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LEARNING MOTIVATION AS A PREDICTOR OF MATHEMATICAL PROBLEM-SOLVING ABILITY: EMPIRICAL EVIDENCE FROM LINEAR EQUATIONS IN TWO VARIABLES

Yuyun Umagapi, Anderson Leonardo Palinussa * and Muhamad Samad Rumalean

Department of Mathematics Education, Faculty of Teacher Training and Education, Pattimura University, Indonesia.
* Corresponding Author

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ABSTRACT

Students' difficulties in solving mathematical problems remain a persistent challenge in mathematics education, particularly in the topic of Systems of Linear Equations in Two Variables (SLETV). These difficulties are often reflected in students' inability to translate contextual problems into mathematical representations, determine appropriate solution strategies, and interpret the results accurately. Learning motivation is considered an important factor that may contribute to students' mathematical problem-solving ability. Therefore, this study aimed to examine learning motivation as a predictor of mathematical problem-solving ability among eighth-grade students at SMP Negeri 1 Sulabesi Tengah. A quantitative approach was employed, involving 28 students. Data were collected through a learning motivation questionnaire and a mathematical problem-solving test consisting of constructed-response items on SLETV. Learning motivation was assessed across five dimensions, while students' problem-solving ability was evaluated through their responses to mathematical problems. Data analysis involved normality and linearity tests, simple linear regression, and a t-test. The results showed that the mean pretest score was 45.36, increasing to 66.25 on the posttest. The mean learning motivation score was 76.14, indicating a moderate level of motivation. Simple linear regression yielded the equation $\hat{Y} = 58.639 + 0.168X$, indicating a positive regression coefficient. However, the t-test produced a significance value of 0.173, with a calculated t-value of 1.402, which was lower than the critical t-value of 2.056. Thus, the results did not provide sufficient statistical evidence of a significant effect of learning motivation on mathematical problem-solving ability at the 5% significance level. These findings suggest that although learning motivation showed a positive association with mathematical problem-solving ability, its predictive contribution was not statistically significant in the present sample.

Keywords: Learning Motivation, Mathematical Problem-Solving Ability, Systems of Linear Equations in Two Variables, Mathematics Education.

1 INTRODUCTION

Mathematics is closely intertwined with various aspects of human life. Its applications can be found in everyday activities, such as calculating discounts, determining profits, and analyzing financial losses (Wibawa et al., 2022). Beyond these routine applications, mathematical principles play a crucial role in addressing complex problems across various fields, including engineering, economics, pharmacy, and accounting (Hayal, 2018; López-Díaz & Peña, 2021).

This broad applicability demonstrates that mathematics is not merely a school subject but also a fundamental foundation for the advancement of science and technology (Yeh et al., 2019). Accordingly, mathematics instruction needs to be designed more comprehensively, extending beyond the mastery of formulas, computational procedures, and theoretical concepts to foster higher-order thinking skills, particularly students' analytical thinking abilities (Laurens et al., 2018). Developing these competencies is essential not only for supporting students' academic achievement but also for equipping them with the capacity to identify, analyze, and effectively solve various real-world problems (Laurens et al., 2018). Penguasaan kemampuan tersebut menjadi penting karena tidak hanya mendukung keberhasilan peserta didik dalam proses pembelajaran, tetapi juga membekali mereka dengan kecakapan untuk mengidentifikasi, menganalisis, dan menemukan solusi atas berbagai permasalahan dalam kehidupan nyata secara tepat dan efektif (Anggoro et al., 2025). Mathematics occupies a fundamental position as a universal language of science and a cornerstone of STEM education (Palinussa et al., 2025). The integration of mathematical and scientific concepts enables students to develop essential competencies, including problem-solving, computational thinking, logical reasoning, and strategic decision-making (Jamaludin et al., 2026). In this context, mathematics serves not only as a tool for performing calculations but also as a means of representing and communicating scientific ideas through numbers, symbols, equations, graphs, and geometric models. Consequently, mathematical competence is closely associated with scientific process skills, as both involve the ability to identify problems, conduct analyses, construct logical arguments, and formulate evidence-based solutions. Ultimately, mathematics provides the conceptual framework and analytical tools necessary for describing, understanding, modeling, and predicting various phenomena and processes occurring in the natural environment and everyday life (Usak & Slisko, 2026).

