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# Mathematical resilience and problem-solving ability in systems of linear equations with three variables

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**Abstract**

Although mathematical resilience is often thought to support students' persistence in solving math problems, the evidence regarding its relationship to problem-solving ability remains inconsistent across various contexts. This quantitative study with a correlational approach aims to examine the association between mathematical resilience and problem-solving ability of Grade 10 students in the subject of Systems of Linear Equations with Three Variables. Through the cluster random sampling technique, a sample of 83 students from classes X-2, X-3, and X-4 at SMA 10 Yogyakarta was obtained. Data collection included test and non-test instruments. The test instrument consisted of 4 open-ended questions to measure the variable of mathematical problem-solving ability, while the non-test instrument was a questionnaire comprising 20 statements to measure the variable of mathematical resilience. The data analysis technique used was nonparametric analysis employing the Spearman's rank correlation test. This test was used because the assumption of data normality was not met. The results of the study indicate that there is no significant correlation between mathematical resilience and students' mathematical problem-solving ability, with a correlation coefficient of -0.021 and a significance level of 0.850 ($p > 0.05$). Therefore, no statistically significant association was found between these two variables in this sample and context.

**Keywords**: High School Students; Mathematical Problem-Solving; Mathematical Resilience; Spearman Correlation; Systems of Linear Equations in Three Variables

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## INTRODUCTION

Mathematics is a discipline whose development is international in nature. This means that mathematics is used and studied in various countries as a foundation for developing science and technology. Mathematics contains a variety of basic concepts that are useful in the dynamics of human life, particularly in helping individuals solve various problems logically and systematically (Ginanjar, 2019). On the other hand, mathematics also serves as a tool for developing critical, analytical, and methodical thinking skills (Hasratuddin, 2008). Therefore, mathematics instruction today needs to be directed toward the development of high-level

thinking skills, one of which is students' ability to solve mathematical problems (Rusmini et al., 2024)

According to (National Council of Teachers of Mathematics, 2000), one of the skills that plays a fundamental role in mathematics learning is problem-solving. This ability can be understood as a systematic way of thinking to find solutions to a problem through directed and logical steps, including *(1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) looking back* (Polya, 1973). Problem-solving does not merely require students to listen, take notes, and memorize material; rather, through problem-solving, students are expected to think actively, communicate with one another, seek and process data, and ultimately draw conclusions (Kania & Ratnawulan, 2022). This process emphasizes that solving problems is not merely about obtaining an answer, but about understanding the thought process used to arrive at that answer. This ability is also considered the core of mathematics learning, where the outcomes of the learning process are manifested in several specific dimensions, including problem deconstruction, mathematical formulation, and solution execution or problem-solving. In fact, students' ability to solve problems serves as a benchmark for their success in learning mathematics (Rahmatiya & Miatun, 2020).

The phenomenon of students' low ability to solve mathematical problems remains a significant empirical challenge in Indonesia. PISA 2022 data shows that more than 80% of Indonesian students have not yet reached the minimum proficiency standard (Level 2). This indicates that the majority of students still struggle to apply mathematics in practical life contexts. Even more concerning is that the percentage of students capable of reaching high proficiency levels (Levels 5 and 6), which require critical thinking and complex analysis, is nearly zero (OECD, 2023). Such conditions indicate that a significant number of students still face barriers in comprehending basic mathematical concepts and applying them to solve problems in daily life (Alfaruqi & Nurwahidah, 2025). This fact is reinforced by the findings of (Prameswari & Abadi, 2025), which show that students' competence in analyzing and solving problems remains weak, as they only meet one of the four Polya indicators. Thus, this situation indicates that students' competence in problem-solving remains below the expected achievement targets.

Students' mathematical problem-solving abilities are not solely determined by cognitive factors but are also influenced by affective factors such as self-confidence and mental resilience, or what is commonly referred to as mathematical resilience. Conceptually, the term "mathematical resilience" is understood as an attitude of optimism and steadfastness when

facing mathematical difficulties, as well as the willingness to master new strategies to solve such problems (Hutauruk & Naibaho, 2020). Meanwhile, according to Sumarmo, as cited in (Asih et al., 2019), mathematical resilience is defined as an affective response to overcoming fear and anxiety when encountering obstacles in learning mathematics. This response not only involves mental fortitude and a willingness to work hard but is also supported by self-confidence and strong verbal skills when facing problems (Asih et al., 2019). These characteristics indicate that mathematical resilience can influence how students respond to challenges in solving mathematical problems. Students with high mathematical resilience tend to maintain an optimistic attitude and remain persistent when facing difficulties during the problem-solving process, making them more likely to continue searching for solutions rather than giving up. Thus, mathematical resilience can be defined as a constructive and adaptive affective attitude toward the discipline of mathematics, reflected through students' persistence and resilience when facing competency gaps in learning mathematics.

