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# ANALYSIS OF STUDENTS' MATHEMATICAL PROBLEM-SOLVING ABILITY BASED ON POLYA'S STAGES VIEWED FROM MATHEMATICAL RESILIENCE

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***ABSTRACT***

Mathematics learning should facilitate students in developing and exploring their Mathematical Problem-Solving Ability (MPSA). Mathematical resilience is very important in supporting students' MPSA in mathematics learning. This study aims to explore students' MPSA in terms of their mathematical resilience. A qualitative descriptive method was used in this research to analyze the contribution of mathematical resilience to students' MPSA. A senior high school in Lebak Regency, Banten, was chosen as the location for the research. The research sample consisted of 23 eleventh-grade students, from which 3 students were selected for further analysis based on high, medium, and low categories of mathematical resilience. The findings indicate that students with high mathematical resilience have very good MPSA, as evidenced by achieving all four indicators of MPSA based on Polya's problem-solving stages. Students with medium mathematical resilience still require guidance at the fourth stage of Polya's process, namely evaluating the results and the problem-solving process. Meanwhile, students with low mathematical resilience are only able to understand the problem but are not yet able to develop strategies, implement problem-solving, or evaluate the results and the process. Based on the findings, it can be concluded that students' mathematical resilience influences their MPSA, thus requiring attention to mathematical resilience in the mathematics learning process.

**Keywords:** Mathematical Problem-Solving Ability, Polya's Stages, Mathematical Resilience

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## PRELIMINARY

Mathematics is taught not only so that students can perform calculations (Masfufah & Afriansyah, 2021). It is taught with the hope that students will become high-quality human resources through the mathematical abilities taught in schools (Diana & Saputri, 2021). Mathematical Problem-Solving Ability (MPSA) is one of the essential mathematical skills that students must acquire and be taught (NCTM, 1991).

MPSA is very important for students (Hermawan & Hutajulu, 2024). MPSA refers to the ability to identify problems, plan and implement solutions, and evaluate the results

of the problem-solving process (Firda dkk., 2023). MPSA will be useful in the future not only for solving mathematical problems but also for addressing real-life issues (Jupri dkk., 2021). According to (Polya, 1973), there are four indicators of MPSA: (1) understanding the problem, (2) planning a problem-solving strategy, (3) implementing the problem-solving process, and (4) evaluating the process and the results of the solution.

Previous research has shown that junior high school students' MPSA in geometry is still low (Hermawati dkk., 2021). Another study by (Alvesya dkk., 2025) showed that students' MPSA in solving systems of linear equations in two variables (SPLDV) affects their ability to follow Polya's stages. Next, (Oktasya dkk., 2022) further revealed that students face difficulties in solving mathematical word problems. The main difficulty is that students often do not understand the problem presented (Utari dkk., 2019).

There are many factors behind students' MPSA, including internal and external factors. One internal factor that influences MPSA is mathematical resilience. Mathematical Resilience is a positive stance towards mathematical learning (Johnston-Wilder & Lee, 2024). When learning mathematics, learners often need to be able to deal with challenging works, particularly in mathematical problem-solving (Al Ghifari dkk., 2022), which requires higher-order thinking skills, flexible strategies, and perseverance in dealing with difficulties. Therefore, the ability to remain persistent, think positively, and adapt to challenges becomes a crucial aspect for students to continue developing and achieving success in learning mathematics.

Students need to develop a resilient attitude in order to generate innovative solutions when facing situations that require complex and difficult decision-making (OECD, 2023). Helping learners develop mathematical resilience is important if sufficient people are to go onto study mathematics or other subjects that require mathematical thinking at higher levels (Johnston-Wilder & Lee, 2024). A person with high resilience will be able to solve a problem (Nurhayati & Ni'mah, 2023).

Several previous studies have examined students' mathematical problem-solving abilities from different perspectives, such as mathematical resilience (Rahmmatiya & Miatun, 2020), cognitive styles (Pradiarti & Subanji, 2022), learning motivation (Robbani & Sumartini, 2023), and personality types (Eminarti & Nasution, 2025). While previous studies have investigated problem-solving ability from the perspective of mathematical resilience, none have explicitly addressed this relationship within the context of the subjects and setting used in this study. Hence, this research serves as a preliminary study aimed at exploring broader phenomena related to mathematical resilience.

