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ANALYSIS OF STUDENTS' CRITICAL THINKING SKILLS BASED ON MATHEMATICAL RESILIENCE

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Abstract

The purpose of this study is to determine whether students are able to think critically based on their mathematical resilience. This study is a qualitative study using a descriptive method. The study was conducted at SMPIT Nurul Islam Tengaran, Semarang Regency, Central Java, during the 2024/2025 academic year. The research subjects were 29 eighth-grade students. The data collection techniques used were a mathematical resilience questionnaire, a critical thinking test, and interviews. The questionnaire was used to identify the mathematical resilience groups. A written essay test was used to assess students' critical thinking abilities. Interviews were conducted based on high, medium, and low mathematical resilience groups. Two students with dominant critical thinking abilities were selected from each group. There were two students in the high mathematical resilience group, two students in the medium mathematical resilience group, and two students in the low mathematical resilience group. The results of the questionnaire, written test, and interviews revealed that (1) students in the high and moderate mathematical resilience groups had five well-developed and comprehensive skills in interpretation, analysis, inference, evaluation, and explanation; (2) students in the low mathematical resilience group only had two well-developed and comprehensive critical thinking skills in interpretation and analysis. Findings show that mathematical resilience has an impact on critical thinking skills.

Keywords: mathematics, critical thinking, mathematical resilience

Abstrak

Tujuan dari penelitian ini adalah untuk mengetahui apakah siswa mampu untuk berpikir kritis berdasarkan mathematical resilience yang dimilikinya. Penelitian ini merupakan jenis penelitian kualitatif dengan metode deskriptif. Penelitian dilaksanakan di SMPIT Nurul Islam Tengaran, Kabupaten Semarang, Jawa Tengah pada tahun ajaran 2024/2025. Subjek penelitian adalah siswa kelas 8 sebanyak 29 siswa. Teknik pengumpulan data yang digunakan adalah angket mathematical resilience, tes berpikir kritis, dan wawancara. Angket digunakan untuk mengetahui kelompok mathematical resilience. Tes tertulis berbentuk uraian digunakan untuk mengetahui kemampuan berpikir kritis siswa. Wawancara dilakukan berdasarkan kelompok mathematical resilience tinggi, sedang, dan rendah. Setiap kelompok dipilih 2 siswa dengan kemampuan berpikir kritis yang dominan pada masing-masing kelompok. Siswa pada kelompok mathematical resilience tinggi sebanyak 2 orang, siswa pada kelompok mathematical resilience sedang sebanyak 2 orang, dan siswa pada kelompok mathematical resilience rendah sebanyak 2 orang. Hasil angket, tes tertulis, dan wawancara didapatkan (1) siswa pada kelompok mathematical resilience tinggi dan sedang memiliki 5 kemampuan yang baik dan lengkap pada keterampilan interpretasi, analisis, inferensi, evaluasi, dan penjelasan; (2) siswa pada kelompok mathematical resilience rendah hanya memiliki 2 keterampilan berpikir kritis yang baik dan lengkap pada keterampilan interpretasi dan analisis. Temuan penelitian yaitu mathematical resilience memiliki pengaruh terhadap kemampuan berpikir kritis.

Kata kunci: matematika, berpikir kritis, resiliensi matematis

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INTRODUCTION

Critical thinking by careful analysis and consideration. (Kain et al., 2024) also argue that the abilities needed is a high-level skill that students need to prepare for the challenges of 21st century life. Students need to have critical thinking skills because critical thinking is a defense mechanism for them in processing all kinds of information. However, each individual must have different abilities (Wesna et al., 2021). According to Johnson E, students with critical thinking skills tend to be able to learn new things in a structured manner, face challenges systematically, formulate innovative questions, and devise new and original solutions (Zakiyah, 2019). In addition to this, students who have critical thinking skills have an understanding of mathematical concepts, implement the knowledge they have in everyday life, are able to communicate, good cooperation in groups (Fazryn et al., 2023; Nugraheni et al., 2022), think rationally in solving problems , because Critical thinking requires deep evaluation and analysis, not just accepting information without any thought (Sumarni & Kadarwati, 2020).

Critical thinking is a personal skill in understanding difficult problems, can connect one information with other information to form a deep understanding, solve a problem, critical thinking can also be defined as the ability to reason through a problem so that it is easier to understand, reveal various facts in the field, compile information that has been obtained, can solve various problems that look easy (Ariza et.al, 2021). Bailin in Zakiyah (2019) defines critical thinking as a high-quality thinking process that is consistent with standards of accuracy and precision.

