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ANALYSIS OF MATHEMATICAL REASONING ABILITY BASED ON MATHEMATICS ANXIETY IN JUNIOR HIGH SCHOOL STUDENTS

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ABSTRACT

Mathematical reasoning ability is one of the abilities that students must master. Influencing factors include math anxiety. This study analyzes and describes mathematical reasoning ability based on mathematics anxiety in junior high school students. The type of research conducted is descriptive qualitative research. This research was conducted at UPT SMP Negeri 17 Gresik class VII B with three students as research subjects for three categories of mathematical anxiety: high, medium, and low. Research data was obtained from mathematics anxiety questionnaires, reasoning ability tests, and interviews. Based on the results of the analysis, it was found that students with low levels of mathematical anxiety could fulfill all indicators of mathematical anxiety, and students with moderate levels of mathematical anxiety fulfilled three indicators of mathematical reasoning, namely making conjectures, manipulating mathematics, and determining patterns or properties of mathematical phenomena. Learners with high levels of mathematical anxiety only fulfill one indicator of mathematical anxiety, namely, making conjectures. From the results of the study, it can be concluded that the higher the students' mathematical anxiety, the lower their mathematical reasoning ability, so it is recommended that educators and students pay attention to mathematical anxiety in learning to improve their mathematical reasoning ability.
Keywords: Mathematical Reasoning, Math Anxiety, Junior High School Students

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PRELIMINARY

In mathematics, there is a mathematical reasoning ability that is included in one of the five process standards that must be owned and mastered by students in learning mathematics; this is revealed by the National Council of Teachers of Mathematics (NCTM) (2000) (Bernard, 2015). According to Bambang and Rusdi, the importance of mathematical reasoning ability is a foundation for obtaining or constructing mathematical knowledge. Teachers in mathematics learning must develop mathematical reasoning skills in primary and secondary schools (Riyanto & Siroj, 2011).

Reasoning skills are essential for everyday life and mathematics. Reasoning, according to Keraf (Shadiq, 2004) is a process of thinking that leads to a conclusion with

an attempt to connect known facts. There are indicators to measure the extent to which mathematical reasoning ability has been achieved in the learning process. The following are indicators of mathematical reasoning proposed by (Sholihah, 2022). 1) Ability to make conjectures, 2) Ability to perform mathematical manipulations, 3) Ability to determine patterns or properties of mathematical phenomena, 4) Ability to compile evidence or reasons for several solutions, 5) Ability to draw conclusions or make generalizations.

In Indonesia, mathematical reasoning skills are low at the international level. In the PISA international survey conducted by the OECD Institute in 2018, Indonesia ranked 73 out of 78 participants in the field of mathematics (Hadi, 2016). Sumartini argued that mathematical reasoning ability can help students build ideas to solve problems in mathematics and prove and conclude a question (Sumartini, 2015). learners who foster thinking with reasoning skills will be successful in learning mathematics (Hasna et al., 2023).

Low reasoning ability must be overcome by knowing the factors that cause it. Many factors affect the low mathematical reasoning ability of students, one of which is the psychological side, namely the anxiety experienced by students when learning mathematics, called mathematical anxiety (Sudarti et al., 2020). Most mathematics still needs to be considered a difficult and tedious lesson by students, an obstacle during mathematics learning activities. There are indicators of math anxiety, according to Suharyadi (Sholichah & Aini, 2022) namely, the cognitive aspect contains indicators of self-ability, self-confidence, difficulty concentrating, and fear of failure. Affective aspects contain indicators of nervousness, lack of pleasure, and anxiety. The physiological aspect contains nausea, cold sweats, palpitations, and headaches. Negative perceptions, thoughts, or anxiety about learning mathematics are known as mathematical anxiety (Wahyuni, 2021).

