gap between a student's actual ability and the potential ability achievable through the assistance of others. Furthermore, Van De Pol et al., (2010) explain that effective scaffolding is characterized by contingency (support tailored to student needs), fading (the gradual reduction of support), and the transfer of responsibility (shifting the responsibility for learning to the student).

In mathematics education, scaffolding is a promising approach for enhancing the understanding of junior high school students. Through this strategy, teachers provide assistance, direction, and guidance in a step-by-step manner, enabling students to better grasp complex mathematical concepts (Wulandari et al., 2024).

The scaffolding strategy plays a significant role in enhancing students' problem-solving abilities by providing assistance tailored to their specific needs and proficiency levels. This assistance aims to help students connect their existing knowledge with the new information required to complete a task or solve a problem. Throughout the process, the support provided by the teacher is adjusted and gradually reduced as student competence grows. Consequently, the ultimate goal of the scaffolding strategy is to foster learner independence, enabling students to complete tasks and solve problems without external assistance (Saifurrisal et al., 2023). According to Putra et al., (2023), scaffolding strategies in mathematics education can be implemented through the stages of action, process, object, and schema. Providing assistance tailored to student needs at each stage is expected to improve the understanding of mathematical concepts and support student success in the learning process.

Numerous studies indicate that scaffolding can enhance problem-solving abilities. Ramadhani et al., (2022) found that scaffolding improves conceptual understanding and students' problem-solving skills, while Ulansari & Hartanto, (2025) reported that students learning via scaffolding strategies experienced a more significant increase in problem-solving capabilities compared to those receiving conventional instruction. Retnodari & Elbas, (2020) also affirmed that scaffolding helps alleviate students' difficulties in solving mathematical problems and fosters a step-by-step mindset, enabling them to better comprehend complex problems. Furthermore, Rahayu & Kusaeri, (2024) concluded that scaffolding is effective in enhancing students' mathematical mastery and maximizing their critical thinking and problem-solving skills.

During the plan implementation stage, Polya (as cited in Wood et al., 1976) emphasizes that students should employ the predetermined strategy to solve the problem. At this stage, scaffolding can be provided through questioning, immediate feedback, and the use of relevant examples to assist students in discovering the solution. Subsequently, during the review phase, students evaluate their results and the steps taken to reach the solution. Teachers may assign similar problems to assess student understanding. As students' abilities progress, the assistance provided is gradually reduced until they are capable of solving problems independently. The scaffolding provided must be tailored to the students' Zone of Proximal Development (ZPD).

According to Vygotsky's theory, the Zone of Proximal Development (ZPD) as cited in Shabani et al., (2010) represents the gap between the actual developmental level (the student's ability to solve problems independently) and the potential developmental level (the student's ability after receiving assistance from a teacher, peer, or more competent individual). The actual developmental level is demonstrated by the student's ability to complete tasks without assistance, whereas the potential developmental level is evident when the student can complete tasks with guidance or support from others (Ulya et al., 2023). Before implementing scaffolding strategies, teachers need to understand the students' ZPD.

While extensive research has been conducted on scaffolding strategies, their application to enhance the mathematical problem-solving skills of students in rural areas remains limited; specifically, no prior research has been conducted at MTs Al Washliyah Pasar Miring, located in Dusun Setia, Pasar Miring Village, Pagar Merbau District, Deli Serdang Regency. School observations revealed that students still struggle with understanding problems, determining solution strategies, and verifying their answers. Consequently, a teaching strategy is needed to help students overcome these difficulties. One such approach is the scaffolding strategy, which provides gradual assistance tailored to student needs, thereby potentially improving their mathematical problem-solving abilities. Generally, teaching and learning activities at the school remain dominated by teacher-centered models. Based on this context, the researcher aims to conduct a study titled "The Effect of Scaffolding Strategy on Mathematical Problem-Solving Skills in Linear Equations," with the objective of determining the impact of the scaffolding strategy on the mathematical problem-solving skills of Grade VIII students.

## METHODS

This study employs a pre-experimental design specifically a one-group pretest-posttest design using a quantitative approach to assess students' mathematical problem-solving abilities before and after the intervention. The study population consisted of all Grade VIII students at MTs.S Al Washliyah Pasar Miring (classes VIII-1 and VIII-2) during the 2025/2026 academic year; class VIII-2 was selected as the sample using cluster random sampling. Assessment instruments included pretest and posttest questions based on Polya’s problem-solving criteria. Once the questions were validated and met the requirements for a quality instrument, they were used to evaluate the students' mathematical problem-solving skills. Additionally, a module was utilized as the medium for the scaffolding strategy intervention. Data analysis involved descriptive statistics, a homogeneity test, and hypothesis testing to determine the effect of the scaffolding strategy on students' mathematical problem-solving abilities.