Critical thinking can be interpreted as a person's expertise in choosing a difficult choice, the ability to reason, reveal facts, analyze problems so that they are easy to understand, understand interconnections between systems, and can solve problems appropriately (Agry et al., 2023). Meanwhile, this critical thinking ability is needed in learning mathematics (Sulistiani et al., 2018). Students' critical thinking skills can be identified based on the specified criteria. Facione in Seventika et al. (2018) mentions, among others: interpretation, analysis, evaluation, inference, explanation, and self-regulation.

The Program for International Assessment (PISA) is a test conducted for 15-year-old students. It explores knowledge and skills in problem solving, critical thinking, and

communication in math, reading, and science. 18% of students in Indonesia reached at least level 2 in math, much lower than the average across OECD countries (OECD average: 69%). At the very least, these students can interpret and recognize without direct instruction how a simple instruction can be presented mathematically. More than 85% of students in Singapore, Macau (China), Japan, Hong Kong (China), Chinese Taipei and Estonia (in descending order of percentage) were at this level or above. Almost no students in Indonesia reached level 5 or 6 (top performing students) in the PISA math test (PISA, 2023).

As a basic science, mathematics is a key element in strengthening science and technology (Suparni et al., 2021). Ristanti & Murdiyani in Virdinarti Putra et al. (2024) mentions this, saying that math is seen as a science that deals precise knowledge that has been systematically arranged, including rules, ideas, logical reasoning, and logical structures. Mathematics teaches students to think systematically and logically. This is similar to the opinion of (Apriliyani & Murtiyasa, 2024), who say that mathematics encourages the development of analytical, logical, and critical thinking skills. The internal conditions of students and their environment contribute to the quality of learning. The intra-personal condition that makes a difference to how well students learn math is their mathematical resilience. Most students still find mathematics to be one of the most challenging subjects, tend to avoid math, and tend to have a negative attitude towards math. So, teachers need to foster a positive attitude towards mathematics. According to Rahmawati (2019), the positive attitudes needed include learning independence, self-confidence, self-efficacy, self-concept scale, and a sense of perseverance and resilience in facing the difficulties of learning mathematics (Mathematical resilience). Resilience is a concept to describe the phenomenon of a person avoiding negative consequences and succeeding despite facing significant difficulties (Lee, 2017).

Mathematical resilience is needed so that students are able to deal with feelings of helplessness and anxiety in mathematics class. Good mathematical resilience will more easily rise when facing difficulties, creative in finding solutions, and able to master themselves in difficult situations. Students with mathematical resilience are characterized by their ability to tackle any new problem they encounter, the willingness to try to develop fluency, and the ability to gather the support needed to increase mathematical growth (Lee, 2017). This

resilience is needed with the aim that students easily rise from adversity and master themselves to get through difficult situations (Suparni et al., 2021). Resilient students are those who have the ability to adapt to new environment and overcome challenges. They are also able to maintain their motivation and focus on their goals, even when faced with obstacles. This study found that students with high mathematical resilience were able to adapt to new situations and overcome challenges, while those with low mathematical resilience were unable to do so (Nuraini et al., 2023). Rahmawati (2019; Wahidah et al., 2022) revealed that students' resilience abilities gave a positive response to mathematics learning.

Resilience in addressing problems is needed in solving math problems. Those with high mathematical resilience will possess good critical thinking skills. Research conducted by Wahidah et al. (2022) states that students with high and moderate resilience are able to meet critical thinking indicators, including interpretation and analysis in the good category. A study by Rifdah & Cahya (2020) states that there is a significant relationship on mathematical resilience towards improving critical thinking skills. Ridlo & Rukmigarsari (2021) mentions a significant relationship on mathematical resilience towards improving critical thinking skills.

Challenges and difficulties in dealing with math problems are normal and can be experienced by anyone. However, it must be believed that mathematics can be learned by anyone. So this can be used as a motivation to create an environment that can help students develop mathematical resilience and critical thinking skills. Thus, it is necessary to investigation into students' critical thinking based in mathematical resilience in grade 8 junior high school students.

METHODS

The study design is qualitative with a descriptive method, which describes students' critical thinking skills based on mathematical resilience. The subjects of this study were students of class 8F SMPIT Nurul Islam Tengaran second semester of the 2024/2025 school year consisting of 29 students.

