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Students' Mathematical Problem-Solving Ability from the Perspective of Mathematical Anxiety Levels

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Abstrak

Kemampuan pemecahan masalah matematis siswa di Indonesia masih tergolong rendah, dengan kecemasan matematis diidentifikasi sebagai salah satu penyebab utamanya. Penelitian ini bertujuan untuk menggambarkan kemampuan pemecahan masalah matematika siswa berdasarkan tingkat kecemasan matematisnya, menggunakan pendekatan kualitatif dengan metode studi kasus. Partisipan terdiri dari 39 siswa kelas XI dari sebuah SMA di Kota Serang, Provinsi Banten, yang telah mempelajari barisan dan deret geometri. Data dikumpulkan melalui tes tulis untuk mengukur kemampuan pemecahan masalah matematika serta menggunakan teknik non-tes seperti kuesioner kecemasan matematis dan wawancara. Hasil penelitian menunjukkan bahwa siswa dengan tingkat kecemasan matematis rendah memenuhi semua indikator kemampuan pemecahan masalah matematis, siswa dengan tingkat kecemasan matematis sedang memenuhi tiga dari empat indikator, dan siswa dengan tingkat kecemasan matematis tinggi hanya memenuhi satu dari empat indikator tersebut. Oleh karena itu, guru dan siswa harus mempertimbangkan strategi yang tepat untuk mengurangi kecemasan matematis dalam metode pembelajaran guna meningkatkan kemampuan pemecahan masalah matematis siswa.
Kata Kunci: Kecemasan matematis; Kemampuan pemecahan masalah matematis; Masalah matematis; Sekolah menengah atas.

Abstract

The mathematical problem-solving ability (MPSA) of students in Indonesia is low, with mathematical anxiety identified as a contributing factor. This research sought to explore students' MPSA from the perspective of mathematical anxiety levels using a qualitative approach with a case study method. The participants included 39 grade XI students from a senior high school in Serang City, Banten Province, who had learned arithmetic and geometric sequences. Data collection included written tests for MPSA and non-test techniques such as mathematical anxiety questionnaire and interviews. The results reveal that students with low mathematical anxiety level fulfilled all the indicators of MPSA, students with moderate mathematical anxiety level fulfilled three of the four indicators of MPSA, and students with high mathematical anxiety level only fulfilled one of the four indicators of MPSA. Therefore, teachers and students should consider appropriate strategies to reduce mathematical anxiety in learning methods, aiming to enhance students' mathematical problem-solving ability.
Keywords: High school; Mathematical anxiety; Mathematical problems; Mathematical problem-solving ability.

I. INTRODUCTION

Education is crucial in a person's life, as it plays a key role in developing knowledge and character. Everyone has the right to education, which helps unlock individual potential and fosters personal growth. This is in line with Article 1 of Constitution number 20 of 2003 regarding the National Education System, which underscores education as a deliberate effort to establish a learning environment where students actively develop the personality, intelligence, and skills needed for themselves and society (Depdiknas, 2003). According to Amaliyah and Rahmat (2021), developing students' potential is a key aspect of education, achieved primarily through the learning process. A good learning process will determine good results, too, and mathematics learning is no exception.

The learning mathematics process is deemed essential for students across all levels of formal education. The National Council of Teachers of Mathematics (NCTM) underscored problem-solving as a pivotal aspect of mathematical proficiency (NCTM, 2000). The Ministerial Regulation of Education and Culture number 22 of 2016 in Indonesia identifies problem-solving as a key objective of mathematics education. Hence, it can be inferred that both NCTM and Indonesia share the perspective that mathematical problem-solving ability (MPSA) is an essential ability that students must acquire.