Based on the above explanation, this study will analyze students' MPSA in contextual problems involving systems of linear equations. The analysis will be viewed in terms of students' mathematical resilience. The results of this study are expected to provide insight into students' MPSA based on high, medium, and low levels of mathematical resilience. This research is also expected to serve as a reference for reflecting on students' MPSA, and for encouraging teachers to consider students' mathematical resilience in the learning process.

## METHODS

The aim of this study is to explore students' Mathematical Problem Solving Ability (MPSA) in terms of high, medium, and low levels of mathematical resilience. This study used a qualitative descriptive research method. The subjects in this study were eleventh-grade students at a senior high school in Lebak Regency, Banten Province, during the 2025/2026 academic year. The steps carried out in this study were analyzing the problem, determining the research objectives, selecting data collection techniques and developing research instruments, analyzing the results and drawing conclusions.

The data collection techniques included administering questionnarires to assess students' mathematical resilience, written test to measure their mathematical problem solving abilities, and interviews to gain deeper verification regarding student's mathematical problem solving abilities and mathematical resilience.

The mathematical resilience instrument The mathematical resilience instrument was a Likert scale questionnaire consisting of 20 items with four response options: strongly agree, agree, disagree, and strongly disagree. The indicators of mathematical resilience used in this study refer to (Lee & Johnston-Wilder, 2017), which include: (1) having a persistent and resilient attitude in facing difficulties, (2) being able to collaborate with peers, (3) possessing the language skills necessary to express understanding, and (4) having a sound understanding of mathematical learning theories.

The written test instrument, in the form of essay questions shown in Figure 1, was used to assess students' mathematical problem solving abilities.

Nendra, Yana, dan Jamal bersama-sama pergi ke kantin sekolah untuk membeli buku dan pulpen. Nendra membeli 2 buah buku dan 2 buah pulpen dengan harga Rp16.000,00. Yana membeli 3 buah pulpen dan 1 buah buku dengan harga Rp18.000,00. Jika Jamal membeli 2 buah buku dan 3 buah pulpen, tentukan uang yang harus dibayar Jamal!
(Gunakan sebanyak mungkin cara penyelesaian masalah di atas!)

Nendra, Yana, and Jamal went together to the school canteen to buy books and pens. Nendra bought 2 books and 2 pens for Rp16,000. Yana bought 3 pens and 1 book for Rp18,000. If Jamal buys 2 books and 3 pens, determine how much money Jamal has to pay!
(Use as many different problem-solving strategies as possible!)

**Figure 1.** Instument Test to Explore MPSA

Data analysis was carried out in three stages according to (Miles & Huberman, 1994), namely data reduction, data display, and conclusion drawing. The data reduction process carried out in this study includes data obtained from the questionnaire results. The data from the questionnaire are used to determine students' levels of resilience, which were then categorized into three groups: high, medium, and low mathematical resilience. The categorization of mathematical resilience levels referred to (Kurnia dkk., 2018). The steps for determining the categories of mathematical resilience are presented in Figure 2 below.

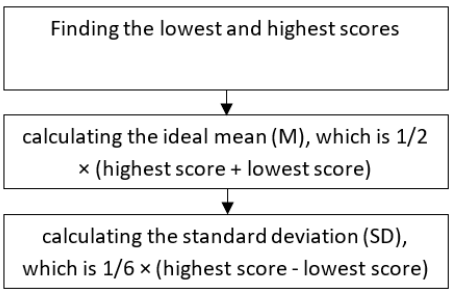



**Figure 2.** Steps for Determining Categories of Mathematical Resilience

The category of mathematical resilience based on the calculation results is presented in the following Table 1.