Depression and anxiety recorded an increase in Indonesia (Khoiriyah & Handayani, 2020). Mathematical anxiety experienced by students is that they become unfocused during learning, making it difficult for students to accept and understand learning related to mathematical concepts the teacher conveys (Hakim & Adirakasiwi, 2021). According to Richardson and Suinn, mathematical anxiety is a feeling of pressure and anxiety that can interfere with manipulating numbers and solving mathematical problems in academic or everyday life (Disai et al., 2018). Irfan explained that mathematical anxiety can occur whenever someone has a negative view or thought about learning mathematics or anything related to mathematical activities (Irfan, 2018). Math anxiety can limit their understanding

of math and make them avoid it (Maghfiroh & Pradipta, 2023). Therefore, mathematics anxiety experienced by students must be overcome by teaching and learning strategies by educators (Zakaria et al., 2012).

Many previous studies have explained the effect of math anxiety on mathematical reasoning ability. Research conducted by Sudarti, et al (2020) found that when students' mathematical anxiety while learning increases, the mathematical reasoning ability of students will decrease. In line with that, research conducted by Wa Ode Fatimah, et al (2021) states that the correlation coefficient between mathematics anxiety and mathematical reasoning ability in students is negative. This means that the higher the mathematical anxiety experienced by students, the lower their mathematical reasoning ability. Meanwhile, in this study, researchers analysed using qualitative methods with the subject of students in class VII at UPT SMPN 17 Gresik.

Based on research that reveals that students' mathematical reasoning ability in Indonesia is still low, the researcher aims to describe students' mathematical reasoning ability based on low, medium, and high levels of mathematics anxiety. The benefit of this research is that it can be used to increase knowledge and contribute thoughts about students' mathematical reasoning ability based on mathematics anxiety. In addition, students can provide input or motivation to improve mathematical reasoning ability and be a positive suggestion in learning.

METHODS

The type of research used in this research is descriptive qualitative research. The qualitative approach according to (Sugiyono, 2013) descriptive qualitative research is research used to study subjects in accordance with the actual circumstances using the philosophical basis of postpositivism. this research is presented in narrative form so that it can better understand the situation experienced by the actual subject in his mathematical reasoning ability based on the mathematical anxiety experienced. The purpose of this qualitative research is to analyse and describe mathematical reasoning ability based on mathematics anxiety of junior high school students.

This research was conducted at UPT SMP Negeri 17 Gresik in the 2023/2024 school year. The population in this study were students in class VII B, as many as 26 students. The research population filled out the math anxiety questionnaire given. The results of filling out the questionnaire show that students are classified into three criteria, namely high, medium, and low math anxiety. One learner takes each criterion with a

purposive sampling technique to determine the research subject. The three subjects were given mathematical reasoning tests two times at different times, and interviews were also conducted to obtain additional data.

The mathematics anxiety questionnaire contains 15 statements that support mathematics anxiety and 13 statements that do not support mathematics anxiety. This questionnaire is an adaptation of (Sholichah & Aini, 2022). The results of the mathematics anxiety questionnaire in class VII B UPT SMPN 17 Gresik showed that there were 6 students (23.08%) with high mathematics anxiety category, 15 students (57.69%) with moderate mathematics anxiety category, and 5 students (19.23%) with low mathematics anxiety category. These results were obtained from the criteria for the level of mathematics anxiety in Table 1 (Sholichah & Aini, 2022).

Table 1. Criteria Level Math Anxiety

Score Intervals	Criteria
$x < \bar{x} - 1.SD$	Low
$\bar{x} - 1.SD \leq x < \bar{x} + 1.SD$	Medium
$\bar{x} + 1.SD \leq x$	High

This research uses a type of triangulation, namely time triangulation. Triangulation is a way of obtaining data that is truly valid by using a dual method approach. Data validity test with time triangulation is done by collecting data at different times. The data in question is a mathematical reasoning ability test which is carried out at least twice at different times. The questions given between test 1 and test 2 are different, but have the same content and number of questions. Semi-structured interviews were also conducted with the research subjects to obtain additional data. The reasoning ability test and interview were given to three students with different anxiety categories who had been selected using purposive sampling technique. Both instruments were validated by two validators, namely, a lecturer in mathematics education at Universitas Muhammadiyah Gresik and a mathematics teacher at UPT SMP Negeri 17 Gresik.