Students' MPSA will appear when facing new mathematics problems as highlighted by Polya (1957) who describe problem-solving as the process of overcoming difficulties to get solutions not immediately apparent. MPSA involves the capability to solve diverse mathematical problems, categorized by Prabawanto (2013) into closed and open-ended problems within and outside mathematics contexts. Marlina, Jafar, and Sudia (2020) define a mathematical problem as a non-routine problem with no known solution procedure, where the problem will depend on the time, place and problem solver. MPSA are important for students because they are needed in solving problems in everyday life (Putri & Warmi, 2022). Thus, Students are anticipated to discover the mathematical concepts they learn by engaging in problem-solving activities (Putra, Thahiram, Ganiati & Nuryana, 2018; Minggi, Arwadi, & Bakri, 2022). Additionally, problem-solving can provide information about mastery of learning materials and train students to apply their knowledge to various situations and problems (Umrana, Cahyono & Sudia, 2019; Marianti, 2023). Therefore, learning situations in the classroom should get students used to facing problems that hone their ability to think and analyze problems.

Students can learn to think and analyze problems by working on non-routine problems. Non-routine problems are essential in learning mathematics and should be featured in the resource book (Sari, 2022). Meanwhile, in reality, students were not used to solving non-routine problems and teachers were only guided by exercise questions in the sourcebook (Qomariyah, Zainudin, Isnaini & Rohmah, 2023). Thus, the urgency does not align with what happens in the field. Therefore, students find it difficult to train to master problem-solving ability, so it is predicted

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that Indonesian students still have low MPSA levels.

Several surveys and research reveal low MPSA among Indonesian students. For instance, according to Programme for International Student Assessment (PISA) survey results in 2022, Indonesian students were ranked 70th out of 81 countries, with an average score of 366 in mathematics (OECD, 2023). Additionally, International Mathematics and Science Study (TIMSS) 2015 evaluated students' proficiency in solving mathematics and science's non-routine problems, placed Indonesia at the bottom of the rankings, specifically 45th out of 50 countries, with an average score of 397 (Mullis, Martin, Foy & Hooper, 2015). This shows that Indonesian students are suspected of making mistakes when given non-routine problems.

Students make mistakes when solving problems because they cannot perform the problem-solving steps properly. This is supported by research results from Rinaldi and Afriansyah (2019) and (Marlina et al., 2020), who state that students' low MPSA is due to not coherently carrying out the mathematical problem-solving stages. The stages of problem-solving by Polya (1957) are understanding the problem, devising a plan, carrying out the plan and looking back. This is in line with VanGundy and Arthur (2005) also mention that problem-solving involves four distinct stages, namely clarify, ideate, develop and implement. Students' mistakes in solving problems are influenced by both cognitive and affective factors. One affective factor that contributes to low MPSA is math anxiety.

Mathematical anxiety is an uncomfortable feeling, such as fear and worry, when facing specific mathematics-related situations (Tamba & Bermuli, 2023). According to Azizah and Suhendra (2020), mathematical anxiety involves fear and tension when dealing with mathematics problems or learning mathematics, with various symptoms. Safitri, Lukman and Nurcahyono (2022) add that it's a feeling of worry when solving math-related problems. Mathematical anxiety with reasonable or low intensity can provide enthusiasm or encouragement to improve deficiencies in themselves (Ikhsan, 2019). Based on Indriani (2018), anxiety related to mathematics may arise during the process of learning mathematics, completing mathematics exams, or performing numerical tasks, considering aspects such as physical responses, cognitive factors, attitudes, and mathematical understanding. revealed that 31% of 15-years-old students reported feeling helpless or nervous when engaging in mathematical tasks. According to Mujahidah and Khusna (2023), the research results state that students feel insecure about their mathematical abilities, dislike mathematics lessons and feel anxious when working on mathematics problems. The findings suggest that mathematical anxiety is a worrying problem worldwide. Rahmani, Amrullah, Kurniawan, and Sarjana (2024), found a moderate relationship between mathematical anxiety and MPSA, with a correlation coefficient of 0.459 and a determination coefficient of 0.617. This

suggests that mathematical anxiety influences MPSA by 61.7%.

