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The Contribution of Self-Efficacy and Mathematics Anxiety to Students' Mathematical Problem-Solving Ability

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Abstract

This study examines the extent to which self-efficacy and mathematical anxiety contribute to the mathematical problem-solving ability of eleventh-grade students. A quantitative correlational design was employed with 35 students from class XI-11, a Science class at MAN 1 Medan, selected as an intact class sample. Data were collected using a self-efficacy questionnaire, a mathematical anxiety questionnaire, and a mathematical problem-solving test, and were analyzed using multiple linear regression after all regression assumptions had been satisfied. The results showed that self-efficacy contributed positively and significantly to mathematical problem-solving ability ($t = 3.252$; $p = 0.003$), whereas mathematical anxiety contributed negatively and significantly ($t = -3.969$; $p < 0.001$). Simultaneously, the two variables explained 69.5% of the variance in mathematical problem-solving ability ($F = 36.382$; $p < 0.001$). Mathematical anxiety made a greater effective contribution (38.89%) than self-efficacy (30.55%).

Keywords: *mathematics anxiety; mathematical problem-solving; multiple regression; self-efficacy; senior high school*

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INTRODUCTION

The Problem solving lies at the heart of learning mathematics. Students who can solve problems are able to understand a situation, choose an appropriate strategy, carry it out carefully, and check whether the answer makes sense. Polya (1973) formulated these four steps long ago, and they still serve as a reference in mathematics instruction today. The trouble is that many Indonesian students find it difficult to solve mathematical problems. In the 2022 PISA survey, Indonesian students obtained a mathematics score of 366, far below the average of OECD member countries, which ranged from 465 to 475 points (OECD, 2023). This result indicates that most Indonesian students still struggle to use mathematical knowledge and skills to solve more complex problems.

It is tempting to assume that this happens simply because students have not mastered the material. Research findings suggest otherwise. How students feel about mathematics also determines whether the knowledge they possess is actually put to use.

Two feelings recur repeatedly across studies: how confident students are in themselves and how anxious they become when facing mathematical problems. Bandura (1997) termed the first of these self-efficacy, that is, a person's belief that they are capable of completing a particular task. In mathematics, students' self-belief encompasses their interpretation of past achievements, their self-assessment of their abilities, and their personal expectations regarding their performance on the mathematical tasks assigned to them (Zakariya, 2022). Rahmawati & Nopriana (2024) showed that students' self-efficacy in learning mathematics is reflected through several aspects, including confidence in one's own success, the ability to face problems and challenges, the courage to take risks, and resilience in facing difficulties. These findings show that self-efficacy is related not only to confidence in one's own ability but also to students' readiness to face challenges during the mathematics learning process. Students with high self-efficacy keep trying when a problem is not solved on the first attempt, whereas students with low self-efficacy tend to give up more easily when facing tasks they consider difficult. Research by Primawati et al. (2026), based on findings from 25 articles, showed that students with high self-efficacy display greater persistence, set more ambitious goals, and show greater resilience in challenging subjects.

Research in Indonesia also supports a link between self-efficacy and mathematical problem-solving ability. Simamora et al. (2019) showed that implementing guided-discovery learning within a local cultural context can significantly improve both students' mathematical problem-solving ability and self-efficacy. Meanwhile, Busnawir et al. (2023) found differences in mathematical problem-solving ability based on self-efficacy category among eleventh-grade senior high school students. Quantitatively, differences in problem-solving ability were found between students with high and low self-efficacy ($p = 0.020$) and between students with moderate and low self-efficacy ($p = 0.008$), while the difference between the high and moderate self-efficacy groups was not significant ($p = 0.879$). Qualitatively, students with high self-efficacy showed better ability in understanding the problem, devising a solution plan, carrying out the strategy, and checking the results compared with students with lower self-efficacy. These findings show that the level of self-efficacy is related to the quality of students' ability to carry out the stages of mathematical problem solving. Winata et al. (2024), through an ex post facto study of 88 tenth-grade students at SMA Muhammadiyah 1 Palangka Raya, found that self-efficacy has a significant effect on mathematical problem-solving ability. Simple linear regression analysis showed that self-efficacy explained 20% of the variation in students' mathematical problem-solving ability. This finding shows that self-efficacy is related not only to problem-solving ability but also makes a measurable contribution to that ability. These findings indicate that self-efficacy is related not only to students' ability to solve problems but is also an aspect that can be developed through appropriate experience and instruction. In line with this, systematic review by Zakariya (2022) showed that self-efficacy can be enhanced through properly designed instruction.

