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Mathematical Problem-Solving Ability of Junior High School Students Based on Mathematical Resilience in the Pythagorean Theorem

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ABSTRACT

This study uses a qualitative descriptive method to categorize the level of mathematical problem solving based on mathematical resilience, namely high, medium, and low. The data collection technique used a problem-solving ability test on the Pythagorean theorem material and a mathematical resilience questionnaire. The sample of this research is the VIII grade students of SMP Negeri 39 Pekanbaru. This study's problem-solving ability category is based on the students' mathematical resilience ability in high and medium categories. The ability to solve mathematical problems of students with high mathematical resilience is better than those with moderate category resilience abilities. Based on the results of the research that has been done, the level of mathematical problem-solving ability of the students of SMP Negeri 39 Pekanbaru is still very low on the 1st question point, with a score of 6%. In the second question, students' ability to solve mathematical problems is classified as moderate, with a score of 55%. In the third question, students' ability to solve mathematical problems is very low, namely getting a score of 38%.

INTRODUCTION

Mathematics is a subject given to students from the lowest education level to tertiary institutions whose use is not only to teach arithmetic or quantitative, but mathematics is also useful in organizing ways of thinking and solving life problems faced. Mathematics is a universal science that underlies the development of modern technology, has an important role in various disciplines, and develops the power of human thought [1]. Rohmawati et al. in [2] stated that learning mathematics aims not only to focus on cognitive abilities, but students are also required to solve mathematical problems so that they can have a systematic, logical, and critical mindset when solving life problems they face. In addition, mathematics has a role in providing various abilities and attitudes humans need to live intelligently in their environment [3]. Veugelers and Groot [4] state that meaningful learning includes mathematics.

One of the goals of mathematics education is to improve the ability to solve mathematical problems because this can be said to be one of the essential abilities in the learning process. In Permendikbud Number 21 of 2016 regarding content standards, it is stated that mathematics education has a goal so that students have competencies which include reflecting a logical, critical, analytical, careful, and thorough attitude, having a sense of responsibility, being responsive, and never giving up to solve problems. Rahmawati [5] states that solving problems is a goal, especially in the process of learning mathematics, and is an important thing for students to have.

The ability to solve mathematical problems is basic and is important for students. Ahmad et al.

[6] stated that solving problems is the core of the teaching and learning process, which is the main ability in learning mathematics activities. Solving mathematical problems is one of the main goals of mathematics education. It is the core of the mathematics curriculum. It can be said that the process of solving problems and even the process of solving mathematical problems is the heart of mathematics [7]. The number of students who can solve mathematical problems will affect the success of learning mathematics at the school because the success of learning mathematics can be determined by the success of students in solving problems [8].

According to Polya in the article Rahmawati and Warmi [5], solving a problem is one of the efforts to immediately find a solution to a goal that is not easy. The term problem solving is also explained by Ruseffendi in [7] that something can be said to be a problem if it is something new for those who experience it and is in accordance with the circumstances and stages of mental development. So he has insight into the prerequisite knowledge on which to base it. According to Rambe and Afri [9], the ability to solve problems is students' ability to find solutions to complex and non-routine problems. So the, problem-solving ability is a basic ability that students have to find a solution or a way out of a newly discovered problem where he already knows a prerequisite before.

Polya suggested the steps to solve the problem into four parts: 1) identifying the problem, 2) planning a strategy, 3) implementing a strategy to solve the problem, and 4) rechecking the answers. Huang, Liu, & Chang stated that students could solve mathematical problems through correct arithmetic procedures [4]. In the mathematics education process, students are expected to be able to solve the mathematical problems they find, namely first by understanding the problem, because understanding the problem is part of the answer. Understanding the problem can be seen in the ability of students to include what is known and asked from the questions to be solved. After understanding the problem, students should be able to develop plans that are marked by the ability of students to make mathematical models and include formulas to solve them. The plan is then applied with mathematical calculations to solve the problems obtained. Finally, students are expected to be able to recheck the solutions of the problems that have been solved, marked by the students' ability to include conclusion answers in answering problems.