**Table 1.** Categories of Mathematical Resilience

| Interval Range | Category |
|---|---|
| **value < 40** | low |
| **40 ≤ value< 60** | medium |
| **value ≥ 60** | high |

Then, the data display consisted of students' problem-solving test results, which were grouped according to their level of mathematical resilience. One sample from each category of mathematical resilience was selected to be analyzed for their Mathematical Problem Solving Ability (MPSA). The data were organized using narrative text. The

MPSA indicators used in this study refer to Polya's four step problem solving process, which consists of Table 2:

The results of the questionnaire and mathematical problem-solving test were examined in greater depth through interviews. The conclusion was drawn using data triangulation based on the results of the mathematical resilience questionnaire, mathematical problem-solving ability test, and interviews. The results of the data analysis are presented by describing the MPSA of students with high, medium, and low levels of mathematical resilience.

**Table 2.** Indicators of MPSA based Polya's Stage

| Polya's Stage | Description |
|---|---|
| **Understanding the problem** | Students write down the known and unknown information and construct a mathematical model |
| **Planning a problem solving strategy** | Students write down the steps or methods used to solve the problem |
| **Implementing the problem solving process** | Students describe the process of problem solving |
| **Evaluating the process and results of the problem solving carried out** | Students verify the results obtained to test their correctness |

The results of the questionnaire and mathematical problem-solving test were examined in greater depth through interviews. The conclusion was drawn using data triangulation based on the results of the mathematical resilience questionnaire, mathematical problem-solving ability test, and interviews. The results of the data analysis are presented by describing the MPSA of students with high, medium, and low levels of mathematical resilience.

## RESULT AND DISCUSSION

The participants in this study were eleventh grade students at a public senior high school in Lebak Regency during the 2024/2025 academic year. The study began by administering a mathematical resilience questionnaire and an essay-type test on the topic of matrices. The questionnaire results were then categorized into three levels of mathematical resilience: high, medium, and low. From these results, a sample of three students was

selected one student from each category of mathematical resilience (high, medium, and low).

The results of the mathematical resilience assessment, which was administered to 23 students, are presented as follows.

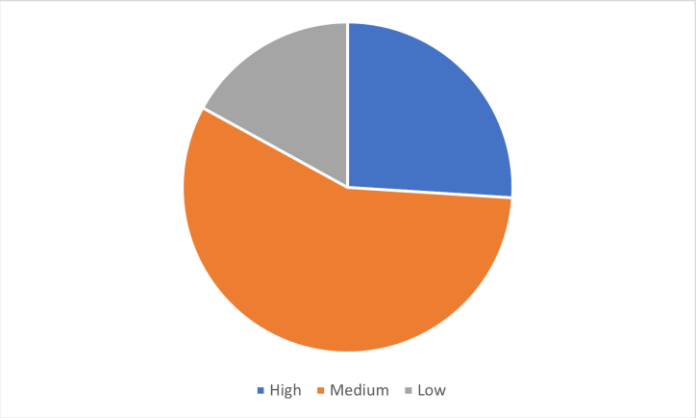
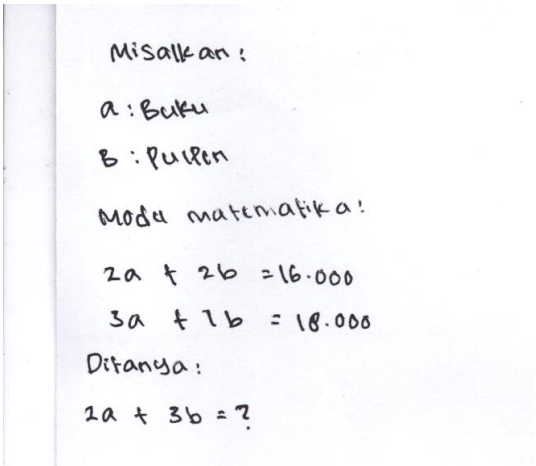



**Figure 3.** Graph of Students' Mathematical Resilience

Based on the table above, it can be seen that out of 23 students who served as research subjects, 6 students (26%) had high mathematical resilience, 13 students (57%) had medium resilience, and 4 students (17%) had low resilience. Subsequently, one student from each category was selected as a sample for analyzing their problem-solving results. The samples were chosen using random sampling. The selected samples were: SP23 for the high resilience category, SP16 for the medium resilience category, and SP7 for the low resilience category.