Mathematics is a discipline with a long historical trajectory that has evolved alongside the advancement of civilizations and cultures throughout the world. From its early emergence in ancient societies to its continued development in the modern era, mathematics has undergone successive transformations, each contributing significant ideas, discoveries, and intellectual advances to the broader development of scientific knowledge (Jadhav, 2026). As one of the fundamental foundations of scientific inquiry and widely recognized as the language of science, mathematics plays a central role in examining patterns, structures, regularities, and relationships among various phenomena in the universe. Its continuous development has established mathematics as an essential instrument for understanding phenomena and addressing problems across diverse fields of human endeavor. From an academic perspective, mathematics encompasses several branches, each characterized by distinct features, areas of investigation, and practical applications. Its major branches include algebra, geometry, calculus, number theory, probability and statistics, and mathematical logic (Ganpatrao, 2022). Collectively, these branches provide the foundation for the development of mathematical concepts and theories while establishing a conceptual basis for conducting analyses, solving problems, and advancing theoretical investigations (Agbata et al., 2024). Although twenty-first-century competencies have become a major focus in discussions concerning the direction and future of education, subject-matter knowledge remains equally important, particularly in mathematics education. Ideally, mathematics instruction should not focus exclusively on developing general competencies but should also equip students with conceptual understanding and the ability to apply mathematical knowledge across various real-world contexts. These competencies are essential for enabling students to use mathematics to address practical challenges in both professional environments and everyday activities. In this regard, the application of mathematics in the context of workforce readiness and employability has become increasingly important, particularly as digitalization continues to transform competency requirements, occupational characteristics, and the mathematical skills individuals need to succeed in the modern era (Gravemeijer et al., 2017).

In the present study, the mathematical topic examined is Systems of Linear Equations in Two Variables (SLETV), which is closely related to contextual problems encountered in everyday life. Santoso et al. (2019) found that junior high school students continue to experience difficulties in solving problems involving systems of linear equations in two variables. These difficulties were reflected in three major types of errors: comprehension errors, transformation errors, and process skills errors. Such errors were attributed to students' limited ability to identify the information provided and what was being asked, difficulties in translating contextual problems into mathematical models, and a lack of accuracy in applying solution procedures and performing calculations. Overall, the ability to comprehend problems and transform given information into mathematical models represents a critical aspect that needs to be strengthened to improve students' mathematical problem-solving ability. Students also experience considerable difficulties, particularly in understanding the meaning of mathematical problems and applying mathematical concepts to obtain accurate solutions. Although students are able to read the questions, they do not always fully comprehend the information presented, identify the known and unknown quantities, or translate the given information into mathematical models. Furthermore, students frequently make errors in applying mathematical concepts, determining appropriate solution procedures, performing computational operations, and completing the subsequent stages of problem-solving. These difficulties are associated with insufficient conceptual understanding of SLETV, an inability to interpret information presented in problems, a lack of computational accuracy, and failure to verify their solutions (Pulungan & Suhendra, 2019). Further research has revealed that although approximately 47–63% of students are able to solve problems presented in symbolic equation formats, only approximately 10–47% succeed in solving word problems. These findings indicate that students have not yet fully developed the ability to identify relationships between variables, translate verbal information into mathematical equations, apply appropriate solution methods, and verify the

accuracy of their calculations. Accordingly, this study highlights the importance of contextualized mathematics instruction grounded in real-world situations, particularly through instructional strategies that help students develop conceptual understanding and strengthen their problem-solving ability in systems of linear equations in two variables (Jupri et al., 2026).