The indicators of mathematical resilience essentially reflect an individual's ability to adapt, persevere, and maintain a positive attitude when facing various challenges. According to Sumarmo, these indicators include (1) a diligent attitude, confidence, hard work, and a refusal to give up easily when facing problems, failures, and uncertainties; (2) a desire to socialize, a willingness to help peers, and the ability to adapt to one's environment; (3) generating new ideas or approaches and seeking creative solutions to challenges; (4) using experiences of failure to build self-motivation, (5) demonstrating curiosity, reflection, research, and utilizing various sources, and (6) possessing language skills, self-control, and emotional awareness (Asih et al., 2019). Meanwhile, according to S. Johnston-Wilder, indicators of resilience consist of (1) the belief that brain capacity can be developed, (2) an understanding of the personal value of mathematics, (3) an understanding of how to approach mathematics, and (4) awareness of available support from peers, adults, and technology(Johnston-Wilder & Lee, 2010). Both views emphasize the importance of perseverance, self-confidence, adaptability, utilization of learning resources, as well as a positive attitude and self-awareness as key factors in building mathematical resilience.

Mathematical resilience serves as one of the primary drivers in optimizing improvements in students' performance in solving mathematical problems (Lutfiyana et al., 2023). Students identified as having high resilience tend to be better able to implement problem-solving steps in a sequential and organized manner, possess self-confidence, and are able to cope with obstacles and negative situations while solving problems ('Athiyah et al., 2020; Attami et al.,

2020). Conversely, students identified as having low resilience tend to become easily discouraged, avoid challenging problems, and perform suboptimally in executing the problem-solving stages across Polya's four indicators (Harahap & Manurung, 2022; Nurfitri & Jusra, 2021). Therefore, mathematical resilience significantly influences students' success in solving problems.

Stimulating the complexity of problem-solving reasoning is a crucial aspect underpinning various mathematical topics, including the understanding of the concept of the System of Linear Equations with Three Variables (SLETV). This material is categorized as one of the learning topics that emphasizes higher-order cognitive abilities because it involves modeling contextual problems into mathematical forms. In their learning, students are expected to do more than just internalize concepts. They are required to actively analyze problems, design solution steps, and verify the results obtained. However, the reality in the classroom does not reflect these expectations. Many students still do not understand the stages of Polya's problem-solving method, particularly in the SLETV curriculum, resulting in predominantly low mathematics achievement (Usman et al., 2022).

Although many studies have examined the relationship between mathematical resilience and mathematical problem-solving ability, the findings remain inconsistent. Some studies report a significant positive relationship, indicating that students with higher mathematical resilience tend to demonstrate better problem-solving performance (Yuniar et al., 2022; 'Athiyah et al., 2020), and qualitative evidence suggests that such students solve problems more systematically (Rahmatiya & Miatun, 2020; Harahap & Manurung, 2022). Conversely, other studies have found no significant relationship between these two variables (Krisdiyanti, 2025). These inconsistent findings suggest that the relationship between mathematical resilience and mathematical problem-solving ability depends on the context and may vary depending on the mathematical topic, student characteristics, and assessment methods. Therefore, these studies present varying findings and involve participants with different characteristics and different mathematical contexts.

To clarify the position of this study, the key characteristics of the selected previous studies are summarized in Table 1.

**Table 1.** Synthesis of Previous Studies on Mathematical Resilience and Problem-Solving Ability

| Study | Context | Measure/ Instrument | Sample | Main Findings |
|---|---|---|---|---|
| 'Athiyah et al. (2020) | Sequences and series | Mathematical resilience questionnaire, mathematical problem-solving test, and interview guidelines | 30 Grade 7 students from MA Al-Ishlah | Mathematical resilience had a significant effect on mathematical problem-solving ability |
| Rahmatiya & Miatun (2020) | Geometry | Mathematical resilience questionnaire (37 items), mathematical problem-solving test (5 items), and interview guidelines | 30 Grade 7 students from SMP Negeri 160 Jakarta; 2 analyzed | High mathematical resilience students showed more systematic problem-solving ability |
| Yuniar et al. (2022) | General mathematics | Mathematical resilience questionnaire and mathematical problem-solving test | 100 Grade 5 students from SDN Klender 03 Pagi, SDN Klender 04 Pagi, SDN Klender 10 Pagi, and SDN Klender 22 Pagi | Mathematical resilience had a positive and significant relationship with mathematical problem-solving ability |
| Harahap & Manurung (2022) | Contextual Problems | Mathematical resilience questionnaire, mathematical problem-solving test, and interview | 6 Grade 8 students from MTs Ruhul Islam Sialambue | Students with high mathematical resilience are able to solve mathematical problem-solving questions using all four steps of Polya's problem-solving model; students with moderate mathematical resilience are able to solve mathematical problem-solving questions using two of Polya's problem-solving steps; and students with low mathematical resilience are only able to use one of Polya's problem-solving steps, namely understanding the problem. |
| Krisdiyanti (2025) | Pythagorean Theorem | Mathematical resilience questionnaire (24 items) and mathematical problem-solving test | 29 Grade 8 students from SMP Negeri 11 Kota Pontianak | There is no significant relationship between mathematical resilience and problem-solving ability |