Mathematics anxiety works in the opposite direction and is another affective factor related to students' mathematical problem-solving ability. The term refers to feelings of tension, worry, or fear that arise when a person is confronted with a mathematical task. A large meta-analysis by Barroso et al. (2021), covering 223 studies, confirmed a negative relationship between mathematics anxiety and mathematics achievement. Caviola et al. (2022) obtained similar results and argued that this negative relationship is stronger for tasks that require multiple steps. This characteristic is relevant to mathematical problem solving, which generally requires students to understand information, choose a strategy, carry out several steps to reach a solution, and evaluate the result.

In line with this, several findings in Indonesia support the same pattern. Hidayat & Ayudia (2019) found that mathematics anxiety had a negative effect of 57.1% on the

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mathematical problem-solving ability of senior high school students, with the remaining 42.9% attributable to other factors. This finding shows that the higher the mathematics anxiety experienced by students, the lower their tendency toward mathematical problem-solving ability. In addition, Rahmani (2024), in a study of eleventh-grade senior high school students, found a significant effect of mathematics anxiety on problem-solving ability, with mathematics anxiety contributing 61.7% to students' problem-solving ability. Umbara et al. (2024) studied 39 eleventh-grade senior high school students in the city of Serang and found differences in mathematical problem-solving ability based on students' level of mathematics anxiety. The results showed that students with low mathematics anxiety were able to satisfy all of the indicators of mathematical problem-solving ability. Meanwhile, students with moderate mathematics anxiety satisfied only 3 of the 4 indicators, while students with high mathematics anxiety satisfied only 1 of the 4 indicators. This finding indicates that as the level of mathematics anxiety rises, an increasing number of problem-solving indicators go unmet. Quantitatively, Lisfianisa & Hasanah (2025) found that students with low anxiety were better able to carry out the stages of problem solving, whereas high anxiety was associated with difficulty at various stages of problem solving. This reinforces the conclusion that the higher the level of mathematics anxiety, the lower the problem-solving performance.

Although self-efficacy and mathematics anxiety have been widely studied as factors associated with students' mathematical ability and performance, research that examines both variables simultaneously and compares the magnitude of their respective contributions remains relatively limited. Živković et al. (2023) showed that mathematics self-efficacy and mathematics anxiety are important predictors of students' mathematical performance, with self-efficacy contributing positively and mathematics anxiety contributing negatively. Furthermore, Salsabila et al. (2024) examined both variables simultaneously and found that self-efficacy and mathematics anxiety significantly affected students' mathematical problem-solving ability, both partially and simultaneously. However, findings regarding the role of mathematics anxiety are not entirely consistent. For example, Rahman et al. (2025) found that self-efficacy significantly predicted students' performance on both lower- and higher-order thinking tasks, whereas mathematics anxiety was not a significant predictor. These differences in findings suggest that the relationships among self-efficacy, mathematics anxiety, and mathematical ability warrant further investigation. In addition, previous studies have not specifically examined the effective and relative contributions of each variable to students' mathematical problem-solving ability. Therefore, the present study not only examines the partial and simultaneous effects of self-efficacy and mathematics anxiety but also analyzes the magnitude of the relative contribution of each variable in explaining students' mathematical problem-solving ability.