**MPSA of Students with Low Mathematical Resilience**

The problem-solving responses of the student with low mathematical resilience are as follows:




Let
a : Book
b : Pen

mathematical model
2a + 2b = 16.000
3a + 1b = 18.000

Question:
2a + 3b =?

**Figure 4.** Result test MPSA of Students with Low Mathematical Resilience

Based on the student's response, the Mathematical Problem-Solving Ability (MPSA) can be identified as follows.

**Table 3**. Indicators MPSA Achievement of Students with Low Mathematical Resilience

| **Indicators of MPSA** | **Competent (√) / Incompetent (-)** |
|---|---|
| Understanding the problem | √ |
| Planning a problem-solving strategy | - |
| Implementing the problem-solving process | - |
| Evaluating the process and results of the problem-solving carried out | - |

The results of the interview with the student are as follows:

*Researcher : Why did you only make it as far as the mathematical model? Do you not yet know how to solve it?*
*Research Participant : I was only able to create the mathematical model, ma'am, but I know there's an elimination method; I'm just confused about how to carry it out*
*Researcher : During the learning process, what do you do when you experience difficulty solving math problems?*
*Research Participant : Hehe, just stay quiet, ma'am*
*Researcher : Did you not ask the teacher or your friends?*
*Research Participant : Hehe, no ma'am.*
*Researcher : Before the exam, did you like to study at home*
*Research Participant : No ma'am.*
*Researcher : What is your view on the subject of mathematics?*
*Research Participant : I don't really like mathematics because it's confusing and difficult.*

Based on the answers above, it can be seen that students with low mathematical resilience are only able to understand the problem. This is demonstrated by the fact that the student could only translate the information presented in the word problem into a mathematical model. This aligns with the findings of (Utari dkk., 2019) (Oktasya dkk., 2022), who stated that students face difficulties in solving word problems primarily

because they struggle to understand the problem itself. Additionally, (Kisdiono, 2023) argues that students' low problem-solving ability is caused by a poor conceptual understanding, so students with weak conceptual knowledge cannot connect one concept to another.

Furthermore, an interview was conducted with the student categorized as having low mathematical resilience. The interview results showed that the student was aware of alternative problem-solving methods, such as elimination, but still had difficulty applying the method to solve the problem. This indicates that the student lacked confidence to attempt solving the problem. This supports the view of (Özcan & Kültür, 2021), who stated that self-confidence affects students' ability to solve problems. The study by (Fitri dkk., 2025) also states that self-confidence is correlated with mathematical representation ability. Moreover, the student was not accustomed to asking questions or discussing with peers when facing difficulties. In fact, communication skills, especially mathematical communication, are very important. According to (Suhenda & Munandar, 2023), mathematical communication skills are crucial because they involve the ability to convey ideas effectively, both verbally and in writing.

Additionally, the interview revealed that the student did not study before the exam, which resulted in an inability to solve the given problems. Not studying before exams indicates low resilience. This is consistent with the indicators of mathematical resilience proposed by (Lee & Johnston-Wilder, 2017), who stated that one of the resilience indicators is persistence in learning. Furthermore, drill repetition methods are very important to improve mathematical ability (Sukarsana, 2023).

**MPSA of Students with Medium Mathematical Resilience**

The responses of students categorized as having medium mathematical resilience are as follows:

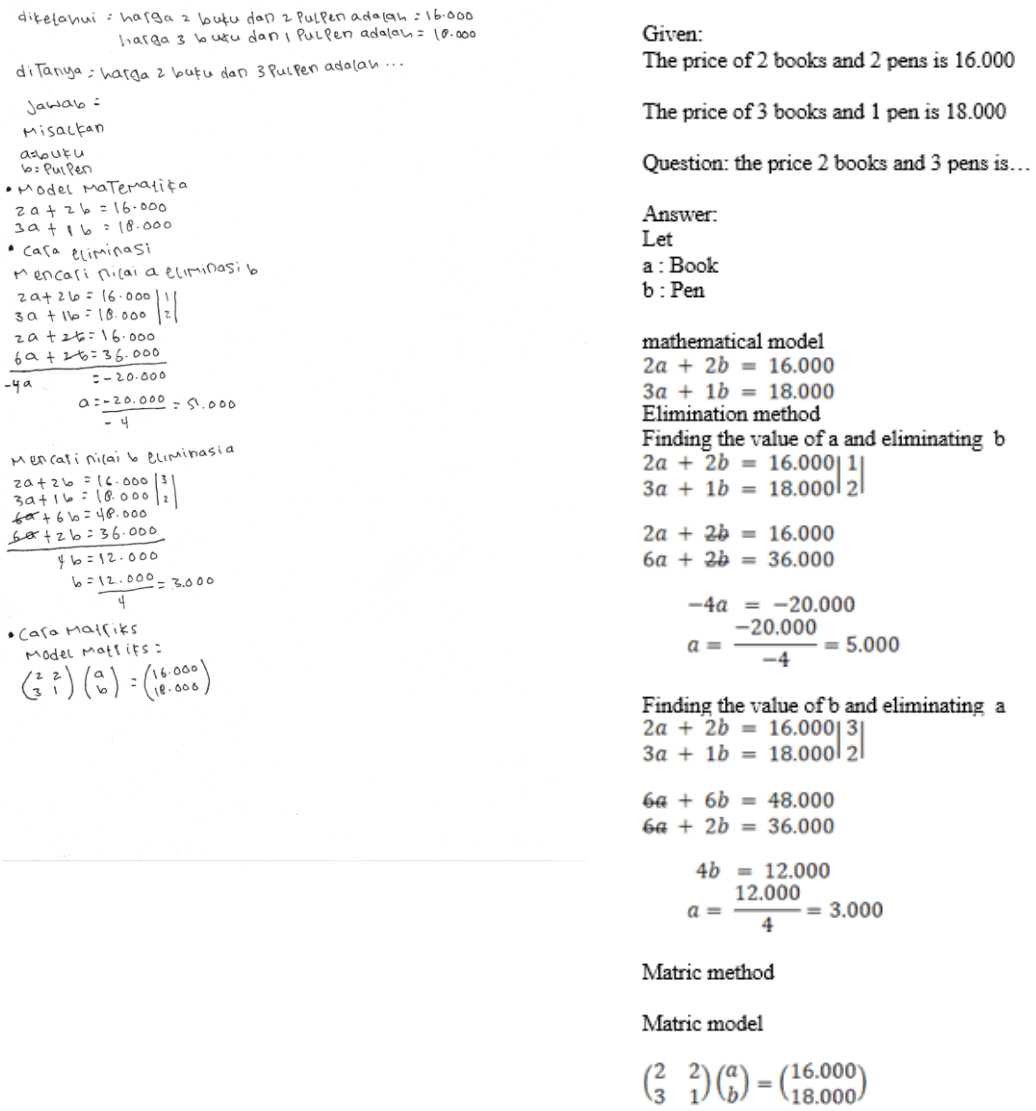



**Figure 5.** Result test MPSA of Students with Medium Mathematical Resilience

Based on the response, the mathematical problem-solving ability can be identified as follows.

**Table 4.** Indicators MPSA Achievement of Students with Medium Mathematical Resilience

| **Indicators of MPSA** | **Competent (√) / Incompetent (-)** |
|---|---|
| Understanding the problem | √ |
| Planning a problem-solving strategy | √ |
| Implementing the problem-solving process | √ |

| | |
|---|---|
| Evaluating the process and results of the problem-solving carried out | - |

The results of the interview with the student are as follows:

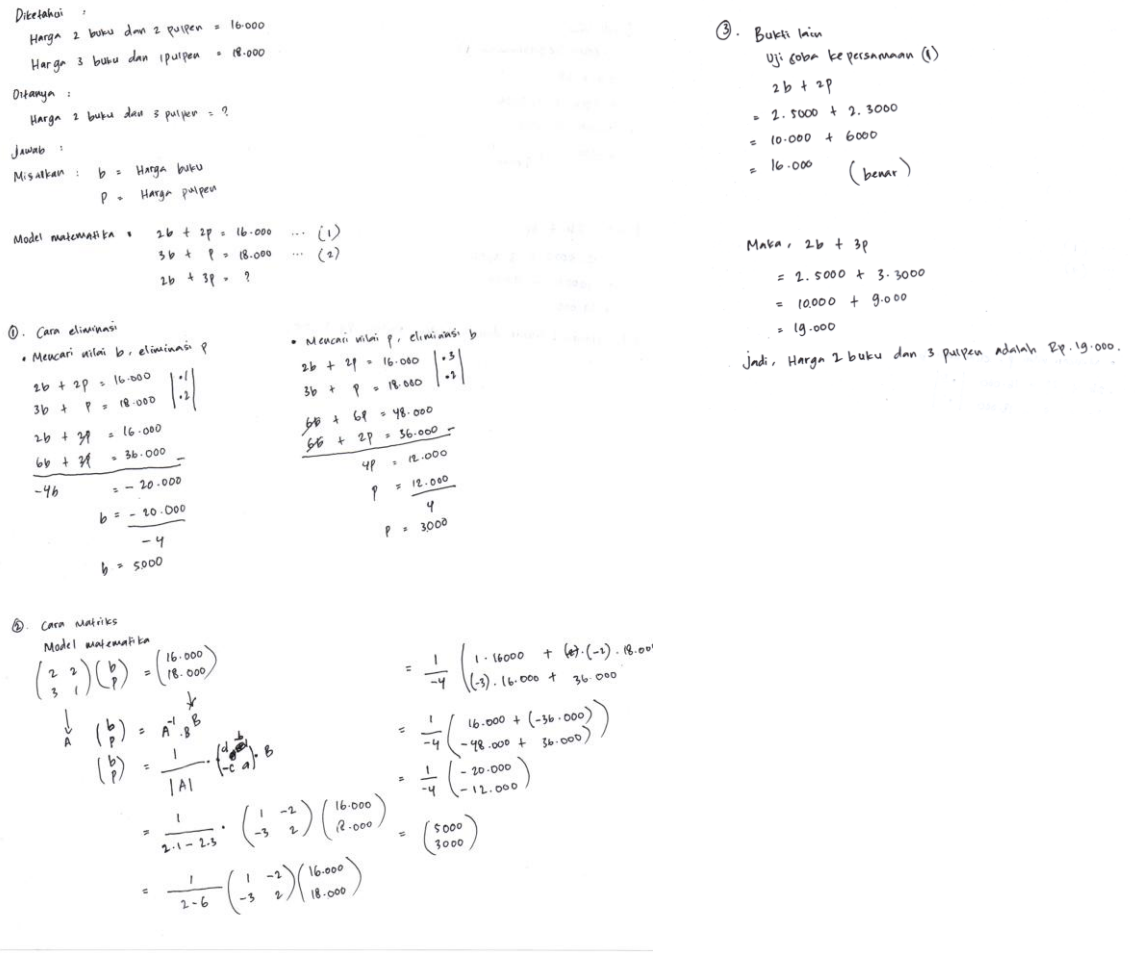
*Researcher : Here, you solved the problem using one correct method and tried another method but didn't finish. Why is that?*
*Research Participant : That's right, ma'am. I was only able to solve it using the elimination method, but I still have difficulties with other methods.*
*Researcher : During the learning process, what do you do when you face difficulties in solving math problems?*
*Research Participant : I've tried to work on it and I like to discuss it with my friends, ma'am, but during exams, I often go blank.*
*Researcher : Before the exam, do you usually study at home?*
*Research Participant : Hehe, sometimes, ma'am.*
*Researcher : What is your view on the subject of mathematics?*
*Research Participant : I quite like mathematics, although I still find it difficult sometimes.*

Based on the responses above, it is evident that students with moderate mathematical resilience are able to understand the problem, plan a problem-solving strategy, and implement the solution. This is shown by their ability to transform the information presented in the word problem into a mathematical model and find the correct solution. However, they have not yet demonstrated the ability to evaluate the process and results of problem-solving. This aligns with (Afri & Windasari, 2021), who noted that only a few students carry out evaluation and verification of their problem-solving results.