The ability to solve mathematical problems of students varies. This is based on several studies that have analyzed students' ability to solve mathematical problems. Rahmawati et al. [9] conducted research analyzing the ability to solve problems based on self-efficacy. The results of Rahmawati's study indicate that students have problems solving problems. In her research, students with moderate and low abilities cannot complete the test problem-solving mathematical problems given. The results of research by Nadhifa et al. in 2019 [10] categorized students' ability to solve mathematical problems at very good, good, poor, and very poor levels. Students with excellent problem-solving skills can solve problems with the polya stage correctly. Students with good problem-solving skills can solve problems but do not conclude the results obtained. Students with the ability to solve mathematical problems are less precise in planning and implementing plans. And students with very less difficult categories identify and work on problems and create mathematical models so that students cannot solve problems.

Research related to the analysis of mathematical problem-solving abilities was also carried out by Ramlan et al. [11], who analyzed students' mathematical problem-solving abilities based on self-confidence. The results of Ramlan et al.'s research found that students with high self-confidence category and high problem-solving ability could meet the four indicators of problem-solving ability. Meanwhile, students with low self-confidence and low problem-solving abilities, students cannot fulfil

the four indicators of problem-solving ability. Thus, it can be concluded that the higher the students' self-confidence, the more capable they are of solving problems. Conversely, the lower the student's self-confidence, the more difficult it will be for students to solve problems.

According to Jhonstin-Wilder & Lee in the article 'Athiyah et al. [12], students are required to work hard and never give up in the problem-solving process, so students need a diligent attitude and have the toughness to go through obstacles and difficulties in the mathematics learning process where this is called mathematical resilience. Still, in the article 'Athiyah in 2020 [12], according to Yeager & Dweck, resilience is a "tough" attitude to positive behaviours, attributions, and emotional reactions and has benefits for the development of academic and social challenges (e.g. trying to find new strategies, contributing more, as well as finding solutions to problems appropriately and wisely). So, it can be said to solve mathematical problems properly, it is necessary to have good mathematical resilience skills,

Maharani and Bernard [13] found that the ability of mathematical resilience can affect students' mathematical problem-solving. Based on Sumarmo's expression in the article by Asih et al. [14], resilience is a positive affirmation in dealing with feelings of anxiety and fear when facing obstacles and difficulties in the mathematics education process, some of which are working hard and being able to speak well, having self-confidence, and being diligent in learning. When faced with obstacles. Hendriana et al. stated that students have the potential to be able to handle problems in learning mathematics with resilience [7]. Based on Newman's opinion in a book written by Hendriana et al., resilience is an attitude in quality mathematics learning, which includes: trying hard for success with confidence, persevering in the face of difficulties, wanting to discuss, think, and research.

Maharani and Bernar researched the relationship between mathematical resilience and problem-solving skills in 2018. Maharani and Bernar's study analyzed students' difficulties in solving problems based on the category of resilience limited to circular material. The problem-solving indicators used by Maharani and Bernar are indicators according to Soemarmo. This study will analyze how students' problem-solving abilities are categorized based on mathematical resilience. Furthermore, this study analyzes students' problem-solving ability on the Pythagorean theorem material. The problem-solving ability indicator used in this study uses indicators according to the polya procedure.

Based on this description, the researcher is interested in analyzing the ability of junior high school students to solve mathematical problems in terms of resilience in the Pythagorean theorem material. First, the research will be conducted by providing a mathematical problem-solving ability test and a questionnaire to see resilience abilities. Then the ability to solve mathematical problems will be analyzed based on the category of student resilience.

METHODS

The application of the method in this research is the descriptive qualitative research method. In this type of research, the purpose of this research is to identify the situation and conditions in the field at the time of the research process. This research will be conducted on students of SMP 39 Pekanbaru class VIII. This study aims to analyze how SMP class VIII students' problem-solving ability in the Pythagorean theorem learning chapter is based on mathematical resilience. The accumulation of data in this study was carried out to determine the level of students' mathematical resilience and test techniques, namely by giving tests to samples that were arranged based on indicators of students' mathematical problem-solving abilities.

The indicator applied to determine the ability to solve problems in this study is the polya

indicator as in Syahril et al.'s article [15], namely understanding the problem, planning strategies, implementing strategies in solving problems, and interpreting the results of the answers. The scoring rubric used was adopted from the scoring rubric of Syahril et al. [15], which can be seen in the table below.