Based on the background description above, further research is needed on students' MPSA in terms of mathematical anxiety levels. Research that examines students' MPSA in terms of mathematical anxiety generally only used Polya's problem solving stages as indicators. Therefore, a more in-depth analysis is needed to understand how students solve different types of problems. This study aimed to measured students' MPSA through various types of problems as indicators and clarify the results by analyzing Polya's problem solving stages from the perspective of high, moderate, and low mathematical anxiety. Thus, this research is expected to contribute to problem-solving problems from the perspective of students' affective aspects, namely mathematical anxiety.

II. METHOD

The objective of this research was to explore MPSA among eleventh-grade students from the perspective of mathematical anxiety levels. To achieve this, researchers employed a qualitative approach using a case study method. This research was carried out at a senior high school in Serang City, Banten Province, involving 39 students who had studied arithmetic and geometric sequences.

Researchers employed a purposive sampling method to select three students, each representing a different level of mathematical anxiety, based on the data collected. Data collection utilized both test and non-test techniques. The test involved a written test of students' MPSA. Non-test techniques included a questionnaire to evaluate students' levels of mathematical anxiety and interview guidelines. To facilitate these data collection methods, several appropriate instruments were required. The research employed two types of instruments: the researcher, as the primary instrument, who was directly engaged in data collection, and various supporting instruments. Below is an explanation of each supporting instrument used.

A written test of MPSA consisting of four items representing an indicator of MPSA was validated by several experts such as mathematics education lecturer and mathematics teacher to assess the clarity, relevance, and feasibility of each item in the test instrument, including the suitability of the question with the research objective and the indicators of MPSA. In addition, a readability test was also conducted on several students with varying levels of mathematics ability. The indicators of MPSA according to Prabawanto (2013) are shown in Table 1.

Table 1.
The Indicators of MPSA

Question Number	The Indicators of MPSA
1.	Solve closed mathematical problems within the context of mathematics.
2.	Solve closed mathematical problems in the context outside mathematics.
3.	Solve open-ended mathematical problems within the context of mathematics.
4.	Solve open-ended mathematical problems in the context outside mathematics.

The achievement of each indicator of MPSA was analyzed based on the stages of problem-solving according to Polya (1957) including understanding the problem,

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devising a plan, carrying out the plan, and looking back.

A mathematical anxiety questionnaire was calculated using the 4-point Likert scale adapted from Indriani (2018) and had a closed-answer format included three parts: anxiety in learning mathematics; anxiety during mathematics exams; and anxiety with numerical tasks. It considered somatic, cognitive, attitude and mathematical knowledge aspects.

Interview guidelines, the interview employed a semi-structured method, with guided questions that were flexibly adjusted based on the subject's responses, allowing for an in-depth exploration of students' MPSA. Interview subjects were a teacher and three selected students represented a mathematical anxiety level.

After collecting the data, the researcher analyzed it by first reducing the data. The researcher evaluated the consistency of students' responses by analyzing positive and negative statements in the questionnaire. Scores were then calculated to determine their level of mathematical anxiety. Then, the researcher examined the students' work in solving the written test of MPSA to select subjects who could represent MPSA based on their mathematical anxiety levels. The criteria for selecting subjects at each mathematical anxiety level were students who had relatively similar ways of working on problems with the most ways of working on problems and suggestions from a mathematics teacher. The last data reduction was carried out on the interview transcript. If there was a mismatch between the MPSA test answers, the mathematical anxiety questionnaire results and the interview results, then the data were not used in data analysis.

The data presented describe the students' MPSA with high, moderate and low mathematical anxiety levels. The final stage of data analysis was to draw conclusions, which took the form of detailed descriptions.

III. RESULT AND DISCUSSION

The results of the MPSA test for all students are depicted as the percentage of accomplishment for each problem-solving stage, as outlined by the MPSA indicators provided in Table 2.

Table 2.
Percentage of Achievement of Polya's Problem-Solving Stages based on indicators of MPSA

Question Number	Percentage Achievement of Polya's Stages			
	Understanding the problem	Devising a plan	Carrying out the plan	Looking back
1	81,2%	57,7%	76,9%	61,5%
2	71,8%	56,4%	88,9%	83,3%
3	70,9%	29,5%	60,7%	48,7%
4	62,4%	35,9%	43,6%	41%

Table 2 shows the indicator of MPSA that most students were able to solve was solving closed mathematical problems in contexts outside mathematics. Meanwhile, the indicator with the lowest achievement was solving open-ended mathematical problems in contexts outside mathematics. The reason students struggled with that indicator is due to students not being able to devise a plan, as shown by the lowest achievement stages on that indicator.