RESULT AND DISCUSSION

For subjects with low mathematical anxiety (S1) in the first indicator of conjecture, the subject can write known and asked questions in the given problem. The subject wrote the information in the form of sentences. In the known subject, it is only written that the

length is known as two times the width. However, the subject needed to write how much width was known in the problem. Figure 1 is the result of S1's work on the first indicator.

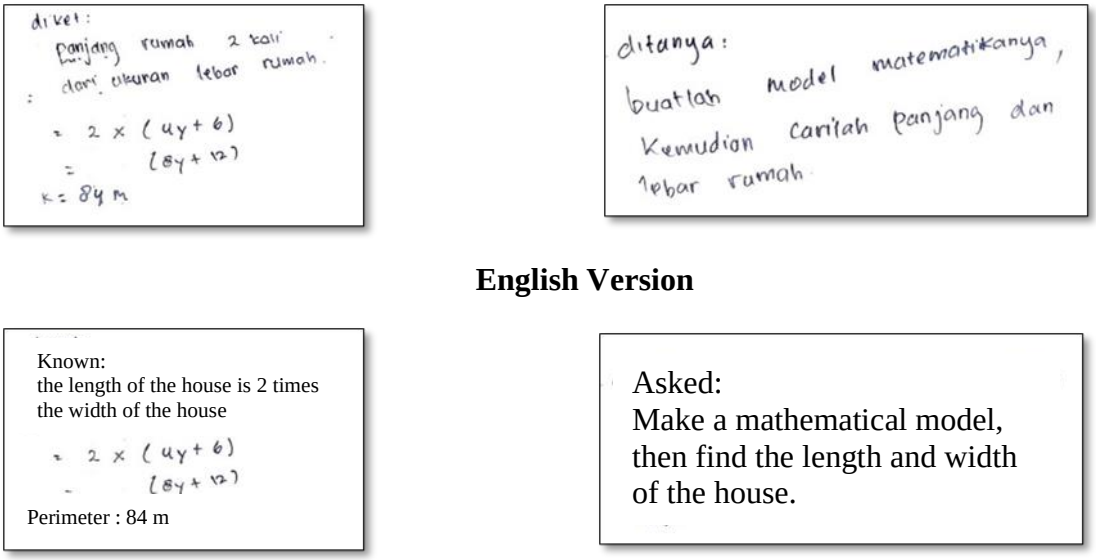


Figure 1. S1's Work on The First Indicator

The following interview results reinforce this.

P : What information did you get from the question?

S1: It is known that the length is 2 times the width of the house and the circumference is 84 meters.

P : Already? What is known is only that.

S1: Oh, this is the same width

P : How much is the width known?

S1: this is 4y + 6

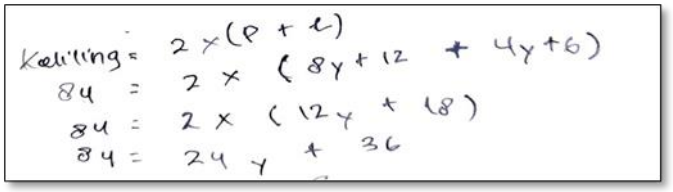
P : This is directly multiplied by 2 to find the length?

S1 : Yes

P : What is being asked?

S1 : Mathematical model, width and length

In the mathematical manipulation indicator, the subject can write mathematical manipulations well. The subject wrote the formula for the perimeter of the rectangle correctly. The subject substituted the length, width, and perimeter values into the formula for the perimeter of a rectangle. The subject can also operate the education as in Figure 2 below.



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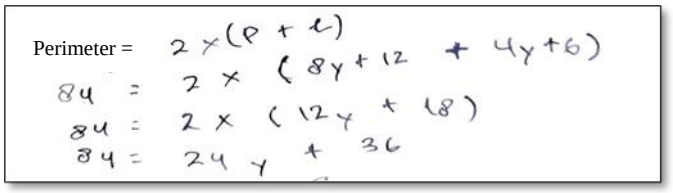


Figure 2. S1's Work on The Second Indicator

The following is a transcript of the interview conducted by the researcher with the subject of strengthening the results of these answers.

P : How do you change the story problem into math form?

S1: The length and width are asked, and the perimeter is also known, so I use the formula for the perimeter of a rectangle.