One of the essential competencies that should be developed through mathematics instruction is mathematical problem-solving ability. Mathematical problem-solving is a core competency that plays a decisive role in students' success in learning mathematics, particularly at the secondary school level, which represents a critical stage in developing an understanding of increasingly complex mathematical concepts (Sinaga et al., 2023). Despite its importance as a crucial skill for mathematical achievement, students' problem-solving performance remains below the expected level, with a substantial proportion of students demonstrating relatively low mathematical problem-solving ability (Hiltrimartin & Pratiwi, 2025). Mastery of this competency enables students to understand relationships among mathematical concepts while contributing to improved learning outcomes (Wartono et al., 2018; Ariani et al., 2024). At the secondary education level, students encounter various essential mathematical topics, including algebra, geometry, and calculus, which require them to analyze problems, select appropriate solution strategies, and apply mathematical concepts accurately. Accordingly, well-developed problem-solving ability can help students approach complex mathematical problems systematically and with greater confidence. In addition to supporting students' performance in mathematics assessments, mastery of this competency may also foster more positive perceptions of mathematics and strengthen their academic self-efficacy (García-Moya et al., 2024). Furthermore, the benefits of mathematical problem-solving extend beyond academic achievement, encompassing the development of logical reasoning, critical thinking, and cognitive flexibility in responding to diverse situations. These competencies provide an important foundation for students' success in further education and their ability to navigate future workplace challenges. Despite its strategic importance in mathematics education, problem-solving ability remains a significant challenge for many students. These difficulties become particularly evident when students encounter topics requiring deeper conceptual and procedural understanding, one example being the concept of derivatives in calculus (Lazarides & Raufelder, 2021; Bayaga, 2024).

This ability is essential not only for solving mathematical problems but also for equipping students to address various challenges encountered in everyday life. Learning motivation is one of the factors that can support students' engagement in the learning process. Strategy-based motivation is an important factor contributing to students' success in mathematical problem-solving. Students who have strong confidence in their ability to use drawing strategies tend to produce higher-quality visual representations and demonstrate better problem-solving performance. Conversely, perceiving the use of such strategies as requiring excessive effort or imposing a substantial cognitive burden may hinder the quality of visual representations and students' problem-solving success. The quality of visual representations also serves as a link between motivational factors and students' mathematical problem-solving performance. These findings highlight that success in mathematical problem-solving is determined not only by mathematical knowledge and skills but also by students' self-confidence and perceptions of the strategies employed to solve problems (Schukajlow et al., 2022). Students' motivation plays an important role in enhancing mathematical problem-solving ability, particularly when dealing with word problems related to everyday life. Students who develop a better understanding of problem contexts tend to be more capable of connecting real-world information with mathematical concepts and procedures, thereby enabling them to solve problems more accurately. Therefore, mathematics instruction should be designed to integrate real-world contexts while strengthening students' confidence in their own abilities, making learning more meaningful and fostering the optimal development of mathematical problem-solving ability (Sigus & Mädamürk, 2025). Mathematical problem-solving ability is influenced by the interaction of motivational factors, self-regulated learning, mathematical self-efficacy, and mathematical thinking skills. Mathematics learning motivation and self-regulation are important factors that foster the development of students' self-confidence and mathematical thinking abilities, which subsequently contribute directly to successful problem-solving. Accordingly, efforts to improve mathematical problem-solving ability should focus on strengthening motivation, learning autonomy, self-confidence, and higher-order thinking skills rather than concentrating exclusively on subject-matter mastery or students' personality characteristics (Wang & Guo, 2026). Through learning motivation, students are expected to demonstrate greater persistence in completing tasks, resilience when encountering difficulties, interest in the learning process, and willingness to make sustained efforts to solve problems. Against this background, the present study was conducted to examine the relationship between learning motivation and students' mathematical problem-solving ability, particularly in the context of systems of linear equations in two variables (SLETV).