The data collection techniques used in this study were questionnaires, tests, and interviews. The questionnaire instrument was used to determine the mathematical resilience of the research subjects. Students are classified based on mathematical resilience categories,

namely high, medium, and low. Grouping students' mathematical resilience into three categories is done by adding up all the scores (X) on the students' mathematical resilience questionnaire intoX , determining the average value (X) and standard deviation (SD), then determining the group boundaries as in Table 1.

Table 1. Mathematical Resilience Categorization Group Limits

Criteria	Score	Category
$X \geq (\overline{X} + SD)$	X	High
$(\overline{X} - SD) \leq X < (\overline{X} + SD)$	X	Medium
$X < (\overline{X} - SD)$	X	Low

(Arikunto, 2013)

The test instrument is in the form of 1 critical thinking question. Indicators of critical thinking questions will be adjusted to the Pythagorean Theorem and critical thinking indicators include: (1) interpretation, (2) analysis, (3) evaluation, (4) inference, and (5) explanation.

Table 2. Critical Thinking Skills in this Study

No	Skills	Description in Research
1	Interpretation	Understand and explain the significance of given data.
2	Analysis	Identifying relationships between statements, questions, concepts, descriptions or other forms of representation referred to in giving reasons or opinions.
3	Inference	Identifying the information needed to draw a reasonable conclusion.
4	Evaluation	Assess the credibility of statements that constitute explanations and to judge the logical force of statements, questions, descriptions, or other forms of representation.
5	Explanation	Stating results and presenting explanations with strong arguments.

After the students did the test, the researcher assessed the students' results then conducted an interview. Interviews were conducted to confirm the results of students' critical thinking tests.

RESULTS AND DISCUSSION

The research conducted began with filling out a mathematical resilience questionnaire. The mathematical resilience questionnaire consists of 21 positive questions and 19 negative questions. The answer options include very appropriate, appropriate, undecided, inappropriate, and very inappropriate. The minimum score of the questionnaire is 54 and the maximum score of the questionnaire is 85.5. The following is a table of the results of the

calculation of the mean, standard deviation of scores, and the results of the student mathematical resilience questionnaire.

Table 3. Categories of Mathematical Resilience

Grouping Criteria	Students	Frequency	Percentage	Category
Student Score ≥74	S03, S05, S15, S02, S23, S29	6 students	20,68%	High
60≤ Student Score <74	S01, S04, S06, S07, S08, S09, S12, S14, S16, S17, S18, S19, S20, S21, S22, S24, S25, S26, S28, S10	20 students	68,96%	Medium
Student Score <60	S11, S13, S27	3 students	10,34%	Low
Total		29 students	100%	

The table above presents the results of the mathematical resilience questionnaire of students in class 8F SMPIT Nurul Islam Tengaran. The highest results were obtained by students with moderate mathematical resilience, totaling 20 students (68.96%), and the lowest results were obtained by students with low mathematical resilience, totaling 3 students (10.34%).

After students work on the mathematical resilience questionnaire, students then continue working on critical thinking questions. The thinking problem consists of 1 description question which is adjusted to the material that has been studied, namely the Pythagorean theorem and adjusted to critical thinking skills. On critical thinking questions, the highest and lowest scores were obtained.

Based on these results, analysis and interviews were conducted by selecting 2 students with dominant critical thinking skills in each category of high, medium, and low mathematical resilience. So that 2 students with high mathematical resilience category, 2 students with medium mathematical resilience category, and 2 students with low mathematical resilience category were selected. The following is a description of the results of student work from each category.