P : So what do you do after writing the perimeter formula?

S1 : Inputting what is known, right earlier there was the circumference of the length and width.

P : After you input it, what do you do?

S1 : Then the one in parentheses is added 8y and 4y and 12 and 6 so 12y + 18 and then multiplied by 2.

The third indicator is determining patterns or properties of mathematical phenomena. The subject can write the steps in finding the value of Y, starting from reducing the two segments by 36 and dividing the two segments by 24. The subject can operate the equation correctly to find the value of Y which is 2. The results of the subject's work are presented in Figure 3.

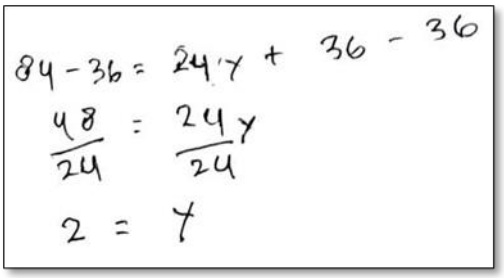


Figure 3. S1's Work on The Third Indicator

The following interview results reinforce this.

P : After you calculate the one in the brackets and multiply by 2, what is the next step?

S1 : Find the y, right? This is in 24 y, so we omit the 36.

P : How do you do that?

S1 : Subtract 36

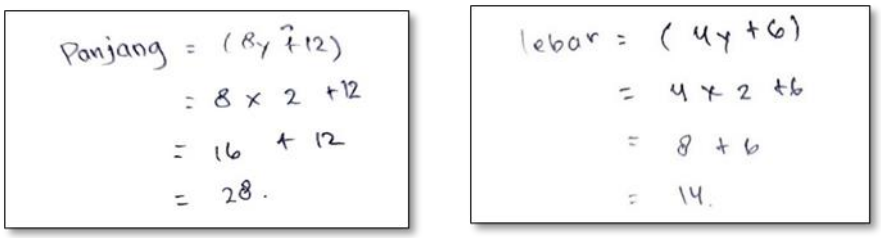
P : Which one minus 36?

S1: This is 84 minus 36 and this one is also minus 36.

P : After subtracting 36, the y is still 24, how do you do it?

S1 : Immediately divide by 24 everything. Both segments are divided by 24 so the y is 2

The fourth indicator is, compiling evidence or reasons for some solutions. On the worksheet, the subject can determine the width of the house and the perimeter of the house by substituting the Y value obtained into the known length and width formulas. The subject was able to operate the length and width values correctly. However, the subject needed to write evidence that the width and house values written down were correct. In Figure 4 the subject's worksheet.



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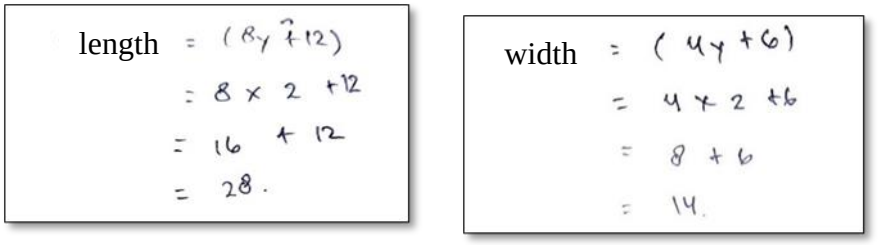


Figure 4. S1's Work Result on The Fourth Indicator

In the re-examination, the subject double-checks by calculating the answers that have been done. This means that the subject does not write the proof of the solution on the worksheet, but the subject only checks the calculations on his work. This is explained in the following interview excerpt.

P : After finding the value of Y, which is 2, what steps do you use next?

S1 : Looking for the length of the width

P : How?

S1 : Earlier, there was already a formula for the length and width, so the y is 2 entered into the formula. The length formula is 8y+12 so 8 times 2 +12 results in 28. Then the Widrh formula is 4y+6. 4 times 2 +6 =14.

P : After you find the length and width values, how do you prove that the width and lenght values you have calculated are correct?

S1 : I check again and then I calculate again silently.