Table 1. Problem Solving Ability Scoring Guidelines

Indicator	Information	Score
Understanding the problem	Does not include what is known and asked	0
	includes what is known but does not include what is asked or vice versa	1
	Include what is known and asked but not quite right	2
	Include what is known and asked correctly	3
Planning strategy	Not writing a problem-solving strategy plan	0
	Write a problem-solving plan, but it's not right	1
	Write a problem-solving plan appropriately	2
Implementing strategies for solving problems	It does not include troubleshooting	0
	Include problem-solving, but not correct	1
	Include an inaccurate problem solving	2
	Write down the correct solution to the problem	3
Interpret answer results	Do not conclude the results obtained	0
	Include the conclusions obtained, but they are not accurate	1
	Include the conclusions obtained correctly	2

The mathematical resilience questionnaire instrument in this study was in the form of a questionnaire with a total of 36 items containing positive and negative statements where the indicators were based on Sumarmo's opinion, namely: (1) developing a diligent, confident/confident attitude, working hard and never giving up when faced with problems, failures, as well as uncertainty; (2) shows a desire to socialize, is not difficult to help, discuss with peers, and adapt to their environment; (3) generating innovations and finding creative solutions with challenges; (4) take advantage of the experience of failure in growing self-motivation; (5) being curious, reflecting, researching, and implementing various sources; and (6) have proficiency in the language, self-control, aware of what you are feeling. Therefore, the data from the mathematical resilience instrument will be divided into three groups: high, medium, and low.

As for classifying students' mathematical resilience abilities, it can be seen in the table below, which is modified from the table of mathematical resilience categories according to Sriffudin in Rahmatiya & Miatun's 2020 article [16].

Table 2. Criteria for Grouping Mathematical Resilience Ability

Mathematical Resilience Ability Criteria	Information
Resilience $\geq (M + 1SD)$	Tall
$(M - 1SD) \leq Resilience < (M + 1SD)$	Currently
Resilience $< (M - 1SD)$	Low

Information:

M : Mean ideal

SD : Standard deviation

The test instrument implemented in this study is the ability to solve mathematical problems which are adjusted based on indicators modified from indicators according to Soemarmo in Martin & Kadarisma's article [4], recognize known elements, develop mathematical models then formulate mathematical problems, implement strategies in the process of solving everyday problems, interpreting and explaining the results. To see the results of this problem-solving ability will be

categorized into the following categories.

Table 3. Criteria for Grouping Mathematical Problem Solving Ability

Score	Criteria
85 – 100	Very high
70 – 84.99	Tall
55 – 69.99	Currently
40 – 54.99	Low
0 – 39.99	Very low

RESULTS AND DISCUSSION

The mathematical resilience ability questionnaire was then categorized into high, medium, and low. The results of the categorization of resilience abilities found in this study can be seen in the table below.

Table 4. Category of Students' Mathematical Resilience Ability

Mathematical Resilience Ability Category	Many students
Hight	2
Currently	13

Table 4 is a table of student grouping based on mathematical resilience abilities. Based on table 4, we can see that the mathematical resilience ability of junior high school 39 Pekanbaru students in class VIII 2 is divided into the high category of 2 students, namely 13% and medium, as many as 13 students, namely 87%. In this study, there were no students with low mathematical resilience categories, so students' ability to solve mathematical problems was only analyzed based on two categories of mathematical resilience, namely high and medium mathematical resilience. The following are the results of students' mathematical problem-solving abilities on each question.

Table 5. Results of Mathematical Problem-Solving Skills

Question	Student Scores	Information
1	6%	Very low
2	55%	Currently
3	38%	Very low

Based on table 5, it is known that the level of students' ability to solve mathematical problems is still included in the very low category at the 1st question point. As seen in table 4, students get a score of 6%. In the second question, students' ability to solve mathematical problems is classified in the medium category; namely, students get a score of 55%. Finally, in the third question, students' ability to solve mathematical problems is very low, with a score obtained by students, namely 38%. The following are the results of students' mathematical problem-solving abilities based on the category of mathematical resilience.