1. Students' Critical Thinking Ability in View of High Mathematical Resilience

   a. Student S03

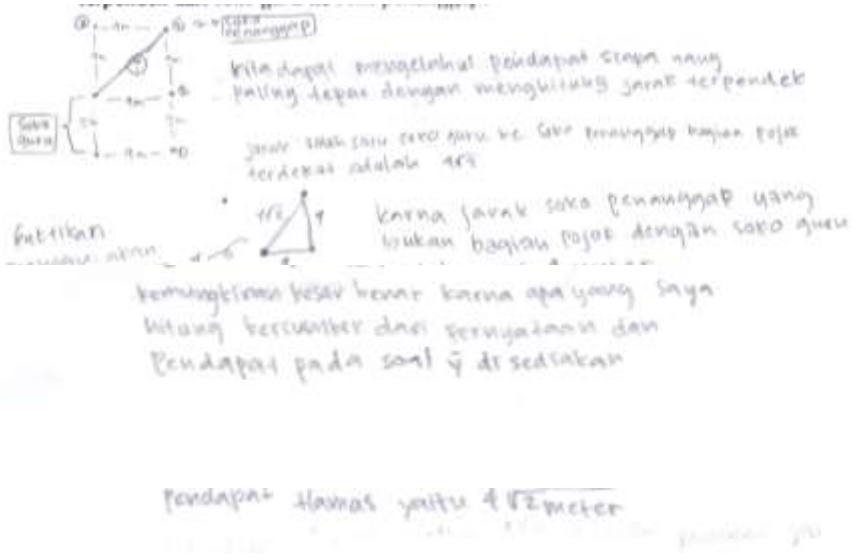

Figure1.

Student S03's Answer

The figure 1 above is the answer of student S03 with high mathematical resilience category. Students are able to interpret the problem in their own language, analyze the relationship between statements and statements by describing the distance with points then forming a right triangle to find out the distance. In inference skills, students identify information that makes sense by writing the length of the known sides of the triangle, namely the distance from the teacher's pillar to the nearest respondent's pillar is 4m. In evaluation skills, students calculate using the ratio of the length of the sides of a right triangle with angle 45^0which is 1:1:2 , so that the distance from the teacher's pillar to the nearest corner pillar is42 m. Students state results and present explanations with strong arguments to justify that Hamas' opinion about the distance from the teacher's pillar to the nearest corner pillar is correct. Student S03 was able to complete all critical thinking skills completely. The explanation and calculation results are correct.

b. Student S05

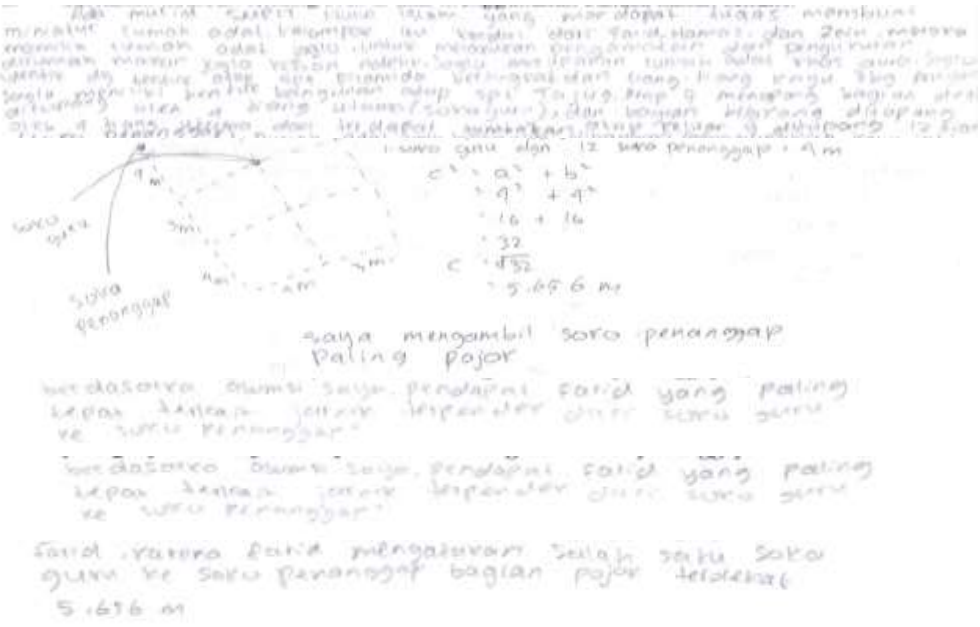

Figure 2. Student S05's Answer

Student S05 is a student with high mathematical resilience category. Students can interpret the problem in their own language. In the analysis skill, students identified the relationship between the question and the statement by describing the location of the teacher's pillar and the respondent's pillar with dots and then connecting the dots to form a right triangle. The distance from the teacher's pillar to the corner pillar is the hypotenuse of the triangle, so they can use the Pythagorean theorem to solve it. In the inference skill, students identify the necessary information by writing down the distance from the teacher's pillar to the nearest responding pillar. In the evaluation stage, students use the Pythagorean theorem to find the distance from the teacher's pillar to the nearest corner pillar and obtain the result of 5.656 m. In the explanation skill, students provide strong and precise arguments, namely Farid's opinion. Student S05 can complete all critical thinking skills completely and precisely. Calculations and explanations are done correctly.