The fifth indicator is concluding or making generalizations. The subject can write the conclusion of the problem in the problem. The subject wrote conclusions in the form of sentences, starting from the length to the width of Mr. Agus' house completely and accurately. Figure 5 is the result of S1's work.

English Version

Conclusion:
So, the length of Mr Agus' house = 28 metres and the width of Mr Agus' house = 14 metres.

Figure 5. S1's Work on The Fifth Indicator

The following interview results reinforce this.

P : What conclusion do you get from the problem?

S1 : In conclusion, we can find the width and length results.

P : What is the result of the conclusion you have made?

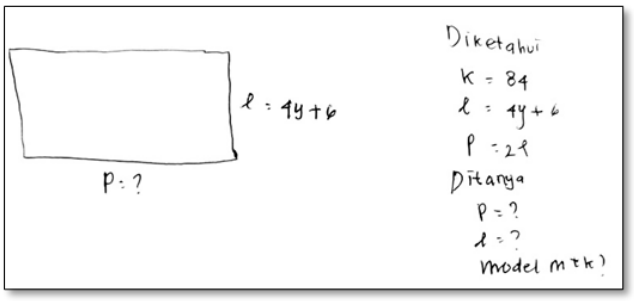
S1 : The length of Mr. Agus's house is 28 meters, and the width is 14 meters.

P : Okay, so from the steps you did earlier, you concluded the length and width of Mr. Agus's house.

S1 : Yes

Based on the results of S1's completion of reasoning ability, on the indicator of conjecture, the subject can understand and write down the information contained in the problem by mentioning what is known and asked about the problem given. In the indicator of performing mathematical manipulation, the subject can write and explain the stages of solution used in the problem taken by adjusting the mathematical operations needed to find the answer. The third indicator, namely determining patterns or properties of mathematical phenomena, is that the subject can choose patterns to analyze problems that are by the mathematical phenomena in the problem. In the indicator of compiling evidence or reasons for several solutions, the subject can collect evidence from the problem solution concerning the pattern that has been developed. So, in the indicator of drawing conclusions or making generalizations, the subject can conclude to determine the truth of a particular statement. This finding is similar to the results of research by Fatimah, Kadir, and Salam (Fatimah M et al., 2021), which states that students with low levels of mathematics anxiety can solve reasoning ability problems correctly.

Subjects with moderate mathematical anxiety (S2) in the first indicator, namely, making conjectures. The subject understood the problem well by mentioning all the information from the problem given, starting from the known perimeter, width, and length of the house to the questioned value of length, width, and also the mathematical model. The subject also described the illustration of the house with a rectangular shape accompanied by a description of its length and width. Figure 6 is the subject's work on the first indicator.



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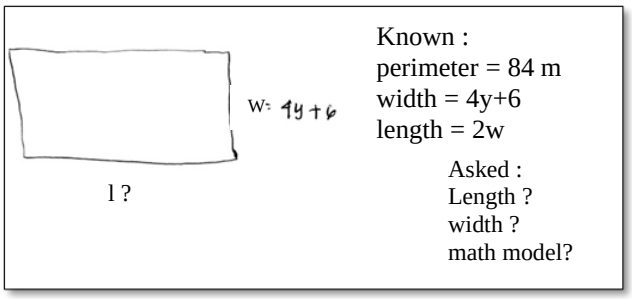


Figure 6. S2's Work on The First Indicator

The following interview results reinforce this.

P: What information did you get from this problem?

S2 : Perimeter, width and length

P : Okay, then what is being asked?

S2 : Length, width, and the math model

P : What is this rectangle drawing for?

S2 : It represents Mr. Agus' house, which is rectangular.

P: This is underneath the picture of the unknown p.

S2 : Yes, the width is unknown.

P : But this is known you wrote the length 2l

S2 : Do not know

P : Try reading the question again

S2 : Oh yes, this is in the question

P : What does the question say?

S2 : The length is 2 times the width, so I wrote 2l

The second indicator is manipulating math. The subject performed math manipulation on the length of the house. The subject wrote that the length was 2 times the width, and then the subject substituted the known width formula. The subject can also operate the equation correctly. Here are the results of his work.