Table 6. The Results of Students' Mathematical Problem-Solving Abilities Based on The Category of Mathematical Resilience

Question	Score Based on the Category Mathematical Resilience	
	Tall	Currently
1	10%	6%
2	90%	53%
3	65%	37%

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Students' Mathematical Problem Solving Ability on the First Problem

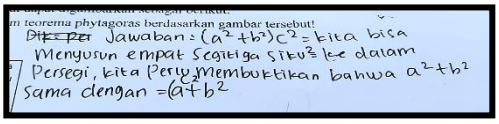

Figure 1. Answers to the First Question About High Resilience Students

After seeing students' answers to the first question, it can be seen that students do not understand the problem. As shown in Figure 1, students cannot include elements that are known and asked correctly. Students immediately write down answers; namely, students include a strategy for a solution plan that is almost correct, namely finding the formula for the Pythagorean theorem by calculating the area of a square composed of 4 right triangles. However, students did not continue the plan. As seen in the picture, students did not complete the solution to the first problem. Finally, the students did not include the conclusion of the answer. In this first problem, students with high mathematical resilience ability get a 10% mathematical problem-solving ability score with a very low category.

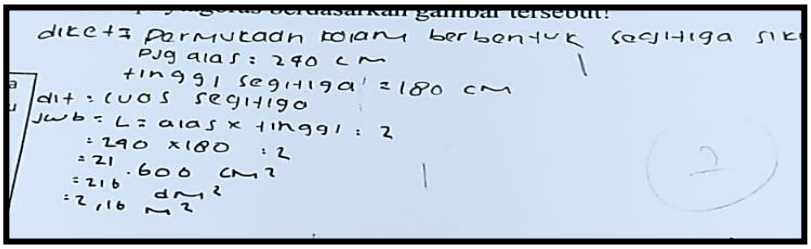

Figure 2. Answers to the First Question of Moderate Resilience Students

Figure 2 shows students' answers with moderate resilience ability categories on the first question. Based on Figure 2, it can be seen that students in the moderate resilience category get a very low mathematical problem solving ability score, which only gets 6%. This is because many students do not answer the questions. For example, some students answer the questions but do not understand the problem correctly, so the student answers are not in line with the questions asked. In addition, students include elements that are known and which are asked but are not correct. For example, they do not include a settlement plan. Students instead make answers by looking for the area of the triangle and do not make conclusions answer.

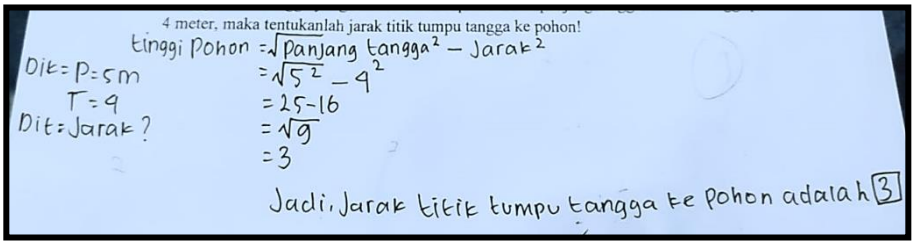

Figure 3. Answers of High Resilience Students to the Second Question

The answers of students with high resilience to the second question, as in Figure 3, are almost correct on all indicators. However, students are less precise in planning solutions to problems than are less precise when writing formulas. For example, it can be seen in the picture that the formulation of the quadratic formula is less precise. Students enter formulas that are known and known correctly. This shows that students understand the problems that exist in this second question. Students then perform mathematical calculations in applying problem-solving strategies, namely finding the distance from the fulcrum of the ladder to the tree. In the last indicator, students write the correct conclusion

of solving the problem. In the second problem, students with high mathematical resilience ability get a score of mathematical problem-solving ability in the very high category, namely 90%. Students have done the problem solving correctly, but students make errors in writing roots and do not include units for distance and height.

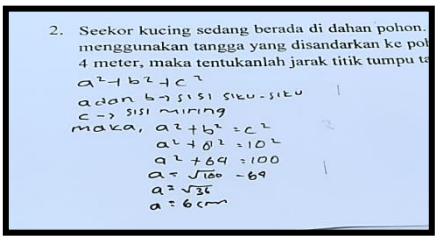

Figure 4. Resilience Students' Answers are the Second Question

Figure 4 shows one of the answers of students with moderate category resilience abilities on the second question. It can be seen in Figure 2 that students do not understand the problem well; namely, students do not include what is known and what is being asked from the question. Students write plans to solve problems, namely using the Pythagorean formula correctly. Still, because they don't understand the questions that can be seen from students, they don't include what is known and asked, students don't apply the solution plan correctly, and it looks like students get incorrect results based on the second question. Students also do not include conclusions. Students who have mathematical resilience ability in the medium category get a score of 53% in mathematical problem-solving ability in the low category.