2. Critical Thinking Ability of Students Based on Medium Mathematical Resilience

a. Student S06

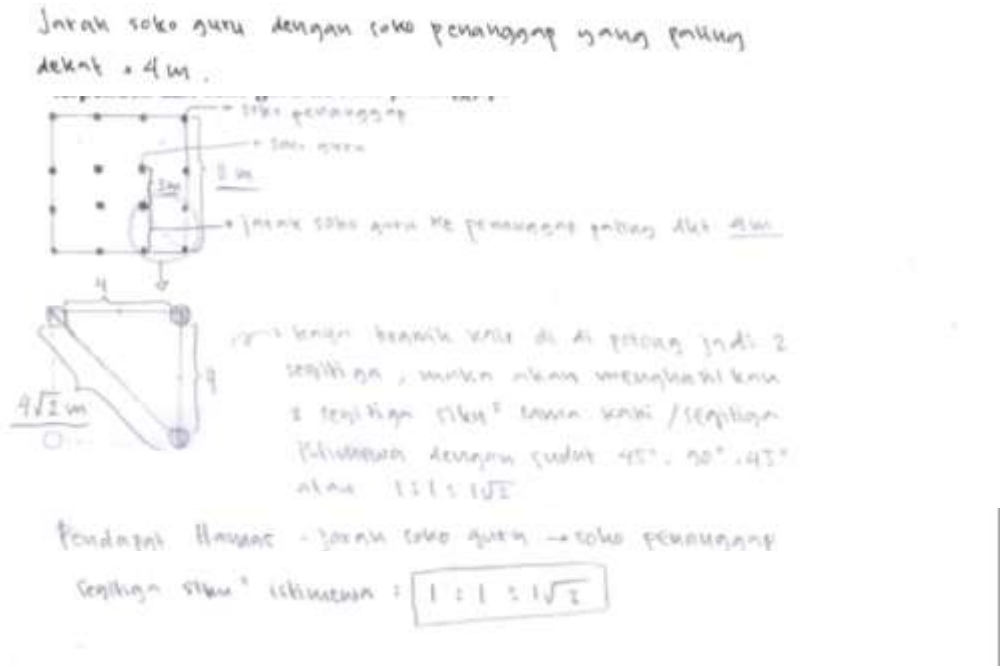

Figure 3. Student S06's Answer

Student S06 is a category of students with moderate mathematical resilience. Students interpret the problem by retelling it using their own language. In analysis skills, students describe the location of the teacher's pillar to the respondent's pillar using dots and connect the points to form a right triangle. In inference skills, students write down the distance from the teacher's pillar to the responding pillar to calculate the distance from the teacher's pillar to the nearest corner. Students see that the right triangle formed is an isosceles right triangle, with two angles of 45^0. In evaluation skills, students use the comparison of the sides in a right triangle with an angle of 45^0, which is $1:1:\sqrt{2}$ so that the value $4\sqrt{2}$ is obtained. In the explanation skill, students state the result, namely the closest distance $4\sqrt{2}$ m and Hamas' opinion is correct.