Based on this discussion, the present study aims to address this research gap by not only examining the significance of the effects of self-efficacy and mathematics anxiety on mathematical problem-solving ability but also determining the magnitude of each variable's contribution. This study has two objectives. First, to examine whether self-efficacy and mathematics anxiety significantly contribute to mathematical problem-solving ability, both partially and simultaneously. Second, to calculate the effective and relative contributions of each variable to identify their respective contributions and provide a basis for determining instructional priorities. In addition, this study was conducted among students in a madrasah aliyah (Islamic senior high school), whose educational context differs from that of general senior high schools, thereby providing an additional empirical context for investigating affective factors associated with mathematical problem-solving ability. The study is expected to provide empirical evidence regarding the contributions of affective factors to mathematical problem-solving ability, as well as more specific

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information about the relative contributions of self-efficacy and mathematics anxiety that may inform mathematics instruction in the madrasah aliyah context.

METHODS

This study used a quantitative correlational design of the ex post facto type. No treatment was given; the researcher measured pre-existing conditions and examined how they relate to one another. This design was chosen because self-efficacy and mathematics anxiety are psychological traits that form gradually through students' cumulative learning experiences, so they cannot be induced or manipulated within the short timeframe of a single study. Deliberately raising or lowering students' anxiety or confidence to create experimental conditions would also raise ethical concerns and could disrupt the regular teaching and learning process, and any effect produced this way would be artificial rather than reflecting how these variables actually operate in the classroom. An ex post facto design therefore allows both variables to be examined as they naturally occur among students, preserving the ecological validity of the findings while still permitting rigorous statistical testing of the relationships among the variables.

The study population consisted of all eleventh-grade science-program students at MAN 1 Medan. Grade XI at this madrasah is divided into three programs: 12 science classes, 4 social-studies classes, and 2 religious-studies classes, each containing 34 to 35 students. The population was limited to the science program, giving a total of approximately 414 students. This restriction was applied because the three programs receive different numbers of mathematics teaching hours and different depths of mathematics content, so combining them would introduce uncontrolled differences into the study. Within the science program, all classes carry an equivalent mathematics workload. The study sample was Class XI-11, one of the science classes, comprising 35 students, taken as a single intact class so as not to disrupt the school's teaching schedule. This sample was drawn using cluster random sampling, by randomly drawing one class from the 12 available science-program classes. The selected class was used in its entirety without altering its student composition. This sample represents approximately 8.5% of the population.

Three instruments were used in this study. Self-efficacy was measured using an 18-item questionnaire constructed based on Bandura's three dimensions of *magnitude*, *strength*, and *generality*. Mathematics anxiety was measured using an 18-item questionnaire covering cognitive, affective, and physiological aspects. Both questionnaires used a 4 point Likert scale. Mathematical problem-solving ability was measured using a 4 item essay test scored according to Polya's four steps. Before being used in the main study, the instruments were first tested for validity and reliability through a try-out involving 32 students outside the study sample. Validity testing included content validity through expert judgment and empirical validity by examining the correlation between item scores and total scores, using IBM SPSS Statistics version 25. Item validity was determined based on the significance of the correlation between item scores and total scores, with items considered valid if $p < 0.05$. The significance values across all items ranged from 0.000 to 0.030, confirming that all items on the self-efficacy, mathematics anxiety, and mathematical problem-solving ability instruments met the validity criterion and were thus suitable for use in the study. Reliability testing was carried out using Cronbach's Alpha coefficient to determine the internal consistency of the instruments. The analysis showed that the Cronbach's Alpha values for all variables were above the minimum threshold of > 0.70, so the instruments were considered reliable and consistent in measuring the research variables. A summary of the validity and reliability test results is presented in Table 1 below:

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Table 1. Summary of Validity and Reliability Test Results for the Research Instruments

Variable	Number of Items	Validity Result	Cronbanch's Alpha	Remarks
Mathematical Problem Solving (Y)	4	All items valid	0.772	Reliabel
Self-Efficacy (X_1)	18	All items valid	0.892	Reliabel
Mathematics Anxiety (X_2)	18	All items valid	0.994	Reliabel

Data were analyzed using multiple linear regression at a significance level of 0.05. Before the hypotheses were tested, four classical assumptions were checked: normality of the residuals using the Kolmogorov-Smirnov and Shapiro-Wilk tests together with a normal Q-Q plot; linearity using the deviation-from-linearity test; multicollinearity using tolerance and VIF values; and homoscedasticity using the Glejser test together with a scatterplot of standardized predicted values against standardized residuals. The hypotheses were then tested using the t-test for each variable, the F-test for both variables together, and the coefficient of determination to determine the magnitude of the independent variables' contribution to explaining the variation in the dependent variable. All statistical analyses in this study were carried out using IBM SPSS Statistics version 25.