One important contextual factor that has not received adequate attention is the mathematical topic itself, specifically Systems of Linear Equations with Three Variables (SLETV). Previous research has generally examined mathematical resilience in relation to mathematical achievement or general problem-solving ability, without adequately considering the specific cognitive demands of particular mathematical topics. Mathematical resilience refers to a positive, adaptive attitude toward mathematics that enables students to persevere, respond constructively to setbacks, and continue learning when they encounter difficulties (Johnston-Wilder & Lee, 2010). Empirical research also indicates that mathematical resilience is associated with students' mathematical problem-solving abilities. (Fitriani et al., 2023), in a study involving 233 seventh-grade students, found a significant relationship between mathematical resilience and mathematical problem-solving ability in the contexts of blended learning and problem-based learning. However, this evidence was largely derived from general mathematics tasks or broad instructional contexts, rather than from specific topics such as SLETV.

SLETV presents unique cognitive demands because students must translate contextual situations into mathematical models, identify and coordinate three interrelated variables, select appropriate solution strategies, perform algebraic manipulations accurately, and verify the reasonableness of the solutions they obtain. These demands make SLETV a meaningful context for examining the role of mathematical resilience in problem-solving. In this context, resilience may be reflected not only in students' persistence when facing difficulties but also in their willingness to revise strategies, draw on conceptual understanding, seek support when needed, and reevaluate their work after making mistakes or unsuccessful attempts. Therefore, the relationship between mathematical resilience and problem-solving performance may operate differently in SLETV compared to other mathematics topics. By focusing on SLETV, this study aims to provide topic-specific evidence on the association between mathematical resilience and students' problem-solving performance in SLETV.

Based on the discussion above, further research is needed to examine the relationship between students' mathematical resilience and their mathematical problem-solving abilities in the context of a System of Linear Equations with Three Variables (SLETV). This topic was chosen because it requires students to translate contextual situations into mathematical models, coordinate multiple variables, apply appropriate solution strategies, and verify the accuracy of their solutions. Accordingly, this study examines the association between mathematical

resilience and problem-solving performance in SLETV. It does not test how this association operates or whether it differs across mathematical topics.

## METHODS

The design applied in this study is a quantitative method using a correlational approach. The objective is to determine the correlation between mathematical resilience and problem-solving ability, where mathematical resilience serves as the independent variable (X) and problem-solving ability as the dependent variable (Y). The study population consists of all 10th-grade students at SMA 10 Yogyakarta for the 2025/ 2026 school year, totaling 216 students spread across 6 classes. The sampling frame includes all 10th-grade classes enrolled at the school. The sample consists of 83 students selected from three classes X-2, X-3, and X-4. These classes were selected using a cluster random sampling method, in which the classes served as the sampling units. The selection was conducted by compiling a list of all 10th-grade classes and randomly selecting three classes from the available options. Students were included in the sample if they were officially enrolled as 10th-grade students at SMA 10 Yogyakarta for the 2025/ 2026 school year and attended the data collection sessions. Students who were absent during the administration of the questionnaire or problem-solving test, or who submitted incomplete responses, were excluded from the analysis.

Data were collected using a mathematical resilience questionnaire and a problem-solving ability test. The questionnaire was designed based on Sumarmo's indicators and used to measure the variable of mathematical resilience using a Likert scale, while the test was designed based on Polya's indicators and used to measure the variable of students' problem-solving ability. The content validity of the research instrument was evaluated by two experts, a mathematics education professor and a senior mathematics teacher. The experts evaluated the relevance of each item to the intended construct. For the mathematical resilience questionnaire, the experts used a five-point relevance scale: 1 = Not Relevant, 2 = Somewhat Irrelevant, 3 = Somewhat Relevant, 4 = Relevant, and 5 = Very Relevant. This five-point scale was used to allow for a more detailed expert assessment, including the identification of items that were moderately relevant and required revision. For the problem-solving test, which consisted of four items based on Polya's indicators, the experts used a four-point relevance scale: 1 = Very Irrelevant, 2 = Somewhat Irrelevant, 3 = Relevant, and 4 = Very Relevant. This four-point scale is used to avoid a neutral midpoint and to encourage more definitive assessments of each item's

relevance to the specified problem-solving indicators. Content validity is calculated for each item using Aiken's V coefficient:

$$V = \frac{\sum s}{n(c-1)}$$

where $s = r - l_o$, $r$ is the rating assigned by an expert, $l_o$ is the lowest rating category, $n$ is the number of experts, and $c$ is the number of rating categories. For the mathematical resilience questionnaire, $l_o = 1$ and $c = 5$, whereas for the problem-solving test, $l_o = 1$ and $c = 4$. Aiken's V values range from 0 to 1, with higher values indicating greater expert agreement regarding item relevance. Results of the Aiken V index calculation can be classified based on the values obtained. The index categories are shown in Table 2.