b. Student S28

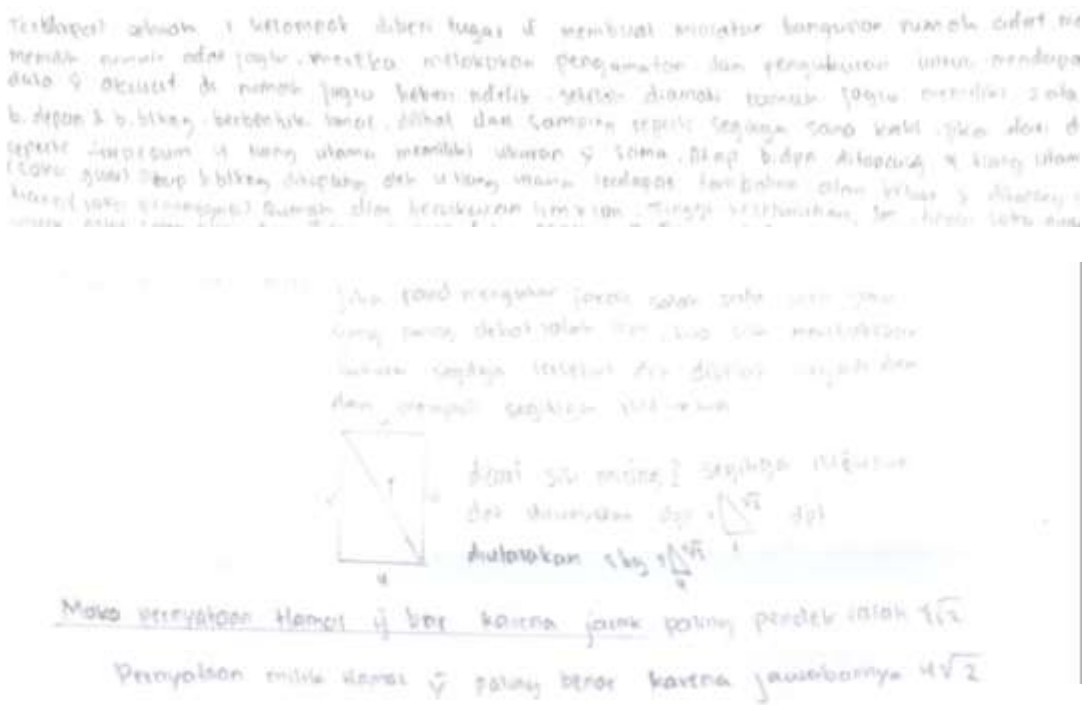

Figure 4. Student S28's Answer

Student S28 is a student with moderate mathematical resilience category. Students interpret the problem by retelling it in their own language. In analysis skills, students identify the relationship between statements and questions by describing the location of the teacher's pillar to the respondent's pillar with dots then connecting the points to form a right triangle. According to the students, the triangle formed is an isosceles right triangle with two angles of 45^0. In the inference skill, students write the distance from the teacher's pillar to the respondent's pillar and the ratio of the sides of an isosceles right triangle is $1: 1: \sqrt{2}$. Looking at the comparison, it is obtained that the hypotenuse is $4\sqrt{2}$. In the explanation skill, students explain that Hamas' opinion is correct because the distance from the teacher's pillar to the nearest corner is $4\sqrt{2}$ m.

3. Students' Critical Thinking Ability in View of Low Mathematical Resilience

a. Student S11

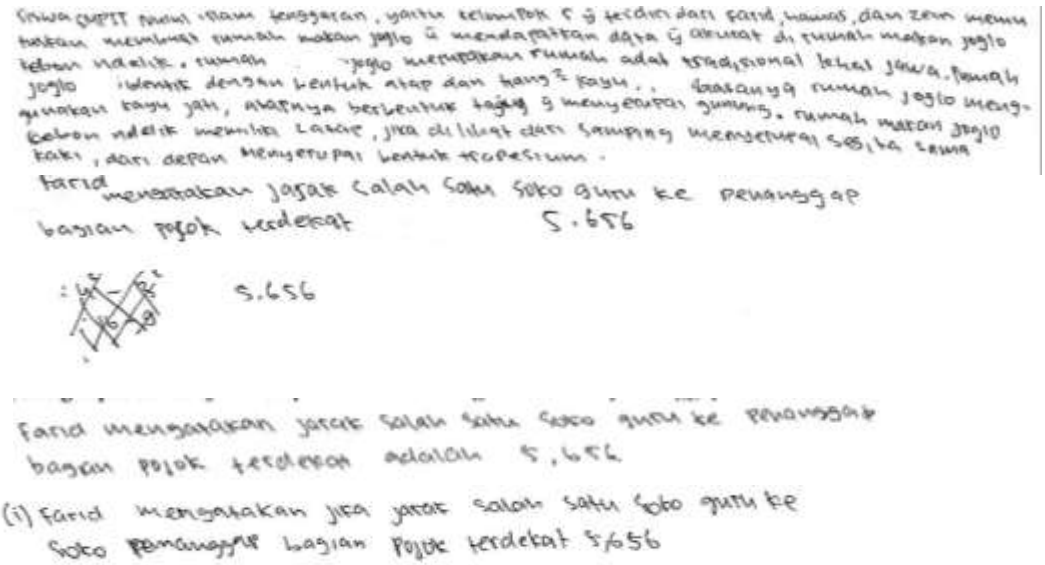

Figure 5. Student S11's Answer

Student S11 with low mathematical resilience category is able to interpret/understand the meaning contained in the problem. Students retell the problem in their own language completely. In analysis skills, students rewrite the statements contained in the problem. Students identify the relationship between questions and statements, but incomplete. In inference skill, students identify information, but incomplete. Students cannot point out the exact facts used to assess the credibility of the statement. The explanation presented by the student is not accompanied by a strong argument.