RESULTS AND DISCUSSION

The Descriptive statistics for the three variables are presented in Table 1. The coefficient of variation is included to make it easier to compare the spread of each variable.

Table 1. Descriptive Statistics of the Research Variables

Variable	Mean	Std. Deviation	N	Coef. of Variation
Mathematical Problem Solving (Y)	73.886	17.352	35	23.49%
Self-Efficacy (X_1)	54.086	8.766	35	16.21%
Mathematics Anxiety (X_2)	46.200	12.875	35	27.87%

The average problem-solving score was 73.89, with a fairly wide spread, meaning that this class contained students with clearly differing levels of ability. Self-efficacy was the most uniform variable, while mathematics anxiety was the most varied, with some students reporting very low anxiety and others very high anxiety. Such variation is actually useful, since a variable that barely changes cannot explain anything.

Classical Assumption Tests

Table 2 summarizes the four assumption tests. All of them were satisfied.

Table 2. Summary of Classical Assumption Test Results

Test	Criterion	Result	Conclusion
Normality (Shapiro-Wilk)	Sig. > 0.05	Sig. = 0.855	Satisfied
Linearity (Y with X_1)	Sig. Deviation > 0.05	Sig. = 0.134	Satisfied
Linearity (Y with X_2)	Sig. Deviation > 0.05	Sig. = 0.221	Satisfied
Multicollinearity	Tolerance > 0.10; VIF < 10	0.589; 1.697	Satisfied
Heteroscedasticity (Glejser)	Sig. > 0.05	0.622; 0.639	Satisfied

The Kolmogorov-Smirnov test yielded a significance value of 0.200, and the Shapiro-Wilk test yielded 0.855. Because the sample size was fewer than 50, Shapiro-Wilk is the more appropriate reference, and its value is well above the 0.05 threshold. The normal Q-Q plot in Figure 1 reinforces this, with the data points closely following the diagonal line without any marked deviation at either end.

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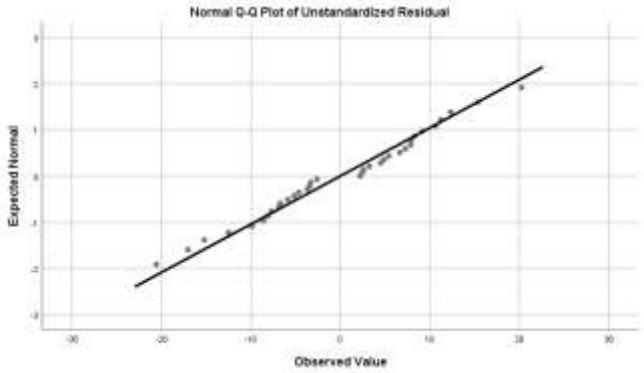

Figure 1. Normal Q-Q Plot of the Unstandardized Residuals

The tolerance value of 0.589 and VIF of 1.697 show that the two independent variables are indeed related to each other, but not to the extent that their respective effects become impossible to separate. This point is worth noting because self-efficacy and mathematics anxiety are correlated at −0.641, a fairly strong figure. The Glejser test produced significance values of 0.622 and 0.639, both above 0.05. Figure 2 shows the same pattern visually, with the residuals scattered above and below zero without forming a funnel shape or any particular pattern.