**Table 2.** Aiken Index Criteria

| Index | Criteria |
|---|---|
| 0,80 – 1,00 | Very high validity |
| 0,60 – 0,79 | High validity |
| 0,40 – 0,59 | Moderate validity |
| 0,20 – 0,39 | Low validity |
| 0,00 – 0,19 | Very low validity |

(Retnawati, 2016)

The instrument's reliability level follows Arikunto 's (2019) criteria: values of 0.80 – 1.00 fall into the very high category, 0.60 – 0.79 high, 0.40 – 0.59 adequate, 0.20 – 0.39 low, and 0.00 – 0.19 very low. The reliability of the mathematical resilience questionnaire was tested using Cronbach's Alpha, which yielded a coefficient of 0.837, indicating fall into the very high category. Therefore, the questionnaire is considered reliable for data collection. The problem-solving instrument consisted of four open-ended questions, each representing one of Polya's four stages. The reliability test results showed a Cronbach's alpha value of 0.598. According to Arikunto's (2019) criteria, this value falls into the "adequate" category. However, this coefficient must be interpreted with caution because the problem-solving test consists of only four items, with each item representing a conceptually distinct stage of Polya's mathematical problem-solving process: understanding the problem, formulating a plan, executing the plan, and reviewing. Therefore, Cronbach's alpha is not considered the sole indicator of the problem-solving test's reliability. To further ensure the reliability of the assessment, the Intraclass Correlation Coefficient (ICC) was calculated based on scores assigned by two independent raters. A two-way random effects model with absolute agreement yielded a Single-Measure ICC of 0.937 (95% CI [0.904, 0.959]), indicating excellent inter-rater reliability. High inter-rater agreement provides evidence of consistency in scoring among raters, while the relatively

limited internal consistency should be interpreted in light of the heterogeneous nature of Polya's four stages.

The questionnaire consisted of 20 statements, and the test included 4 open-ended questions. The mathematical resilience questionnaire was developed based on Sumarmo's indicators and consists of 20 statements distributed across six indicators. These test items were developed to reflect each of the six indicators. The questionnaire uses a four-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree), with reverse scoring applied to statements that are unfavorable. The total score ranges from 20 to 80, with higher scores indicating a higher level of mathematical resilience. In addition, the mathematical problem-solving test consists of four open-ended questions designed to assess students' performance across the four stages of problem-solving according to Polya: understanding the problem, formulating a plan, carrying out the plan, and look back. The questionnaire was completed via Google Forms, while the test was administered on a paper-based test sheet. Due to a violation of the assumption that the data distribution is not normally distributed, the data analysis technique was shifted to a nonparametric method. The technique used was Spearman's rank correlation analysis, which is specifically designed to measure the strength of relationships between variables with monotonic association characteristics. For descriptive purposes, students' mathematical resilience scores and mathematical problem-solving ability scores were classified into high, moderate, and low categories using the criteria of the mean and one standard deviation proposed by (Saifuddin, 2020). This classification was used to facilitate the interpretation of the distribution of students' scores and to describe the characteristics of each achievement level. Table 3 are guidelines for interpreting correlation coefficients.

**Table 3.** Guidelines for Interpreting Correlation Coefficients

| Coefficient Interval | Correlation Level |
|---|---|
| 0.00 – 0.199 | Very Low |
| 0.20 – 0.399 | Low |
| 0.40 – 0.599 | Moderate |
| 0.60 – 0.799 | Strong |
| 0.80 – 1.000 | Very Strong |

(Sugiyono, 2013)

This mathematical resilience questionnaire was developed based on six indicators proposed by Sumarmo. The distribution of questionnaire items across each indicator, including both positive and negative statements, is presented in Table 4.

**Table 4.** Mathematical Resilience Questionnaire Matrix

| Indicator | Statement | | Item No |
|---|---|---|---|
| | Positive | Negative | |
| Attitude: perseverance, self-confidence, hard work, not giving up easily when facing problems, failure, and uncertainty | 3 | 1 | 1,3,5,19 |
| Willing to socialize, willing to help peers, and adaptable to their environment | 2 | 1 | 2,4,8 |
| Generating new ideas or approaches and seeking creative solutions to challenges | 2 | 1 | 6,10,18 |
| Using experiences of failure to build self-motivation | 2 | 1 | 7,12,15 |
| Demonstrating curiosity, reflecting, researching, and utilizing various sources | 2 | 1 | 9,11,13 |
| Possessing language skills, self-control, and awareness of one's feelings | 2 | 2 | 14,16,17,20 |
| Total | 13 | 7 | 20 |

This mathematical problem-solving test is structured according to Polya's four stages of problem-solving. Each question in the test represents one stage in the problem-solving process. The test framework is presented in Table 5.