The outcomes of MPSA test indicated that most students achieved the second MPSA indicator, namely solving closed mathematical problems in the context

outside mathematics. According to Rahmi (2019) results, the highest achievement, at 75.8%, was observed in solving closed mathematical problems presented in non-mathematical contexts. Then, the fourth MPSA indicator, namely solving open-ended mathematical problems in the context outside mathematics had the lowest achievement. Align with Rami (2021) results, students address open-ended mathematical problems both in and beyond mathematical contexts due to their limited familiarity with these types of problems.

Next, three students were selected to represent each level of mathematical anxiety. Subject S2 represents a high level, S32 represents a moderate level and S31 represents a low level of mathematical anxiety. The results of the MPSA test for each selected subject can be seen in Table 3.

Table 3.
Achievement of Subjects with High, Moderate and Low Mathematical Anxiety Levels in Indicators of Mathematical problem-solving ability (MPSA)

Subject	1st Indicator	2nd Indicator	3rd Indicator	4th Indicator
S31	✓	✓	✓	✓
S32	-	✓	✓	✓
S2	-	✓	-	-

Table 3 shows the outcomes of students' MPSA test and interviews conducted for this research. A low level of mathematical anxiety subject S31 fulfilled all indicators of MPSA. During the stage of carrying out the plan, the subject effectively implemented their problem-solving as strateg. The subject solved each MPSA indicator well because the subject considered mathematics as one of his favorite lessons, marked by having high motivation to learn mathematics by practicing working on various mathematical problems. Figure 1 shows an answer of subject S31 on the third MPSA indicator, namely solving open-ended mathematical problems within the context of mathematical context. S31 answered in a unique way on that indicator.

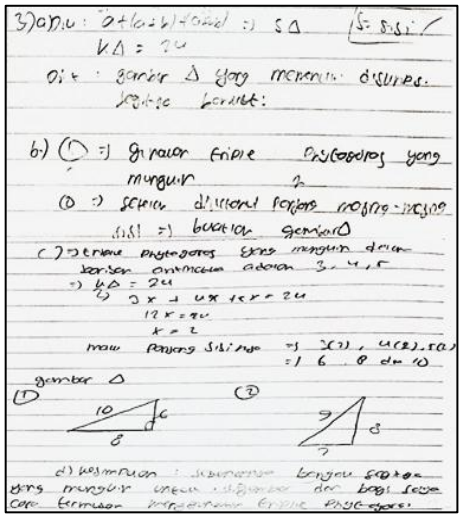

Figure 1. Answer of Subject S32 on the 1st MPSA Indicator

Students with low mathematical anxiety levels fulfilled all MPSA indicators. This aligns with research conducted by Apriyani and Imami (2022) which indicated that low levels of mathematical anxiety students tend to have excellent problem-solving ability and can complete all steps proposed by Polya. Based on the interview results, the students with low mathematical anxiety solved each indicator of MPSA well because the subject considered mathematics as one of his favorite lessons, marked by having high motivation to learn mathematics by practicing working on various mathematical problems. This aligns with research results by Noor (2017), which state that students with low mathematical anxiety feel an internal pressure to solve problems, leading to a challenge that

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fosters a desire and motivation to successfully tackle the given problems.

Students with low mathematical anxiety demonstrated a strong understanding of all MPSA indicators. This was confirmed through interviews, the subject felt that the problem in the problem was clear. This aligns with research results conducted by Rizki, Rafianti and Marethi (2019), noting that students with low mathematical anxiety can effectively comprehend problems, as shown by their ability to fully analyze the given and required elements. During the stage of carrying out the plan, low mathematical anxiety subjects were able to use their problem-solving plan as a solution strategy. It can help them to solve the problem and get the correct solution. The research results by Adhimah, Ekawati and Fardah (2020) support this, indicating that low mathematical anxiety students can use the context of the problem in the process of solving mathematical calculations.