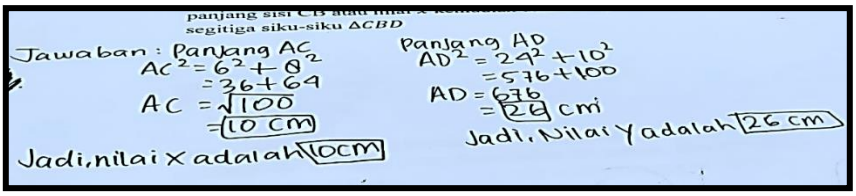

Figure 5. Answers of High Resilience Students to the Third Question

It can be seen that the results of the answers of students who have high category mathematical resilience abilities in Figure 5, students immediately write down the solutions to the problems in the third question and do not include what is known and asked from the questions, do not include problem-solving plans, namely not writing formulas to solve problems, students apply The problem-solving strategy uses the Pythagorean theorem correctly, but it is not accurate in answering the length of AD, namely not writing the square root of 2 at 676, and students include the conclusions of the results obtained correctly. At the point of the third question, students with high mathematical resilience got a problem-solving ability score of 65%, which is the medium category.

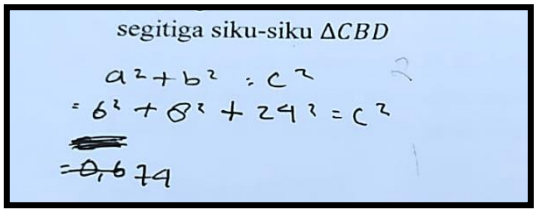

Figure 6. Resilience Students' Answers Are on the Third Question

The answers of students with moderate mathematical resilience abilities on the third question can be seen in Figure 6. Student answers in Figure 6 show that students do not understand the

problems contained in the third question; namely, they cannot solve the problem of solving mathematical problems incorrectly. Students do not write down what is known and asked. Still, students make plans for problem solutions, namely the Pythagorean Theorem formula, to answer the questions correctly, and students do not include the conclusions of the answers. Students with mathematical resilience ability in the medium category obtained a score for solving mathematical problems in the very low category, namely, 37%.

Based on table 4, it can be seen that the mathematical problem-solving ability of 39 Pekanbaru junior high school students with high category resilience abilities is better than the mathematical problem-solving abilities of students with moderate category resilience abilities. The answer scores for each question of students with high mathematical resilience are better when compared to the scores of students with mathematical problem-solving abilities who have moderate category resilience abilities. This proves that the abilities of students who have high category resilience abilities are better when compared to students who have moderate category resilience ability in solving mathematical problems. This is in line with research conducted by Rahmatiya and Miatun in 2020 [16], where both stated that students with high resilience could solve mathematical problems correctly according to the polya procedure, while students with moderate category resilience abilities were less able to achieve the steps correctly. And the process of solving mathematical problem-solving problems is arranged according to the polya procedure.

In this study, it can be found that in solving mathematical problems, students with high resilience are better able to solve problems according to polya indicators. Students with high resilience are also more precise in the calculation process in solving problems when compared to students with moderate resilience. Students with moderate resilience have not included the conclusions of answers, while students with high resilience in the second and third questions include the conclusions of answers from solving problems.

CONCLUSIONS AND SUGGESTIONS

Based on the results of the research that has been done, it can be concluded that the level of mathematical problem-solving ability of the students of SMP Negeri 39 Pekanbaru is still very low on the 1st question point, with a score of 6%. In the second question, students' ability to solve mathematical problems is classified as moderate, with a score of 55%. Finally, in the third question, students' ability to solve mathematical problems is very low, namely getting a score of 38%.

The ability to solve mathematical problems of students with the category of high mathematical resilience ability is better than those with moderate resilience abilities. For example, in the first question, students with high mathematical resilience ability got a score of 10% mathematical problem-solving ability in a very low category. In contrast, students with moderate resilience got a very low mathematical problem-solving ability score, which was only 6%. In the second question, students with high mathematical resilience obtained a score of mathematical problem-solving in the very high category, namely 90%, while students with moderate mathematical resilience ability obtained a score of 53% in the low category of mathematical problem-solving ability. Finally, at the point of the third question, students with high mathematical resilience abilities obtained a 65% problem-solving ability score, namely in the medium category. In contrast, students with moderate mathematical resilience abilities obtained a score of mathematical problem-solving ability with a very low category, namely 37%.

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