b. Student S27

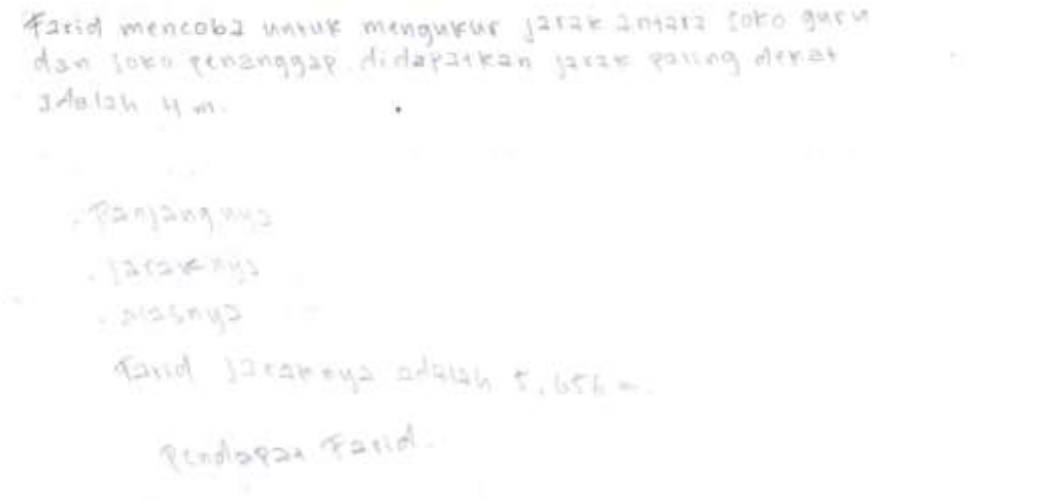

Figure 6. Student Answer S27

Student S27 with low mathematical resilience category interprets by telling the problem in their own language. In analysis skills, students identify the relationship between statements and questions by drawing isosceles triangles, and using the Pythagorean theorem. In inference skills, students identify information by writing the lengths of the known sides and calculating them using the Pythagorean theorem. However, the calculations made by students are not correct. So that in evaluation skills, students cannot assess the credibility of logical statements. In the explanation skill, they cannot present the results and explanations with strong arguments.

Based on the research findings described above, it can be seen that this study discusses the relationship between mathematical resilience and students' critical thinking skills. Students with high and medium mathematical resilience categories are able to complete all critical thinking skills. This is in accordance with the results of research by Wahidah et al. (2022) also mentioned from their research that students with high and moderate resilience were able to fulfill critical thinking indicators including interpretation, analysis in the good category. Students are able to interpret by rewriting the problem using their own language. In analysis skills, students identify the relationship between statements and questions in providing reasons or opinions. In inference skills, students are able to identify the information needed to draw reasonable conclusions. In evaluation skills, students assess the credibility and logical strength of statements and questions. In explanation skills, students are able to present explanations with strong arguments. Whereas in students with low mathematical resilience category, students are only able to interpret the problem in their own language and conduct analysis by identifying the relationship between statements and questions. Inference, evaluation, and explanation skills are not performed by students. Students cannot identify the information needed, cannot assess the credibility of statements, and cannot present explanations with strong arguments. This is in line with research conducted by Rifdah & Cahya (2020) which states that there is a significant relationship between mathematical resilience and improved critical thinking skills. This finding is also in accordance with the research findings of Ridlo & Rukmigarsari (2021) who found that there is an influence between mathematical resilience and students' critical thinking skills.

CONCLUSION

Based on the findings of the research and discussion, researchers can conclude that the critical thinking skills of learners with high and intermediate mathematical resilience are better than those of learners with lower mathematical resilience. Students in the high and intermediate mathematical resilience categories possess strong and comprehensive skills in interpretation, analysis, inference, evaluation, and explanation. Meanwhile, students in the low category have strong and comprehensive skills in interpretation and analysis. This indicates that mathematical resilience has an impact on critical thinking skills

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