Next, a moderate level of mathematical anxiety subject S32 fulfilled three of the four indicators of MPSA. However, the subject encountered difficulty with the first indicator due to a lack of precision in calculation and did not check again. Subject S32 struggled to devise a problem-solving strategy, indicating a comprehension of the problem but a lack of proficiency in determining how to address it in that indicator. Figure 2 shows the mistake of subject S32 fulfilling the first MPSA indicator.

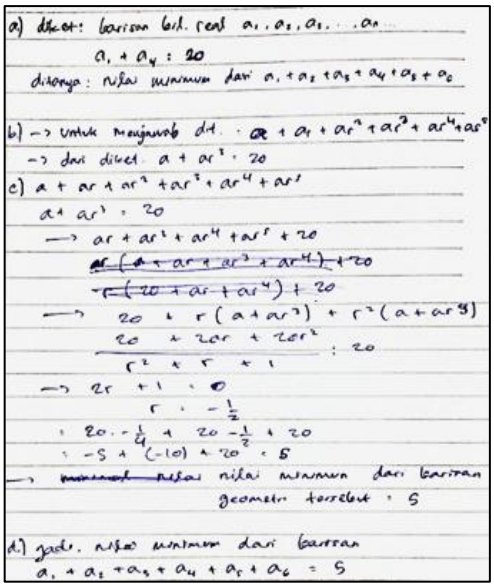

Figure 2. Answer of Subject S32 on the 1st MPSA Indicator

Subject S32 was not able to fulfill the first MPSA indicator because S32 was not careful in calculating at the final stage of work and checking the answers again. However, S32 showed a unique answer on the second MPSA indicator, namely solving closed mathematical problems in the context outside mathematics. Figure 3 shows an answer of S31 on the second MPSA indicator.

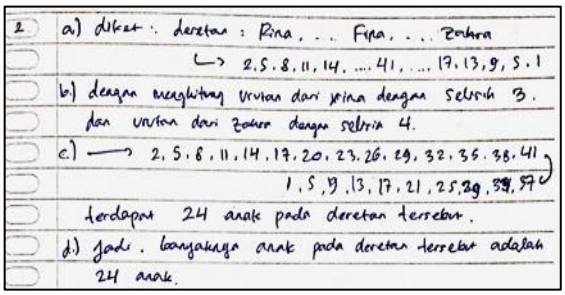

Figure 3. Answer of Subject S32 on the 2nd MPSA Indicator

Students with moderate mathematical anxiety levels were able to fulfill three out of the four MPSA indicators. This is in line with the research results by Rizki et al (2019), which states that moderate level of mathematical anxiety students were able

to interpret the problem even though it was not perfect. The interview results revealed students' inability to make a problem-solving plan because they only understood the problem and could not solve the problem on that indicator. This is supported by the opinion of Setiawan, Pujiastuti and Susilo (2021), which states that moderate levels of mathematical anxiety students tend to have an empty mind during learning.

Furthermore, the moderate levels of mathematical anxiety students demonstrated the ability to apply problem-solving strategies, yet they struggled to arrive at the correct solution initially due to carelessness in the final step of their calculations. This can be caused by mathematical anxiety, a negative reaction from someone involving mathematical calculations that can interfere with manipulating numbers and solving problems (Widaninggar, Mardiyana & Kurniawati, 2017). Thus, the negative reaction of mathematical anxiety can interfere with concentration when counting.

A subject with a high mathematical anxiety level S2 managed to fulfill only one out of the four indicators of MPSA. The failure on the first MPSA indicator and the fourth MPSA indicator was due to the lack of comprehension of the sequence material. In addition, the failure on the third MPSA indicator stemmed from carelessness in reading the problem and neglecting to review their work. During the stage of carrying out the plan, the subject failed to complete the other three indicators of MPSA because the subject had high mathematical anxiety and could not implement the problem-solving plan as the right solution strategy. After all, the subject felt confused when doing calculations. The high mathematical anxiety subject said that when the subject found a complex problem, the subject felt too lazy to find the correct solution strategy. Figure 4 shows the failure of S2 to answer the first MPSA indicator.