An interview was then conducted with a student in the moderate resilience category. The results showed that the student was aware of several alternative problem-solving methods, such as elimination, substitution, and matrices. However, the student preferred to use elimination because it was perceived as easier. This indicates that according to Polya's stages, students with moderate resilience have not fully mastered all stages since they do not confirm answers by using alternative methods. This corresponds with (Rudianti dkk., 2021), who found that most students use only one method to solve mathematical problems. Ideally, eleventh-grade students should be able to solve linear system equations through various methods including graphing and matrices.

**MPSA of Students with High Mathematical Resilience**

The responses of students categorized as having high mathematical resilience are as follows:



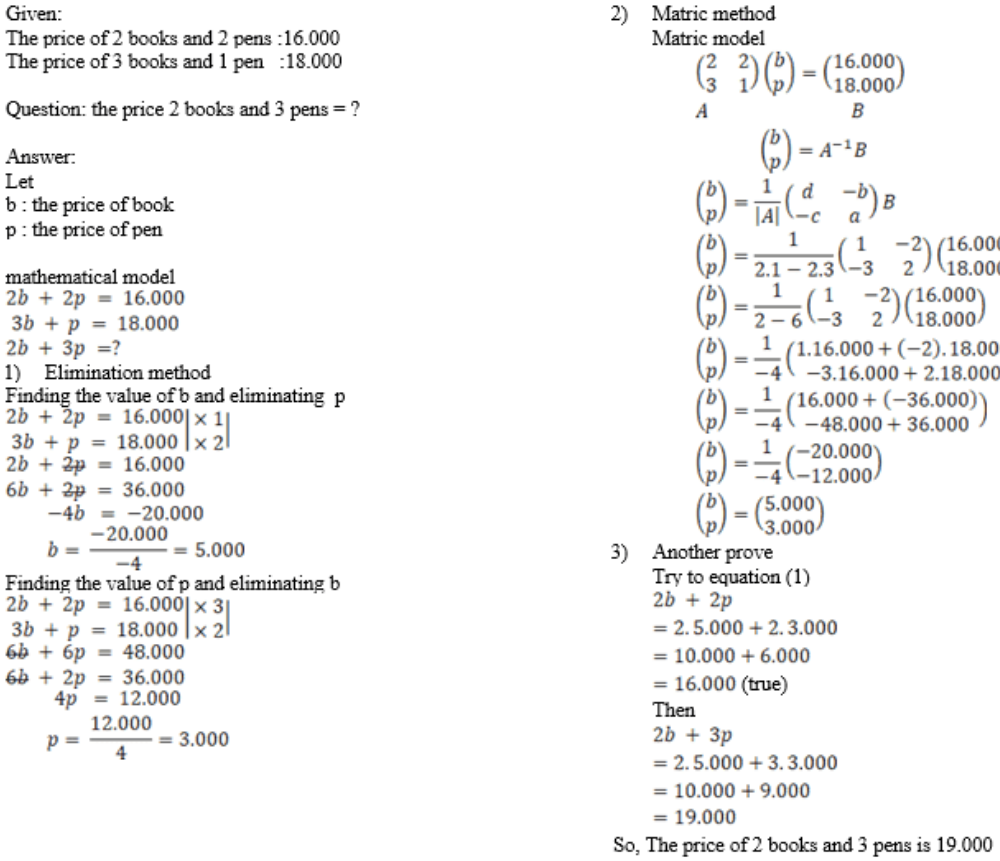



**Figure 6.** Result test MPSA of Students with High Mathematical Resilience

Based on the responses, the mathematical problem solving abilities are identified as follows.