**Table 5.** Problem-Solving Question Outline

| Steps | Indicator | Question No |
|---|---|---|
| Understand the problem | Students are able to identify information and construct a system of linear equations correctly | 1 |
| Devise a plan | Students are able to determine the appropriate method for solving a system of linear equations and explain their reasoning | 2 |
| Carry out the plan | Students are able to solve SLETVs using the correct procedure | 3 |
| Look back | Students are able to verify the correctness of the solution for the given system of equations | 4 |

The separation of the four questions was intentional and served a diagnostic purpose. Rather than treating Polya's framework as four separate problem-solving tasks, the instrument was designed to identify students' performance on each component of the problem-solving process. This problem-solving test consists of four questions, each specifically designed to elicit observable evidence of one of Polya's four components of problem-solving: understanding the problem, formulating a plan, carrying out the plan, and reevaluating. In Question 1, students are asked to identify the given information, determine what is being asked, and formulate a mathematical model. Question 2 assesses students' ability to select the appropriate solution method and explain their reasoning without actually solving the problem. Question 3 requires students to solve the system of equations using the appropriate method. Problem 4 assesses the

re-evaluation component by asking students to verify the given solution. Thus, these four problems are not treated as standalone problem-solving tasks but rather as indicators of specific stages designed to provide observable evidence of student performance on each component of Polya's problem-solving process. Each question was scored on a scale of 0 – 4 based on the completeness and accuracy of the student's response. A score of 4 was assigned when the student demonstrated the targeted problem-solving component completely, correctly, and clearly. A score of 3 was assigned when the student demonstrated the component mostly correctly but with minor errors, omissions, or lack of clarity. A score of 2 was assigned when the student demonstrated only part of the targeted component and the response contained substantial errors or omissions, and a score of 1 was assigned when the student provided very limited evidence of the targeted component or an inadequate response. A score of 0 was assigned when the student provided no answer at all (the question was left completely blank). The scores obtained from the four questions were then summed, resulting in a maximum total score of 16. The total score was subsequently converted to a 0 - 100 scale using the formula:

$$\text{Final Score} = \frac{Total\ Score}{16}\ x\ 100$$

The analysis of the problem-solving test results is calculated based on the percentage of students' actual scores on each test item compared to the ideal maximum score. The percentage of achievement for each stage of Polya's problem-solving model is calculated using the following formula:

$$P = \frac{\sum X}{N\ .\ Smax}\ .100\%$$

Where:

$P$ = The average percentage of Polya stage achievement (%)

$\sum X$ = The total score obtained by all students on the test item

$N$ = The total number of students

$Smax$ = The maximum score per item (4)

The resulting score represented students' overall mathematical problem-solving ability, while the score for each question was analyzed descriptively to provide diagnostic information regarding students' performance on the corresponding component of the Polya problem-solving process. This design allowed the study to assess students' overall problem-solving ability while also describing score attainment on each component.

## RESULTS AND DISCUSSION

The content validity of the mathematical resilience questionnaire and the problem-solving ability test was evaluated using Aiken's V coefficient based on the assessments of two experts. Aiken's V coefficients at the item level are presented in Table 2. The mathematical resilience questionnaire consists of 20 items, while the problem-solving ability test consists of four open-ended questions. A higher Aiken's V value indicates greater agreement among the experts regarding the relevance of each item to the intended construct.

**Table 6**. Item-Level Aiken's V Coefficients for the Mathematical Resilience Questionnaire and Problem-Solving Ability Test

| Variable | Item | Aiken's V | Criteria |
|---|---|---|---|
| Mathematical Resilience | S1 | 1,000 | Very high validity |
| | S2 | 1,000 | Very high validity |
| | S3 | 1,000 | Very high validity |
| | S4 | 1,000 | Very high validity |
| | S5 | 0,875 | Very high validity |
| | S6 | 1,000 | Very high validity |
| | S7 | 1,000 | Very high validity |
| | S8 | 1,000 | Very high validity |
| | S9 | 1,000 | Very high validity |
| | S10 | 1,000 | Very high validity |
| | S11 | 0,875 | Very high validity |
| | S12 | 1,000 | Very high validity |
| | S13 | 0,750 | High validity |
| | S14 | 0,875 | Very high validity |
| | S15 | 1,000 | Very high validity |
| | S16 | 1,000 | Very high validity |
| | S17 | 0,875 | Very high validity |
| | S18 | 1,000 | Very high validity |
| | S19 | 1,000 | Very high validity |
| | S20 | 1,000 | Very high validity |
| Problem-Solving Ability | P1 | 1,000 | Very high validity |
| | P2 | 1,000 | Very high validity |
| | P3 | 1,000 | Very high validity |
| | P4 | 1,000 | Very high validity |