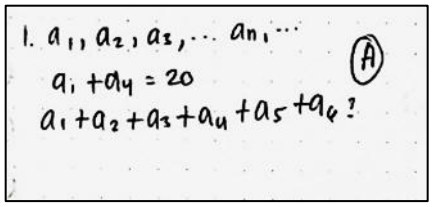

Figure 4. Answer of Subject S2 on the 1st MPSA Indicator

Subject S2 was not able to fulfill the first MPSA indicator. Subject S2 felt confused about solving the questions due to a lack of understanding regarding the sequence material. However, S2 was able to fulfill the second MPSA indicator well by applying Polya's solving-problem stages on the second MPSA Indicator. Figure 5 shows an answer of S2 on the second MPSA indicator.

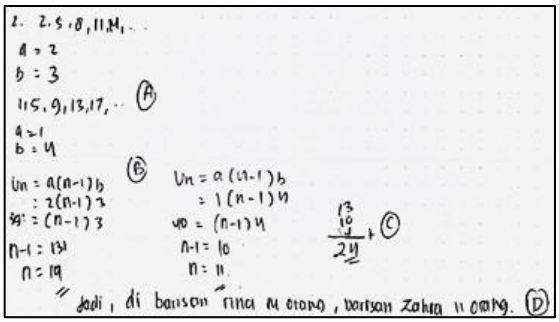

Figure 5. Answer of Subject S2 on the 2nd MPSA Indicator

Subject S2 fulfilled the second MPSA indicator. The solution strategy used an arithmetic sequence formula to determine the correct answer. Students with high mathematical anxiety levels were only able to fulfill one of the four MPSA indicators.

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This is because they considered mathematics difficult and did not like calculations. The students with high mathematical anxiety revealed that when they found a difficult problem to work on, they felt too lazy to find the correct solution strategy. In addition, the lazy feeling of doing mathematics problems also arises if the subject did not find the correct solution. This aligns with the opinion of Pattisina and Sopiany (2021), which states that individuals with high mathematical anxiety show low motivation.

At the third stage of problem-solving, namely carrying out the plan, the students failed to complete the other three indicators of MPSA. Students were unable to execute the problem-solving plan correctly due to confusion and inaccuracy in calculations. This was supported by interview results showing that they did not enjoy mathematical calculations. This finding is consistent with research results by Ardani, Sujiran and Puspananda (2021), which states that students with high mathematical anxiety often struggle to solve problems correctly, leading to mistakes in their work.

IV. CONCLUSION

Relying on the research results and the overall discussion of the mathematical problem-solving ability (MPSA) of eleven grade students from the perspective of mathematical anxiety levels, it can be inferred that low mathematical anxiety students effectively fulfill all MPSA indicators. They were able to appropriately and thoroughly follow Polya's problem-solving stages. Students with moderate mathematical anxiety fulfill three out of the four MPSA indicators. They encounter challenges, particularly in solving closed mathematical problems within the context of mathematics due to carelessness in calculations and failure to recheck their work. Students with high mathematical anxiety fulfill only one of the four MPSA indicators. Their difficulty in solving closed mathematical problems within the context of mathematics and open-ended mathematical problems in the context outside mathematics from a lack of understanding of the material. In addition, their failure in solving open-ended mathematical problems within the context of mathematics is due to not reading the problems carefully and not rechecking their work. Teachers can implement learning strategies by considering students' different levels of mathematical anxiety, namely by creating a pleasant learning environment, providing a choice of tasks that match the level of difficulty, providing additional guidance for students with high mathematical anxiety, thus supporting students to focus more on developing their MPSA. This research is limited in material scope; future research should expand it to explore students' MPSA in relation to mathematical anxiety further.

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