**Table 5.** Indicators MPSA Achievement of Students with High Mathematical Resilience

| **Indicators of MPSA** | **Competent (√) / Incompetent (-)** |
|---|---|
| Understanding the problem | √ |
| Planning a problem-solving strategy | √ |
| Implementing the problem-solving process | √ |
| Evaluating the process and results of the problem-solving carried out | √ |

The results of the interview with the student are as follows:

*Researcher : How were you able to solve the given problem? Do you like mathematics?*

| | | |
|---|---|---|
| *Research Participant* | : | *I kind of like it, ma'am, especially when the teacher explains it in an easy to understand way* |
| *Researcher* | : | *Have you ever experienced difficulties in doing math?* |
| *Research Participant* | : | *Yes, I have, ma'am.* |
| *Researcher* | : | *What do you do when you face difficulties?* |
| *Research Participant* | : | *usually ask the teacher, either during class or outside of lessons.* |
| *Researcher* | : | *Besides that, do you enjoy discussing math problems with your friends?* |
| *Research Participant* | : | *Yes, ma'am, I do.* |
| *Researcher* | : | *Do you like studying at home, especially to prepare for exams?* |
| *Research Participant* | : | *Yes, ma'am, quite a bit* |
| *Researcher* | : | *Have you ever felt like giving up on doing math?* |
| *Research Participant* | : | *Yes, ma'am, but I often get curious when I haven't found the answer yet.* |

Based on the responses above, it is clear that students with high mathematical resilience can solve problems by applying all four of Polya's stages. This is shown by their ability to transform the information in the word problem into a mathematical model, develop a problem-solving strategy, implement the strategy, and evaluate the process and results. This demonstrates that students with high resilience can solve problems and evaluate the process and outcomes using various methods, all yielding consistent results. This indicates that students with high resilience have very good mathematical problem-solving skills. This is supported by research from (Arjun & Muntazhimah, 2023), which concluded that mathematical resilience influences students' problem-solving abilities. Other studies also indicate that mathematical resilience affects mathematical reasoning (Afifah dkk., 2024) and creative thinking (Himawan & Noer, 2021).

An interview with a high-resilience student revealed knowledge of several alternative problem-solving methods including elimination, substitution, and matrices. The student was also familiar with graphing methods but found them difficult and less practical. Students with high mathematical resilience tend to be persistent and diligent in problem-solving. They prepare for exams through independent study and peer discussions and are not reluctant to ask teachers questions when something is unclear. This aligns with (Lee & Johnston-Wilder, 2017), who stated that mathematical resilience comprises four indicators: (1) perseverance in facing difficulties, (2) ability to collaborate with peers, (3) good language skills to express understanding, and (4) mastery of mathematical learning theories.

## CONCLUSION

The research results show that students with high mathematical resilience have excellent mathematical problem-solving skills (MPSA), as evidenced by their ability to achieve all four of Polya's problem-solving stages. Students with moderate mathematical resilience still require guidance in the fourth stage of Polya's process, which is evaluating the results and the problem-solving process. Meanwhile, students with low mathematical resilience are only able to understand the problem but are not yet capable of formulating strategies, implementing solutions, or evaluating the results and processes. Therefore, based on the findings, it can be concluded that students' mathematical resilience affects their problem-solving abilities.

The results of this study show that mathematical resilience affects students' mathematical problem-solving abilities. This research can serve as a reference for reflecting on students' mathematical problem-solving skills (MPSA) during the learning process. Teachers are expected to pay attention to students' mathematical resilience. This is because MPSA is a crucial skill that students must possess. Likewise, mathematical resilience plays an important role in developing students' MPSA.

The researcher acknowledges that this study is far from perfect and still has many limitations. The limitations include a very limited research sample, only one problem used as an instrument to measure MPSA, and the data analysis was only conducted descriptively and qualitatively. This research is certainly not a final study but a preliminary one that can serve as a reflection for educators in developing students' MPSA and mathematical resilience.

Future research could explore similar studies on different mathematical topics. In addition, further studies could examine how mathematical resilience influences students' MPSA using a larger sample and more varied instruments. Moreover, future research could also involve the implementation of learning models, learning approaches, or the development of teaching materials such as modules or worksheets that can enhance students' MPSA and mathematical resilience.

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