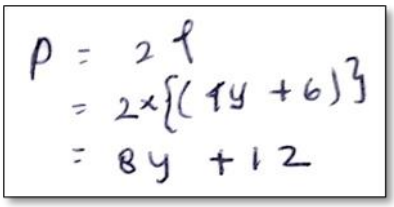


Figure 7. S2's Work on The Second Indicator

The following interview excerpt reinforces this

P : How do you change the story problem into math form?

S2 : Find the length first; it is known that the length is 2 times the width, so I am looking for the length.

P : How do you do that?

S2 : It is 2 times the width. The width was known to be 4y + 6, so I immediately multiplied it all by 2, so the length formula is 8y + 12

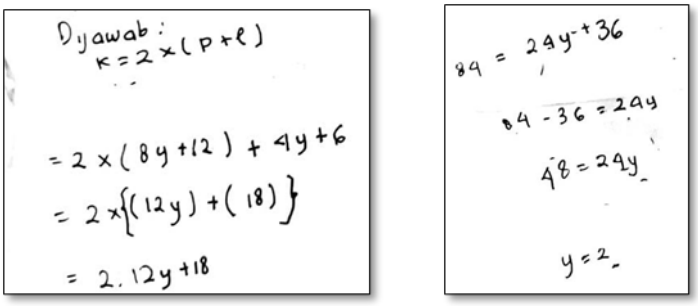
P : After finding the length, what else do you need to find?

S2 : I will go straight to the circumference formula.

P : Did you write the perimeter formula first?

S2 : After the perimeter formula, I entered the known formulas earlier. The perimeter formula is 2 times the length plus the width. I entered the formula for the width and the circumference.

The third indicator is determining patterns or properties of mathematical phenomena. The subject could write the formula for the perimeter of a rectangle. The subject substituted the length and width formulas into the mathematical symbol. The subject also operated the equation by solving the right side first. On the worksheet, the subject moved 36 in the left segment by subtracting the perimeter, 84 -36, to get the value of Y. More clearly, here are the results of the subject's work.



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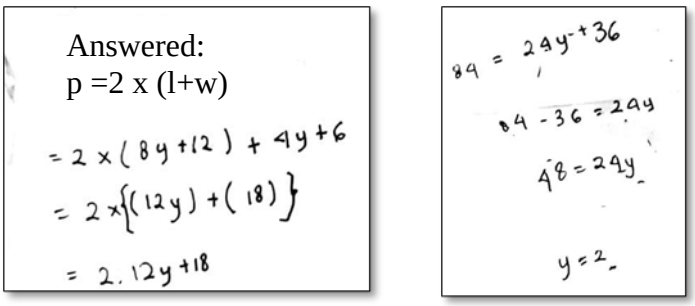


Figure 8. S1's Work on The Third Indicator

The following is the transcript of the interview conducted by the researcher with the subject to strengthen the answer.

P: Here, you wrote the formula for the perimeter of a rectangle; what are you looking for?

S2 : I do not know, I just tried it

P : So you do not need to figure out what to look for?

S2 : I do not know

P : Try to explain what you wrote. How did you do it?

S2 : I put the width and length formula into the circumference formula and then solved it until it was multiplied by 2. Then I move the circumference of 84 and 36 here, so 84-36, so the Y is 2.

P: After subtracting 84 and 36, how come Y suddenly equals 2?

S2 : Oh yes, I divide it directly by 24. 48 divided by 24. 24y is divided by 24 too

P : Are both segments divided by 24? Then the result Y is 2.

S2 : Yes.

The fourth indicator is compiling evidence or reasons for some solutions. The subject was unable to write down the proof of the solution to the math problem because the subject did not write anything on the worksheet. The subject's solution stopped after finding the value of Y in the formula for the perimeter of a rectangle. The subject expressed that he did not understand how to continue. The subject thought that the solution

only arrived when the value of Y was found, namely 2. The following are excerpts of the interview with the subject.

P: After finding the Y value, why don't you continue?

S2 : I do not know how to do it, I am confused

P : After finding the Y value, do you know what the next step is?

S2 : I don't know, I just found the Y value.

P : Was the length and width value not asked earlier?