## RESULTS AND DISCUSSION

### Result

This study involves two variables: the independent variable and the dependent variable. The independent variable is the scaffolding strategy, while the dependent variable is the students' mathematical problem-solving ability. The data used consist of pretest and posttest scores from the experimental class (Class VIII-2). Although the class had 28 students, only 23 completed both the pretest and posttest; therefore, the analysis is based on data from these 23 students. The study was conducted during the even semester of the 2025/2026 academic year.

The students' pretest and posttest scores are presented in the following table:

**Table 1. Results of descriptive analysis for pretest and posttest scores.**

| Deskriptif Statistic | Pretest | Posttest |
|---|---|---|
| Number of Student | 23 | 23 |
| Minimum Score | 9 | 19 |
| Maximum Score | 29 | 47 |
| Mean | 18,48 | 38,83 |
| Standard Deviation | 6,967 | 8,038 |

Based on Table 1, it can be seen that students' average scores increased from 18.48 on the pretest to 38.83 on the posttest. In addition, the minimum score increased from 9 to 19, and the maximum score increased from 29 to 47. This increase indicates that after participating in instruction using the scaffolding strategy, students' mathematical problem-solving skills showed greater improvement compared to before the intervention.

**Table 2. Average Score Improvement Based on Problem-Solving Indicators**

| Problem-Solving Indicators | Pretest Average | Posttest Average | Improvement Margin |
|---|---|---|---|
| Understanding the Problem | 5,43 | 10,65 | 5,22 |
| Developing a Solution Plan | 4,17 | 9,70 | 5,53 |
| Implementing a Solution Plan | 3,91 | 9,39 | 5,48 |
| Reviewing the Results of the Solution | 2,96 | 9,09 | 6,13 |

Based on the table above, it can be seen that scores for all stages of problem-solving skills have increased. The greatest improvement was observed in the ability to review solutions, indicating that targeted guidance has successfully fostered the habit of checking the accuracy of answers and the correctness of steps. Furthermore, the ability to formulate and implement plans has also improved significantly, while the ability to understand problems has developed, although it remains an area that needs continued reinforcement.

Before proceeding with further analysis, a normality test was conducted on the difference between the posttest and pretest scores, yielding a p-value of 0.947 > 0.05, indicating that the data are normally distributed. The results of the paired t-test showed a p-value of 0.000 < 0.05, proving that there is a significant difference between students' abilities before and after instruction. Thus, it has been statistically proven that the implementation of a support strategy has a positive effect on improving students' mathematical problem-solving skills.

**Table 3. Normality Test Results for Pretest-Posttest Difference Data**

| **Data** | **Statistic** | **df** | **Sig.** |
|---|---|---|---|
| Difference (*Posttest – Pretest*) | .983 | 23 | .947 |

Based on Table 3, the significance value (Sig.) is 0.947. Since the significance value is greater than 0.05, the null hypothesis (Ho) is accepted. Thus, the data regarding the difference between pretest and posttest scores are normally distributed. As the research data meet the assumption of normality, the subsequent analysis can be conducted using a parametric test specifically, the Paired Sample t-test to test the formulated hypothesis.

The results of the paired-sample t-test using SPSS 25 are as follows:

| Pair | *Paired Differences* | | | | | t | df | *Sig. (2-tailed)* |
|---|---|---|---|---|---|---|---|---|
| | *Mean* | *Std. Deviation* | *Std. Error Mean* | *95% Confidence Interval of the Difference* | | | | |
| | | | | *Lower* | *Upper* | | | |
| Pair 1: Pre-test Score Post-test Score | -20.348 | 6.050 | 1.261 | -22.964 | -17.732 | -16.130 | 22 | .000 |

Based on the test results using SPSS 25, the significance value was found to be 0.000 (< 0.05); therefore, $H_0$ was rejected and $H_a$ was accepted. Furthermore, the comparison of $|r_{calculated}| > r_{table}$ with df = (n-1) yielded 16.30 > 2.093. Thus, it can be concluded that the provision of scaffolding in mathematics instruction influences the mathematical problem-solving ability of Grade VIII-2 students at MTs Al Washliyah Pasar Miring.

**Disdussion**

This improvement in ability did not occur by chance, but was a direct result of a learning process designed to provide targeted or step-by-step support based on students' zone of proximal development. Unlike studies that merely replicate previous research, this study provides a more in-depth explanation of how this improvement occurs at each stage of problem-solving.

During the problem-understanding stage, the teacher provides guidance in the form of leading questions to help students identify what is known, what is being asked, and how to transform the story into a mathematical model. This guidance is gradually reduced as students become able to analyze the problem on their own, thereby improving their ability to identify key information.

During the planning and implementation stages, students are supported through step-by-step solution examples, guidance, and opportunities to discuss the material with more capable peers. This helps them connect their existing knowledge with new material, reduces confusion when developing problem-solving strategies, and helps them overcome difficulties that arise during the problem-solving process.

During the stage of reviewing results, students are guided on how to check whether their answers match the questions and whether their calculations are accurate, and they are given similar problems to practice the habit of verifying their results independently. This is why this aspect actually showed a significant improvement compared to the other stages.