Based on Table 6, the Aiken's V coefficients for the mathematical resilience questionnaire ranged from 0.750 to 1.000. Nineteen items were categorized as having very high content validity, with coefficients ranging from 0.875 to 1.000. One item, S13, obtained an Aiken's V coefficient of 0.750 and was categorized as having high content validity. For the problem-solving ability test, all four items obtained an Aiken's V coefficient of 1.000 and were categorized as having very high content validity. These results indicate that the experts considered the items in both instruments to be relevant to the constructs of mathematical

resilience and mathematical problem-solving ability. Therefore, all items were retained for use in this study. However, since the content validity evaluation involved only two experts, these results should be interpreted with caution. Based on research conducted at SMA 10 Yogyakarta, data was obtained from the results of the normality assumption test, which has been summarized in Table 7.

**Table 7.** Results of Verification of Compliance with the Assumption of Normal Distribution

| | Kolmogorov-Smirnov | | |
|---|---|---|---|
| | Statistic | df | Sig. |
| Mathematical_Resilience | .128 | 83 | .002 |
| Problem_Solving | .162 | 83 | <,001 |

The Kolmogorov-Smirnov test was chosen as the normality test in this study because the sample size exceeded the threshold of 50 respondents, with a total of 83 students ($n > 50$). The hypothesis rejection threshold was set at a 5% (0.05) significance level, with the stipulation that the significance value (p) must exceed 0.05 for the data to be considered normally distributed. However, the empirical evidence in Table 7. shows the opposite result, where the Sig. value for the mathematical resilience variable is 0.002 and < 0.001 for problem-solving ability. Since the Sig. values for both variables are < 0.05, it can be concluded that the data are not normally distributed. Therefore, correlation analysis between variables cannot proceed using parametric statistics; consequently, a nonparametric test using Spearman's rank correlation was selected.

**Table 8.** Results of the Correlation Test for Mathematical Resilience and Mathematical Problem-Solving Ability

| | | | **Mathematical_Resilience** | **Problem_Solving** |
|---|---|---|---|---|
| Spearman's rho | Mathematical_Resilience | Correlation Coefficient | 1.000 | -.021 |
| | | Sig. (2-tailed) | . | .850 |
| | Problem_Solving | Correlation Coefficient | -.021 | 1.000 |
| | | Sig. (2-tailed) | .850 | . |

The Spearman rank correlation test presented in Table 8. yielded a significance value of 0.850. The rules for drawing statistical conclusions in this test are based on the criterion that a significance value less than 0.05 implies the rejection of $H_0$ (the correlation is proven to be significant), while a significance value greater than 0.05 implies the failure to reject $H_0$. The empirical data in Table 8. show a Sig. value of 0.850. Since this probability threshold is greater than 0.05, the results of this study confirm the insignificance of the correlation between mathematical resilience and students' mathematical problem-solving performance, particularly regarding SLETV material. Additionally, a correlation coefficient of -0.021 was obtained. The

negative sign of the coefficient indicates an inverse correlation between mathematical resilience and students' problem-solving capabilities. Meanwhile, the absolute value of 0.021 falls into the very low category (Table 3.). The correlation coefficient of -0.021 indicates a very weak negative monotonic association between the two variables. However, the relationship was not statistically significant (p = 0.850), indicating insufficient evidence to reject the null hypothesis. Thus, no significant correlation was found between mathematical resilience and problem-solving ability in this sample, without implying that no relationship exists in the broader population. Thus, this condition reflects that students with low or high resilience may have the same potential in solving mathematical problems.

In this case, the researcher grouped the levels of mathematical resilience and problem-solving ability into three categories: high, moderate, and low based on criteria derived from the mean and standard deviation.

**Table 9.** Categories of Mathematical Resilience and Problem-Solving Ability Scores

| Score Interval | Category |
|---|---|
| $X \geq (\bar{x}+SD)$ | High |
| $(\bar{x}-SD) \leq X < (\bar{x}+SD)$ | Moderate |
| $X < (\bar{x}-SD)$ | Low |

(Saifuddin, 2020; Kurnia et al., 2018)

The classification of students' mathematical resilience and problem-solving skills is based on the mean and standard deviation of their respective scores. The mean score for mathematical resilience is 63,388 with a standard deviation 9,191. While the mean score for problem-solving ability is 71,460 with a standard deviation of 21,344. These values were used to establish the score intervals for the high, moderate, and low categories presented in Table 9.