2 METHODS

This study employed a quantitative approach using a predictive correlational design within a non-experimental research framework. This design was adopted to identify relationships between variables and examine the extent to which a predictor variable explains variations in a criterion variable without manipulating the research variables. Limberg et al. (2021) explained that correlational designs enable researchers to examine relationships among variables through various statistical techniques, including regression analysis. Similarly, Karafil & Uyar (2023) employed a

predictive correlational design to identify relationships between variables and examine their predictive capacity using simple linear regression analysis. In this study, learning motivation was designated as the predictor variable (X), whereas mathematical problem-solving ability was treated as the criterion variable (Y). This design was used to examine the direction of the relationship and the statistical significance of the contribution of learning motivation in predicting students' mathematical problem-solving ability in the topic of systems of linear equations in two variables (SLETV). The hypothesis was tested using simple linear regression analysis at a significance level of 5%. In addition, pretest and posttest data were used to provide a descriptive overview of changes in students' mathematical problem-solving ability throughout the learning process. These measurements served as supplementary information and were not used to establish a causal relationship between learning motivation and improvements in mathematical ability. Therefore, the interpretation of the findings focused on the statistical relationship and the predictive capacity of learning motivation in relation to students' mathematical problem-solving ability.

The population of this study comprised all eighth-grade students at SMP Negeri 1 Sulabesi Tengah. The research sample consisted of 28 students selected using a purposive sampling technique. This sampling technique was employed based on the extent to which students' characteristics aligned with the research objectives, particularly their participation in mathematics instruction on the topic of systems of linear equations in two variables (SLETV). The selection of eighth-grade students was based on the alignment of the SLETV topic with the mathematical competencies addressed at this educational level. This topic was considered relevant for assessing mathematical problem-solving ability because it requires students to identify relevant information in a given problem, construct mathematical models, establish relationships between two variables, and systematically apply appropriate solution procedures. All 28 students included in the sample participated in the collection of data on learning motivation and mathematical problem-solving ability. The resulting data were subsequently analyzed using statistical methods to examine the relationship between the two variables.

The research instruments consisted of a learning motivation questionnaire and a mathematical problem-solving test. The learning motivation instrument was developed by Chin & Lo (2026) in the form of a mathematics learning motivation questionnaire comprising 30 items across five major dimensions: learning environment, test anxiety, intrinsic value, self-efficacy, and self-regulation. Both instruments were designed to obtain quantitative data on students' learning motivation and their ability to solve mathematical problems involving systems of linear equations in two variables (SLETV). The questionnaire responses were converted into numerical scores to represent each student's level of learning motivation. These scores were subsequently used as the predictor variable in the simple linear regression analysis. Meanwhile, students' mathematical problem-solving ability was assessed using a written constructed-response test, with a scoring rubric adapted from Kokeb et al. (2025), as further elaborated by Hadi & Csíkos (2026). The test focused on solving SLETV problems relevant to the instructional content developed for this study. Constructed-response items were selected to enable students to demonstrate their thinking processes, conceptual understanding, and systematic problem-solving procedures. Specifically, the test assessed students' ability to comprehend the information presented in problems, identify the given information and required outcomes, formulate mathematical models, determine appropriate solution strategies, obtain solutions, and verify the accuracy of their answers. The mathematical problem-solving test was administered as a pretest and a posttest to provide an overview of students' initial abilities and their performance following the instructional process. Data obtained from both instruments were subsequently tabulated and analyzed quantitatively. Questionnaire scores represented students' levels of learning motivation, whereas test scores reflected their mathematical problem-solving ability. These two sets of data provided the basis for examining the predictive contribution of learning motivation to students' mathematical problem-solving ability in the context of SLETV.