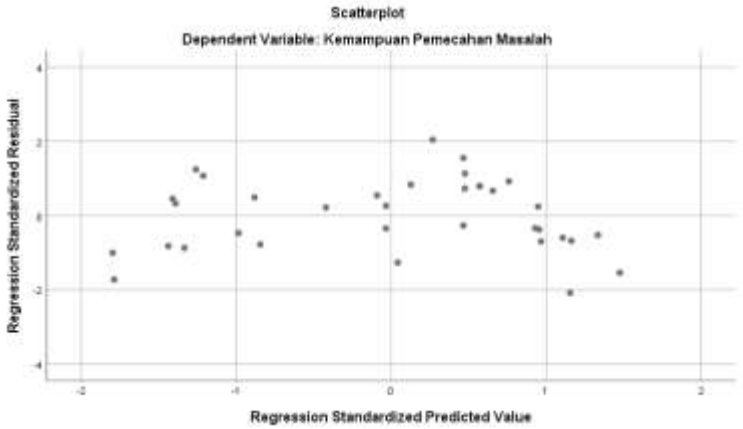

Figure 2. Scatterplot of Standardized Predicted Values against Standardized Residuals

Relationships between Variables

Table 3 presents the correlations among the three variables.

Table 3. Correlation Matrix

Relationship	r	Sig. (1-tailed)	Direction	Strength
Y with X_1	0,738	0.000	Positive	Strong
Y with X_2	−0,770	0.000	Negative	Strong
X_1 with X_2	−0,641	0.000	Negative	Strong

All three correlations are significant. Students who are confident in their ability tend to be better problem solvers, students who feel anxious tend to be worse, and these two feelings pull against each other in opposite directions. The single strongest relationship is between anxiety and problem solving.

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Hypothesis Testing

Table 4. Regression Coefficients

Model	B	Std. Error	Beta	t	Sig.
(Constant)	61.025	19.743	–	3.091	0.004
Self-Efficacy (X_1)	0.819	0.252	0.414	3.252	0.003
Mathematics Anxiety (X_2)	−0.681	0.172	−0.505	−3.969	0.000

The regression equation derived from Table 4 is:

$$\hat{Y} = 61.025 + 0.819X_1 - 0.681X_2 \quad (1)$$

This equation can be read as follows. If self-efficacy increases by one point while anxiety remains constant, problem-solving ability increases by 0.819 points. If anxiety increases by one point while self-efficacy remains constant, problem-solving ability decreases by 0.681 points. Both t-values exceed the critical value of 2.037 at 32 degrees of freedom, and both significance values are below 0.05, so each variable contributes significantly. The 95% confidence intervals 0.306 to 1.333 for self-efficacy and -1.030 to -0.331 for anxiety, do not contain zero, meaning that the direction of each variable's effect is consistent.

Table 5. Model Summary and F-Test

R	R Square	Adjusted R^2	Std. Error of Est.	F	Sig.
0.833	0.695	0.675	9.885	36.382	0.000

Together, the two variables explain 69.5% of the variation in problem-solving ability, and the F-value of 36.382 far exceeds the critical value of 3.29. The remaining 30.5% comes from factors not measured here, such as prior mathematical ability, learning motivation, study habits, or the teaching method used. The adjusted R^2 value of 0.675 is close to R^2, indicating that the model is reasonably stable despite the small sample size. The standard error of the estimate, at 9.885, is far smaller than the standard deviation of the dependent variable of 17.352, meaning that the model predicts far better than simply using the mean value.

Effective Contribution and Relative Contribution

Table 6. Effective Contribution and Relative Contribution of Each Variable

Variable	Beta	r	Effective Contribution	Relative Contribution
Self-Efficacy (X_1)	0.414	0.738	30.55%	44.00%
Mathematics Anxiety (X_2)	−0.505	−0.770	38.89%	56.00%
Total	–	–	69.44%	100%

The total effective contribution of 69.44% corresponds to the R^2 value of 69.5%, with the small discrepancy due to rounding. Mathematics anxiety accounts for 56% of the total variance explained by the model, compared with 44% for self-efficacy. In other words, anxiety carries more weight between the two.

Discussion

The positive contribution of self-efficacy to mathematical problem-solving ability is consistent with previous research findings (Busnawir et al., 2023; Simamora et al., 2019; Winata et al., 2024). This finding is also consistent with Yanti et al. (2025), who reported that self-efficacy was a significant positive predictor of mathematical performance.

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Students with higher self-efficacy tend to have stronger confidence in their ability to handle mathematical tasks and persist longer when facing difficulties. In the problem-solving process, students are required not only to understand the concept but also to determine a strategy, carry it out, and check the results obtained. Confidence in one's own ability can encourage students to keep trying when the initial strategy has not succeeded. Self-efficacy can thus help students optimize the mathematical knowledge and skills they already possess in order to solve problems.