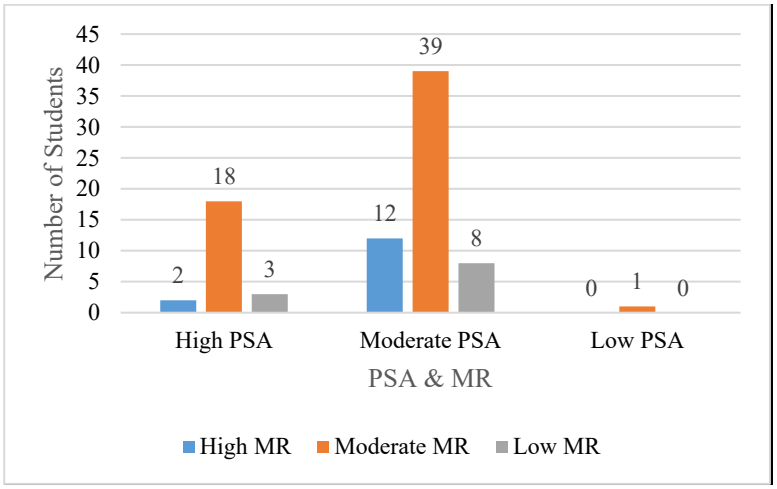



**Figure 1.** Distribution of Students Based on Mathematical Resilience (MR) and Problem-Solving Ability (PSA)

Based on Figure 1., the distribution of students across the mathematical resilience (MR) and problem-solving ability (PSA) categories shows that most students were classified in the moderate PSA category, consisting of 59 students. Of these students, 12 had high MR, 39 had moderate MR, and 8 had low MR. The high PSA category consisted of 23 students, including 2 students with high MR, 18 students with moderate MR, and 3 students with low MR. Meanwhile, only 1 student was classified in the low PSA category, with moderate MR. No students with high or low MR were classified in the low PSA category. Descriptively, the distribution shows that most students fall into the moderate PSA category, while the moderate MR category is the most prevalent in this group.

**Table 10.** Percentage Results of Students' Problem-Solving Abilities Based on Polya's Indicators

| Indicator | Percentage |
|---|---|
| Understand the problem | 99% |
| Devise a plan | 90% |
| Carry out the plan | 57% |
| Look back | 40% |

Based on Table 10., the percentage of achievement for each Polya's problem-solving indicators showed a declining trend across all four stages. These percentages represent the total score obtained relative to the maximum possible score for each indicator, not the percentage of students who mastered each stage. The *understanding the problem* indicator had the highest percentage, at 99% of the maximum possible score, indicating that students' responses at this stage earned scores close to the maximum. The *devise a plan* indicator reached 90% of the maximum possible score, indicating high attainment in determining the appropriate strategy for solving these problems. Attainment dropped to 57% of the maximum possible score for the *carry out the plan* indicator, indicating that students obtained only slightly more than half of the maximum score when carrying out the planned procedures. The lowest attainment was found for the *look back* indicator, at 40% of the maximum possible score, indicating that students' responses were weakest in reviewing of verifying the correctness of their solutions. Overall, these findings suggest that score attainment was highest in understanding the problem and lowest in reviewing the solutions.

Based on the findings of the data analysis, the final inference is that there is no statistically significant monotonic association between mathematical resilience and problem-solving ability in SLETV material among tenth-grade students (classes X-2, X-3, and X-4) at SMA 10 Yogyakarta. With a *correlation coefficient* of -0.021, this indicates that the interaction between these two variables is negatively correlated and falls into the category of very low correlation.

This suggests that students' competence in solving mathematical problems is not solely determined by their level of mathematical resilience; there are other factors that undoubtedly contribute to influencinheg this study. In this case, the researcher suspects several factors related to this condition, including (1) limited time to work on the problems, (2) students not being accustomed to problem-solving questions using Polya's indicators, (3) low student confidence while working on the problems, and (4) uneven conceptual understanding.

Furthermore, an analysis of the distribution of students grouped by mathematical resilience and problem-solving ability categories reveals that the majority of students fall into the moderate problem-solving ability and moderate mathematical resilience categories. This condition indicates that the majority of students already possess the ability to solve problems at a sufficient level; however, their mathematical resilience in facing mathematical difficulties remains at a moderate level, thus requiring further reinforcement to develop optimally. In the high problem-solving ability category, students with moderate mathematical resilience are more dominant than those with high mathematical resilience. This suggests that strong problem-solving ability is not always accompanied by high levels of mathematical resilience, and conversely, students with low mathematical resilience do not necessarily lack strong problem-solving competence. Furthermore, the small proportion of students in the low achievement and low resilience categories generally demonstrates that students at SMA 10 Yogyakarta already possess fairly good problem-solving capabilities.