The Shapiro–Wilk test was employed to determine whether the data distribution met the assumption of normality. The decision was based on a significance level of 0.05, whereby the data were considered to satisfy the normality assumption if the significance value was greater than 0.05. Subsequently, a linearity test was conducted to determine whether the relationship between learning motivation and mathematical problem-solving ability followed a linear pattern. The assumption of linearity was assessed by examining the significance value of the Deviation from Linearity component. The relationship between the two variables was considered to satisfy the linearity assumption if the corresponding significance value was greater than 0.05. After all analytical assumptions had been examined, the research hypothesis was tested using simple linear regression analysis. This analysis aimed to determine the direction of the relationship and the predictive contribution of learning motivation to students' mathematical problem-solving ability. The regression model was expressed as $\hat{Y} = a + bX$, where $\hat{Y}$ represents the predicted mathematical problem-solving score, a denotes the intercept, b represents the regression coefficient, and X refers to the learning motivation score. The regression coefficient was used to identify the direction of the relationship between the two variables, while statistical significance was examined using a t-test at the 5% significance level ($\alpha = 0.05$). The statistical decision was based on the p-value. If the p-value was less than 0.05, the regression coefficient was considered statistically significant. Conversely, if the p-value was greater than 0.05, there was insufficient statistical evidence to conclude that learning motivation was a statistically significant predictor of mathematical problem-solving ability. All analytical results were subsequently interpreted in accordance with the characteristics of the data and the research objectives to draw

empirical conclusions regarding the relationship between learning motivation and mathematical problem-solving ability in the context of systems of linear equations in two variables (SLETV).

3 RESULTS

The findings revealed changes in students' mathematical problem-solving scores. The mean pretest score was 45.36, whereas the mean posttest score was 66.25. This indicates an increase in the average test score following the instructional process implemented in the study. Data obtained from the learning motivation questionnaire administered to 28 students yielded a mean score of 76.14, with a minimum score of 57 and a maximum score of 98. Based on the classification criteria adopted in this study, students' overall learning motivation was categorized as moderate.

Table 1: Shapiro–Wilk Test of Normality

Measurement	W	df	p-value
Learning Motivation	0.933	28	0.075
Mathematical Problem-Solving Ability	0.972	28	0.642

As shown in Table 1, the significance value for learning motivation was 0.075, while that for mathematical problem-solving ability was 0.642. Both values were greater than the significance threshold of 0.05 ($p > 0.05$). Therefore, there was insufficient statistical evidence to reject the normality assumption, indicating that both variables satisfied the normality criterion. Subsequently, a linearity test was conducted to examine whether the relationship between learning motivation and mathematical problem-solving ability followed a linear pattern. The results of the linearity test are presented in Table 2.

Table 2: Test of linearity between mathematical problem-solving ability and learning motivation

Source	Sum of squares	df	Mean square	F	p
Between groups (combined)	2932.750	13	225.596	2.298	0.068
Linearity	302.779	1	302.779	3.084	0.101
Deviation from linearity	2629.971	12	219.164	2.232	0.077
Within groups	1374.500	14	98.179	—	—
Total	4307.250	27	—	—	—

As shown in Table 2, the Deviation from Linearity component yielded a calculated F-value of 2.232 and a p-value of 0.077. Since the p-value exceeded the significance level of 0.05 ($p > 0.05$), the relationship between learning motivation and mathematical problem-solving ability was considered to satisfy the assumption of linearity. Subsequently, a simple linear regression analysis was performed to examine the predictive contribution of learning motivation to mathematical problem-solving ability. The results of the regression analysis are presented in Table 3.

Table 3: Regression Coefficients for the Effect of Learning Motivation on Mathematical Problem-Solving Ability

Predictor	B	SE	β	t	p
Constant	58.639	5.913	—	9.917	< .001
Learning motivation	0.168	0.120	0.265	1.402	0.173

As presented in Table 3, the regression analysis yielded a constant of 58.639 and a regression coefficient of 0.168. Accordingly, the simple linear regression model can be expressed as follows:

$$\hat{Y} = 58{,}639 + 0{,}168X.$$

The regression coefficient of 0.168 indicates a positive relationship between learning motivation and mathematical problem-solving ability. However, the significance test yielded a calculated t-value of 1.402 and a p-value of 0.173, which exceeded the significance threshold of 0.05 ($p > 0.05$). Therefore, the regression coefficient was not statistically

significant, indicating insufficient statistical evidence to conclude that learning motivation significantly predicts students' mathematical problem-solving ability. The relationship between learning motivation and mathematical problem-solving ability is further illustrated in the following scatterplot.