S2 : Yes, that was already there. I am looking for the length 2L

P : That was looking for the formula but not the result yet

S2 : Oh, so we need to find the result first

P : Yes, but do you know how to find the result?

S2 : I do not know.

Indicator of drawing conclusions or making generalizations. The subject was unable to conclude the problem. The subject should have written something on his worksheet. In the indicator of menus evidence, the subject cannot master it, which affects the indicator of conclusion because the subject does not find the result of the width and length of the house, so the subject cannot generalize. The following is an interview with the subject.

P : So you cannot find the value of the area and the perimeter?"

S2 : Yes, I do not know where to put the y value"

P : You have found the formula for area and length, so you substitute the y value into the length and width formula that you have written."

S2 : Oh, I see. At first, I thought the y value was 2, so that is the result, but I do not know what the width is or the length."

P : So what is the conclusion?"

S2 : The y is equal to 2

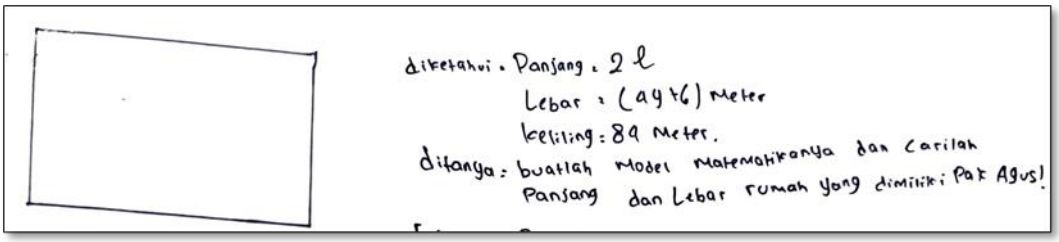
P : Is that all you concluded?

S2 : Yes.

Based on the description of the subject's solution on the indicator of making conjectures, the subject can write as well as understand the meaning described in the problem by writing completely known, asking, and adding picture illustrations. In the indicator of manipulating mathematics, the subject can write the stages of completion by manipulating the question into its mathematical form. In the third indicator, the subject can operate mathematical equations with patterns and solution steps that have been made

correctly, while in the fourth indicator, namely, Arranging evidence or reasons for solutions and indicators of drawing conclusions or making generalizations, the subject is unable to complete it. The subject did not write the next step because the subject needed to learn how, so the subject did not write a solution or proof, and also, the subject was unable to conclude the problem. This finding is by the results of Umaroh's research (Umaroh et al., 2020) which says students with moderate mathematics anxiety do not master the mathematical reasoning indicators of compiling evidence and drawing conclusions.

Subjects with high mathematical anxiety (S3) on the first indicator, conjecture the subject can write what is known and asked in the problem using sentences. The subject also describes a rectangle that illustrates Mr. Agus' house. In the rectangular image, the subject does not write a description of the image; it is just a rectangular image. Figure 9 below is the result of the subject's work.



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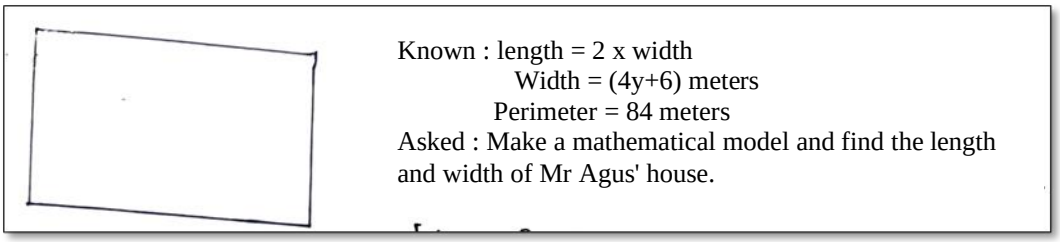


Figure 9. S3's Work on The First Indicator

The following is a transcript of the interview conducted by the researcher with the subject to strengthen the results of the answer.

P: What information do you get on the problem?

S3 : The length is 2L, the width is 4y + 6, and the circumference is 84 meters.

P : Anything else?

S3 : Already

P : What is asked?