Regarding students' problem-solving ability scores, the percentage of achievement for each Polya indicator tends to decrease as the problem-solving stages advance. Students' strongest problem-solving ability is at the "understand the problem" stage. Students' responses at this stage earned scores close to the maximum, suggesting that they were generally able to analyze the initial data provided and formulate the core question contained in this test instrument. However, when they begin to plan a solution strategy, a significant decline begins to occur. This is because they have not yet fully mastered an efficient systematic approach to solving the problem. The stage where difficulties are most likely to occur is this third stage. Students are required to use their knowledge to apply concepts and procedures systematically, resulting in many students making errors at this stage. Meanwhile, the review stage is also the weakest part. At this stage, many students run out of time to work on question number 4, so many students skip it. This may occur because the questions are arranged according to Polya's indicators, so there is a possibility that fatigue or time constraints affect the achievement of the final indicator.

Theoretically, the lack of a significant correlation between mathematical resilience and problem-solving ability on SLETV material can be explained by the distinction between affective-situational aspects and domain-specific cognitive demands. Mathematical resilience focuses on students' emotional resilience, positive affect, and persistence when facing learning obstacles. However, SLETV material requires very specific, high-level cognitive capabilities, such as abstraction, symbolic representation, multi-step algebraic manipulation, and mathematical modeling strategies. A never-give-up attitude and a high level of resilience do not automatically transform students' conceptual understanding or procedural skills if the cognitive schemata related to algebraic prerequisites have not been firmly established. In other words, a never-give-up attitude (resilience) only provides the affective readiness to persevere in learning, but it does not replace the substantive cognitive knowledge and metacognitive strategies required to solve complex algebraic problems.

Furthermore, these findings can also be examined through the lens of Cognitive Load Theory and the dynamics of problem-solving processes (Centre for Education Stratistics and Evaluation, 2017). Contextual SLETV problems may impose a high intrinsic cognitive load because they require the simultaneous coordination of three variables. When students with high resilience are faced with complex SLETV problems, their motivation and perseverance may remain intact, but their working memory could become overloaded if not supported by sufficient automation of mathematical procedures. Under this interpretation, even if students continue to try and do not give up easily (high resilience scores), their problem-solving performance may stall at the planning or execution stage *(carry out the plan)*. However, cognitive load was not measured in this study, so this remains a possible theoretical explanation rather than a mechanism established by the findings, future research could measure cognitive load directly to test it.

The findings of this study are inconsistent with previous research, which generally found a significant correlation between students' problem-solving abilities and their mathematical resilience ('Athiyah et al., 2020; Attami et al., 2020; Nurkhodijah & Abadi, 2025). The lack of a significant correlation between students' problem-solving ability and mathematical resilience indicates the absence of a systematic covariation between increased resilience and improved problem-solving ability in this sample. Spearman's correlation assesses the monotonic association between the ranks of the two variables, not linear or proportional changes in raw scores. A coefficient close to zero, as observed here, indicates that higher ranks in mathematical resilience were not systematically accompanied by higher or lower ranks in problem-solving

ability (Wisniewski & Brannan, 2024). This can occur because problem-solving ability is also influenced by other factors such as learning strategies, practice intensity, conceptual mastery, and students' experience in tackling non-routine problems (Jayson & Orongan, 2025). This study did not control for other variables such as learning strategies and *self-efficacy*, so the correlation results may be influenced by external factors. Nevertheless, the findings of this study are consistent with those of (Wati et al., 2020) and (Krisdiyanti, 2025), both of which also showed no significant correlation between students' problem-solving ability and mathematical resilience. Therefore, these differing findings suggest that the correlation between the level of mathematical resilience and students' problem-solving competence is not always absolute.

This study has several limitations. First, participants were drawn from only one school, which limits the ability to generalize the findings to other school contexts. Second, mathematical resilience was measured using a self-report questionnaire, which may be influenced by students' subjective responses. Third, the correlational design does not allow for causal conclusions. Furthermore, other factors that may be related to problem-solving ability—such as learning strategies, conceptual understanding, practice intensity, and self-efficacy—were not controlled for in this study. Therefore, these findings should be interpreted within the context of the specific sample and SLETV program studied.

## CONCLUSION

The present study did not find sufficient statistical evidence of an association between mathematical resilience and problem-solving ability in this particular sample and SLETV context (Spearman's rho = −0.021, p = 0.850). Descriptively, score attainment declined across Polya's stages, from 99% of the maximum possible score for understanding the problem and 90% for devising a plan to 57% for carrying out the plan and 40% for looking back. These patterns are descriptive quantitative findings for this sample and cannot be interpreted as statistical generalizations. Based on these descriptive patterns, educators could consider giving students more practice in carrying out solution procedures and in verifying their answers, and future research could examine other factors such as conceptual understanding, learning strategies, and self-efficacy. The effectiveness of these suggestions remains untested in this study. The limitations of this study lie in the use of a single educational institution with a limited number of respondents, the use of a *self-report* instrument, and a correlational design that does not allow for causal conclusions.

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