The negative contribution of mathematics anxiety to problem-solving ability is likewise consistent with earlier research (Barroso et al., 2021; Caviola et al., 2022; Hidayat & Ayudia, 2019). Mathematics anxiety can interfere with the attention and cognitive resources needed during the problem-solving process. When students worry about making mistakes or failing to solve a mathematics problem, some of their attention may be directed toward these worries, reducing their focus on the task at hand. This condition becomes even more important in problem solving, which generally requires students to process several pieces of information and carry out several solution steps in sequence. Higher mathematics anxiety may therefore be associated with a decline in students' ability to carry out the problem-solving process optimally.

An important finding of this study is the difference in the size of the contribution made by each predictor variable. Mathematics anxiety provided an effective contribution of 38.89%, while self-efficacy provided an effective contribution of 30.55%. This pattern shows that, in the context of this study, mathematics anxiety contributes more to the variation in mathematical problem-solving ability than self-efficacy does. This finding is consistent with Caviola et al. (2022), who showed that the relationship between mathematics anxiety and mathematics performance can become stronger for tasks with higher cognitive demands. This result implies that affective aspects, particularly mathematics anxiety, need attention in problem-solving instruction. Teachers can create a learning atmosphere that allows students to make mistakes safely, provide constructive feedback, and design tasks with gradually increasing levels of difficulty. At the same time, strengthening self-efficacy remains important so that students have the confidence and persistence to face challenging mathematical tasks.

The negative correlation of -0.641 between self-efficacy and mathematics anxiety indicates a fairly strong negative relationship between the two variables. This means that, in this study's data, students with higher self-efficacy tend to have lower levels of mathematics anxiety. However, this relationship cannot be taken as evidence that increasing self-efficacy directly causes a decrease in mathematics anxiety, or vice versa, because the study design does not allow for causal conclusions.

This study has several limitations that should be noted. First, the sample consisted of only one class of 35 students. The findings are therefore best understood as describing the relationships and contributions of the variables within the group studied, and cannot yet be broadly generalized to all eleventh-grade science students at that madrasah. Second, this study used a correlational design, so the term “contribution” here refers to the ability of the predictor variables to explain variation in mathematical problem-solving ability, not to a proven cause-and-effect relationship. The findings thus show that self-efficacy and mathematics anxiety together explain a fairly large portion of the variation in mathematical problem-solving ability among the students studied, but other factors outside this research model also continue to play a role.

CONCLUSION AND SUGGESTIONS

Conclusion

Based on the results, self-efficacy makes a positive and significant contribution to

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mathematical problem-solving ability, while mathematics anxiety makes a negative and significant contribution. Together, self-efficacy and mathematics anxiety explain 69.5% of the variation in mathematical problem-solving ability among the students studied. In terms of effective contribution, mathematics anxiety contributes 38.89%, while self-efficacy contributes 30.55%. Thus, in the context of this study, mathematics anxiety makes a larger effective contribution than self-efficacy to mathematical problem-solving ability. These results show that both affective factors are important predictors to consider in understanding students' mathematical problem-solving ability.

Suggestions

Based on these findings, teachers are advised to pay attention to mathematics anxiety in problem-solving instruction, for example by creating a classroom atmosphere that allows students to make mistakes without undue pressure, providing constructive feedback, and designing tasks that progress from simpler to more complex levels of difficulty. At the same time, efforts to strengthen self-efficacy should continue through gradual and measured experiences of success, so that students gain confidence in their own ability to complete mathematical tasks. Both aspects can be considered together in problem-solving instruction.

Future research is advised to involve a larger sample across several classes or schools so that these findings can be tested in more varied contexts. Future studies could also include other variables, such as prior mathematical ability and learning motivation, to gain a more comprehensive understanding of the variation in mathematical problem-solving ability not yet explained by this research model. In addition, experimental or intervention studies could be conducted to test whether efforts to increase self-efficacy or reduce mathematics anxiety directly improve mathematical problem-solving ability.

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