S3 : Mathematical model, find the length and width of the house

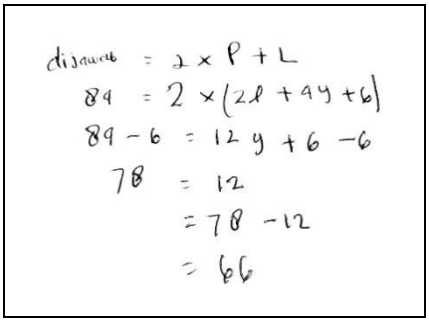
P : Okay, then, what is this picture?

S3 : Picture of Mr. Agus' house

P : So because Mr. Agus' house is rectangular, can you describe it?

S3 : Yes

The second indicator is manipulating math. The subject was unable to perform mathematical manipulation. On the worksheet, the subject does not look for the length formula first but directly at the formula for the perimeter of the rectangle. The subject also needed to understand the meaning of the problem, which is that the length is 2 times the width. The subject wrote the formula for the perimeter of the rectangle and substituted what was known into the perimeter formula. The subject was unable to perform operations on equations. Here are the results of the subject's work.



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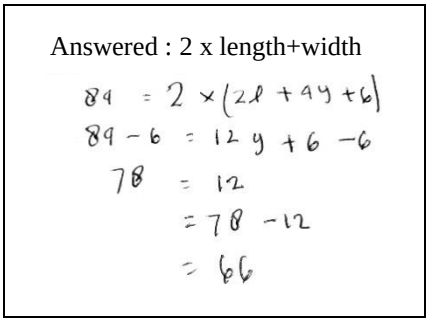

Figure 10. S3 Work Result

The following are excerpts of interviews conducted with the subject to determine the understanding of mathematical reasoning on the question.

P : You already know what is known and asked in the problem; after that, what steps do you take to solve it?

S3: Use the perimeter of the rectangle

P : Try to explain how you do it

S3: In fish, I use the formula for the circumference of a rectangle, and then I enter what is known so this is calculated.

P : So, how did you calculate this? This has L and Y, right? Why isn't it at the end?

S3 : I do not know how to calculate it, so I subtracted 6 directly, so 78 - 12 equals 66.

P: What is the result of 66?

S3: width

P : If that results from the width, what is the length?

S3: I do not know. I cannot.

In the results of interviews and work on the subject, S3 needed help understanding and completing the indicators of manipulating mathematics, determining patterns or properties of mathematical phenomena, compiling evidence for the correctness of the solution, and indicators of concluding. The subject said that he was confused and could not solve the problem in the problem.

Based on the results of job descriptions and interviews, on the indicator of making conjectures, the subject can describe what is known and asked that is obtained in the problem correctly. On indicators of manipulating mathematics, determining patterns or properties of mathematical phenomena, constructing evidence for the correctness of the solution, and indicators of drawing conclusions or making generalizations, the subject is unable to write and explain the steps of the work, the patterns used, the mathematical operations and cannot make conclusions. The subject did not know how to work on the problem. This finding is by the research (Umaroh et al., 2020) that students with high anxiety are only able to work on problems on the indicator of making conjectures. These findings is different from the findings (Muhsana & Diana, 2022) which say that students with high math anxiety can answer questions well according to the indicators of mathematical reasoning ability.

CONCLUSION

Based on the results of the research and discussion, it shows that there are differences in mathematical reasoning abilities between students with low, medium, high levels of mathematical anxiety. students with low levels of mathematical anxiety can fulfil all indicators of mathematical anxiety, students with moderate levels of mathematical anxiety fulfil 3 indicators of mathematical reasoning, namely conjecture, manipulate mathematics, and determine patterns or properties of mathematical phenomena. Learners with high levels of mathematics anxiety only fulfil 1 indicator of mathematical anxiety, namely making conjectures.

From this study, it is recommended that educators minimise the level of mathematical anxiety in learning so as to improve mathematical reasoning ability to the maximum. besides that it is recommended for other researchers to explore further and use

other variables that have an influence on the mathematical reasoning ability of students so that they can broadly or variations recognise the analysis of mathematical reasoning ability.

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