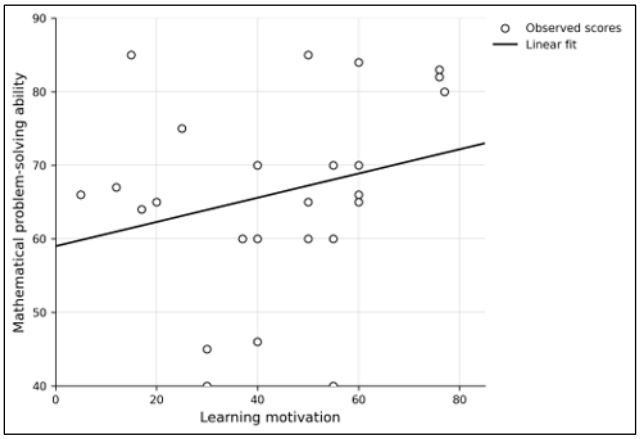


Figure 1: Scatterplot of the Relationship Between Learning Motivation and Mathematical Problem-Solving Ability

4 DISCUSSION

The findings indicate a descriptive improvement in students' mathematical problem-solving ability in the topic of Systems of Linear Equations in Two Variables (SLETV), as reflected in the increase in the mean pretest score from 45.36 to 66.25 on the posttest. This increase suggests that students' problem-solving performance improved following the instructional process. Nevertheless, the higher mean score cannot be regarded as evidence of a statistically significant improvement, as this study did not report the results of a paired comparison between pretest and posttest scores. Furthermore, the observed improvement cannot be directly attributed to learning motivation as a causal factor, given that the regression analysis revealed no statistically significant predictive effect of learning motivation on mathematical problem-solving ability. Accordingly, the observed changes in students' performance should be interpreted as descriptive findings that require further statistical investigation. Regarding learning motivation, the mean score of 76.14 indicates that students' motivation was at a moderate level. This suggests that students generally demonstrated a willingness to engage in mathematics learning; however, this motivation may not necessarily be accompanied by sufficient persistence, effective learning strategies, self-regulation, and confidence in their mathematical abilities when dealing with complex problems. The findings indicate that a moderate level of learning motivation was insufficient to explain variations in mathematical problem-solving ability to a statistically significant extent. This finding is consistent with Al Umairi (2024), who reported that mathematics motivation did not mediate the relationship between mathematical self-efficacy and mathematics achievement. This evidence suggests that motivation does not always function as a direct or independent factor in explaining mathematical achievement but may interact with other psychological factors and learning processes. Therefore, the present findings reinforce the perspective that learning motivation should be examined in conjunction with other factors associated with students' success in solving mathematical problems.

The simple linear regression analysis yielded a regression coefficient of 0.168, a standardized beta coefficient of 0.265, a t-value of 1.402, and a significance value of 0.173. The positive regression coefficient indicates a tendency for higher learning motivation to be associated with greater mathematical problem-solving ability. However, the significance value exceeding 0.05 indicates that this tendency was not statistically significant. This means that, based on the data from the 28 students included in this study, there was insufficient empirical evidence to conclude that learning motivation was a statistically significant predictor of mathematical problem-solving ability in the context of Systems of Linear Equations in Two Variables (SLETV). This finding does not imply that learning motivation is unimportant in mathematics education; rather, it indicates that its predictive contribution could not be statistically established using the simple regression model employed in this study. These results should also be interpreted in light of the relatively small sample size and the possibility that other factors may account for differences in students' problem-solving abilities. The potential involvement of other factors is supported by Özcan & Eren Gümüş (2019), who found that reading comprehension, mathematical self-efficacy, and metacognition were associated with problem-solving performance. Specifically, mathematical self-efficacy and metacognition mediated the relationship between reading comprehension and problem-solving ability. These findings suggest that successful mathematical problem-solving depends not only on students' motivation to learn but also on their ability to comprehend information, their confidence in their own capabilities, and their capacity to regulate and evaluate their thinking processes. In the context of SLETV, students are