These results are consistent with the findings of previous studies, which indicate that scaffolding strategies are superior to conventional instruction; however, this study emphasizes that success depends heavily on the flexibility of the support provided: support should be given exactly when needed and gradually reduced so as not to create a state of constant dependence among students. This allows students not only to solve problems, but also to build self-confidence and develop a structured way of thinking that will be useful for future material.

The differences in achievement among students also indicate that this strategy is effective in bridging the gap in initial ability, allowing weaker students to develop to their full potential through targeted support.

## CONCLUSION

The results of descriptive statistical analysis showed an average pretest score of 18.48

with a minimum score of 9 and a maximum score of 29. This finding indicates that students' mathematical problem-solving abilities before the implementation of the scaffolding strategy were still low, which was characterized by difficulties in understanding problems, identifying information, and building appropriate mathematical models. Based on Polya's problem-solving stages, most students were not able to carry out each step optimally. Difficulties were seen in the stages of understanding the problem, planning a strategy, implementing the solution, and re-checking the answers. This finding is in line with research (Prabawanto et al., 2023) which stated that students' mathematical problem-solving abilities tend to be low when they do not receive appropriate assistance in learning. In addition, (Tarigan et al., 2025) found that lack of guidance causes students to experience obstacles in understanding problems and determining solution strategies, so that mathematical problem-solving abilities have not developed optimally.

Regarding mathematical problem-solving skills following the implementation of the scaffolding strategy, descriptive statistical analysis revealed a mean post-test score of 38.83, with a minimum score of 19 and a maximum of 47. These results indicate an improvement in students' mathematical problem-solving abilities after the scaffolding strategy was applied to the topic of Linear Equations with One Variable. This improvement occurred because the teacher provided gradual learning support tailored to student needs such as guiding questions, directions, worked examples, and feedback. As the students' understanding deepened, this support was reduced, enabling them to solve problems more independently.

These results align with research by Srimuliati et al., (2023), which indicates that scaffolding strategies are more effective than conventional instruction in enhancing mathematical problem-solving skills. These findings are also supported by Ulya et al., (2023), who state that scaffolding through guiding questions, worked examples, and constructive feedback helps students achieve a better understanding of mathematics.

Based on Polya's problem-solving stages, the implementation of scaffolding led to improvements in students' ability to understand problems, formulate and execute solution plans, and review their answers. Students became more proficient at identifying key information, determining appropriate mathematical models, and systematically verifying their results. Furthermore, the use of scaffolding-based learning modules supported this improvement by providing structured material, example problems, and guided practice.

Hypothesis testing results showed that $t_{calculated} > t_{table}$, indicating that the null hypothesis ($H_0$) was rejected. Thus, it can be concluded that there was an improvement in students' mathematical problem-solving skills regarding the topic of Linear Equations in One Variable (SPLSV) following the implementation of the scaffolding strategy.

The analysis results indicate that the teaching strategy implemented by the teacher influences students' mathematical problem-solving abilities. This is because instruction was conducted in stages, with students grouped according to their Zone of Proximal Development (ZPD); this arrangement fostered discussion and mutual assistance particularly where students with a higher ZPD supported those with a lower ZPD and required students to draw conclusions about their learning outcomes. Throughout the process, the teacher facilitated the gradual development of students' knowledge; for instance, if students struggled to grasp the problem-solving steps outlined in the provided modules and student worksheets, the teacher would demonstrate the process again using different examples or cases and explain the necessary sequence of steps required to solve the problem. The modules and worksheets utilized in the lesson incorporated guiding questions designed to break down problem-solving tasks into more structured stages, thereby making it easier for students to identify areas where they needed assistance.

Similar findings were observed in the study by Srimuliati et al., (2023), which found that scaffolding strategies can enhance students' understanding of mathematical concepts through active engagement, critical thinking, and independent learning. These findings align with Adinda Adinda et al., (2024), who stated that scaffolding helps students reach the Zone of Proximal Development (ZPD) through the provision of gradual assistance. Mustofa et al., (2021) also explained that assistance in the form of hints, directions, and problem-solving guidance can foster student independence in learning. In the present study, such assistance was provided through student worksheets (LKPD) based on guiding questions that helped students grasp concepts and solve problems. The results are consistent with the findings of Ulansari & Hartanto, (2025) and Ramadhani et al., (2022), which demonstrated that scaffolding-based instruction yields superior mathematical abilities compared to conventional instruction. Thus, scaffolding strategies are shown to have a positive impact on students' conceptual understanding and mathematical problem-solving skills.

Scaffolding strategies are effective not only for linear equations with one variable but can also be extended to advanced algebra, geometry, ratios, statistics, probability, and topics requiring reasoning or modeling. Teachers should assess students' prior knowledge and tailor their approach: provide detailed guidance for struggling students, directional prompts for those at an intermediate level, and challenging tasks or peer-tutoring roles for advanced students. Utilize structured worksheets, guiding questions, mixed-ability groups, and timely feedback, while gradually reducing assistance to foster student independence.

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