required to understand information presented in word problems, identify relationships between variables, formulate mathematical equations, select appropriate solution procedures, and verify the results obtained. Therefore, learning motivation that is not accompanied by adequate cognitive and metacognitive strategies may not necessarily lead to optimal mathematical problem-solving performance.

The characteristics of SLETV problems may also help explain the findings of this study. Learning this topic requires students not only to master elimination and substitution procedures but also to connect contextual information with symbolic representations. Accordingly, successfully solving SLETV problems requires both conceptual understanding and the ability to apply mathematical procedures systematically. Students with high levels of learning motivation may not necessarily solve problems correctly if they do not adequately understand the relationships between variables or experience difficulties translating verbal information into mathematical equations. This suggests that cognitive and procedural aspects remain essential components in developing mathematical problem-solving ability. Furthermore, a study by Granello et al. (2026), involving 382 secondary school students, demonstrated that a self-regulated learning-based instructional intervention could improve mathematical persistence, perceived usefulness of mathematics, mindsets regarding intellectual ability, and mathematical performance. These improvements were achieved through activities involving planning, monitoring, and evaluating the learning process. These findings suggest that efforts to foster students' motivation should extend beyond providing encouragement or rewards and should also incorporate systematic learning strategies that help students regulate their problem-solving processes. In SLETV instruction, teachers can guide students to establish problem-solving goals, identify relevant information, select appropriate elimination or substitution methods, monitor the accuracy of computational steps, and evaluate their final solutions. Such an approach enables motivational development to occur alongside the enhancement of students' cognitive and metacognitive abilities.

5 CONCLUSION

This study involving 28 eighth-grade students at SMP Negeri 1 Sulabesi Tengah revealed that the mean mathematical problem-solving score increased from 45.36 on the pretest to 66.25 on the posttest. The mean learning motivation score was 76.14, indicating a moderate level of motivation. The regression analysis yielded the equation $\hat{Y} = 58.639 + 0.168X$. However, the t-test results showed that the calculated t-value (1.402) was lower than the critical t-value (2.056), with a significance value of 0.173, exceeding the 0.05 threshold. Therefore, based on the statistical decision criteria at the 5% significance level, there was insufficient evidence to conclude that learning motivation had a statistically significant effect on mathematical problem-solving ability in the context of Systems of Linear Equations in Two Variables (SLETV) within the present sample. These findings suggest that mathematics instruction, particularly on SLETV, should integrate the development of learning motivation with the systematic enhancement of problem-solving skills. Students are encouraged to engage in more frequent SLETV exercises and develop the habit of following systematic problem-solving procedures. Teachers should provide contextual mathematical problems and implement instructional strategies that encourage students to actively ask questions, participate in discussions, and engage in problem-solving activities. Problem-based learning grounded in real-world contexts can help students connect mathematical concepts with everyday situations while developing their abilities to comprehend information, identify problems, construct mathematical models, and select appropriate solution strategies. Furthermore, teachers should encourage students to plan, monitor, and evaluate each stage of the problem-solving process to strengthen their metacognitive skills and learning autonomy. Providing constructive feedback, positive reinforcement, and opportunities to explore different solution strategies may also help foster students' self-confidence and persistence when encountering learning difficulties. Future research should involve larger and more diverse samples and consider additional factors, such as reading comprehension, mathematical self-efficacy, conceptual understanding, self-regulation, and metacognitive skills, to provide a more comprehensive understanding of the factors associated with mathematical problem-solving ability. Further studies should also employ more comprehensive research designs and analytical approaches to examine the development of problem-solving abilities and the relationships among relevant variables in greater depth.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

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