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Identifying the Mathematical Concept Understanding Ability of Junior High School Students in Learning Linear Function Material

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Abstract: Understanding mathematical and mathematical concepts is one of my fundamental abilities. Therefore, it is necessary to teach mathematics by emphasizing concept understanding so that students are trained to solve problems with the concepts they understand appropriately. This study aims to analyze the knowledge of mathematical concepts of students at junior high school level grade VIII on linear function material. This research is qualitative research with a descriptive method. The research subjects were VIII grade students, as many as 33 students. Data collection through two description questions was then analyzed according to the ability of high, medium, and low student categories. Furthermore, direct interviews were conducted to obtain more in-depth information about students' understanding of mathematical concepts. The results showed that 39.39% of students had high-category mathematical concept understanding ability (ST), 6.06% of students in the medium category (SS), and 54.55% of students in the low category (SR). ST fulfills all indicators with the correct answer, and SS fulfills all indicators, but the answers produced could be more precise. SR cannot apply concepts, so it only fulfills some indicators, which results in errors in solving problems.

Keywords: Concept Understanding, Linear Functions.

1. Introduction

Maths is a compulsory subject because it is essential to learn. This means that math has a vital role in helping people understand and solve problems in everyday life. To solve problems in learning mathematics, it is necessary to understand each problem given. However, mathematics is also often considered an unloved subject. Rosita et al. (2021) said that mathematics is very disliked because it is seen as a complicated subject.

Understanding mathematical concepts is the main foundation in learning and mastering mathematics. Understanding mathematical concepts is the ability of students to solve, describe, and convey using their language. Students memorise material and understand the concepts studied to improve their understanding. The idea itself is a basic understanding that is the key to understanding the concept of the material students study. Therefore, students with good concept-understanding skills can support their learning process so that they can solve the mathematical problems they face. Based on this, students who are said to understand a mathematical concept can solve issues related to new material. According to Nussy, Laurens & Ayal (2022).

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stated that concept understanding is needed to help students correctly remember formulas and the meaning of learning. Therefore, the basis that must be instilled in students to learn mathematics is first understanding mathematical concepts Pebrianti & Puspitasari, (2023).

In essence, understanding this concept is very important as a basis for learning mathematics to make learning mathematics more meaningful for students. By understanding mathematical concepts, students can also develop higher-order thinking skills so that students are trained in solving problems logically. However, it can be accepted that many students still need to understand concepts better. If students get a different type of problem from the example given, they cannot solve it. Meanwhile, students' knowledge of mathematical ideas is very influential in solving mathematical problems.

Meanwhile, students can only solve problems if concept understanding is optimal. According to Yanala, Uno, & Kaluku (2021). Students will need help determining the right formula if they only rely on memorising formulas without understanding concepts. Therefore, the inability to understand concepts can cause difficulties for students in solving mathematics problems. Consequently, students need to understand concepts to improve their understanding of mathematics material. This means that knowledge of mathematical concepts is the ability of students to understand and master a material so that they can apply it in learning mathematics.

The facts show that there are still many students who need help learning linear function material, so there are difficulties in solving problems. A linear function is one of the junior high school materials that discusses a polynomial function whose variable is a power of one or a function whose graph is a straight line. Judging from the results of student sheets, students still need help converting problems into mathematical models and solving linear functions. In this study, researchers must conduct research on students' mathematical concept understanding ability, especially in linear function material. So, this research specifically aims to identify students' mathematical concept understanding ability in learning linear function material.

2. Methodology

This research is qualitative research with a descriptive method. The method aims to analyze the understanding of mathematical concepts of Class VIII junior high school students in solving mathematical problems on linear function material. The subjects of this research consist of 33 students.

Students' understanding of mathematical concepts is obtained from test results on linear function material. Student test results are grouped based on the categories of high, medium, and low concept understanding. In analyzing, researchers coded ST for subjects with high-category students, SS for subjects with medium-category students, and SR for subjects with low-category students. Criteria for grouping understanding based on the average and standard deviation the criteria used are:

Table 1 - Mathematical Concept Understanding Test Results

Criteria	Category
Score < mean-standard deviation	High score
Average-standard deviation of scores ≤Value<Average+standard deviation of scores	Medium
Score ≥ Average	Low

Utami & Kusumah, (2023).

The research instruments were two mathematical concepts: understanding test questions and interviews. According to Yunita, A., & Lovia, L. (2023), the concept understanding test aims to determine student ability. Data is obtained through the results of the response to the answers to student test questions and the results of interviews. The test questions given were in the form of description questions on linear function material. At the same time, the interview results are needed to explore or seek more in-depth information from the results of the student's responses to the test questions. The study of the ability to understand mathematical concepts is measured using three indicators, as seen in Table 2.

Table 2 - Mathematical concept understanding test questions

Indicator of concept understanding	Problem Indicators on Understanding Concepts in Linear Functions
Understand mathematical concepts	Identify data or concepts in the information given, and students can write what is known and asked from the problem.
Use certain arithmetic operations.	Calculate the mathematical process by including the concepts used in each work step and students.
Apply problem-solving concepts.	Linking one concept to another and expressing it in mathematical symbols determines the solution and why students can use problem-solving algorithms appropriately.

Dewi, I. L. K. (2021).

3. Results and Discussion

3.1 Results

The mathematical concept understanding of students used as subjects in this study can be seen from the acquisition of description test scores on linear function material. Based on the test scores, the understanding of mathematical concepts is grouped into three categories: high, medium, and low. To determine the boundaries of these categories, data from students' test scores is taken, as shown in Table 3. Criteria for Understanding Mathematical Concepts of Students After knowing the average value is 40.60, based on the analysis of 33 students, there are 13 in the high category, 2 in the medium category, and 18 in the low category. This shows that students' minimum and maximum values are 25.77 and 55.43

Students in the high category have been able to answer the questions correctly, and the solutions are based on the indicators of concept understanding. As for students who are categorised as medium, they can answer questions, but not all indicators of understanding the concept are responded to, and errors occur. Furthermore, students with low mathematical concept understanding need help understanding mathematical concepts, especially in linear function material. The test results show that students are still low. The cause of students' low knowledge of mathematical concepts is that students need to be more able to solve concept-understanding problems correctly. Half the students need to correct many things, such as choosing indicators for arithmetic operations and applying concepts to problem-solving. This shows that students need help understanding mathematical concepts when explaining the relationship between concepts and appropriately using concepts in problem-solving.

After obtaining the results of the mathematical concept understanding test, the next step is to conduct interviews to get more in-depth information about understanding mathematical concepts from students' answers. The research results are described by paying attention to the process of understanding mathematical concepts seen by each student in answering questions.

The criteria for understanding mathematical concepts in students with high, medium, and low categories can be seen in Table 3. The score acquisition in each category refers to the criteria calculation in Table 1.

Table 3 - Criteria for Students' Mathematical Concept Understanding

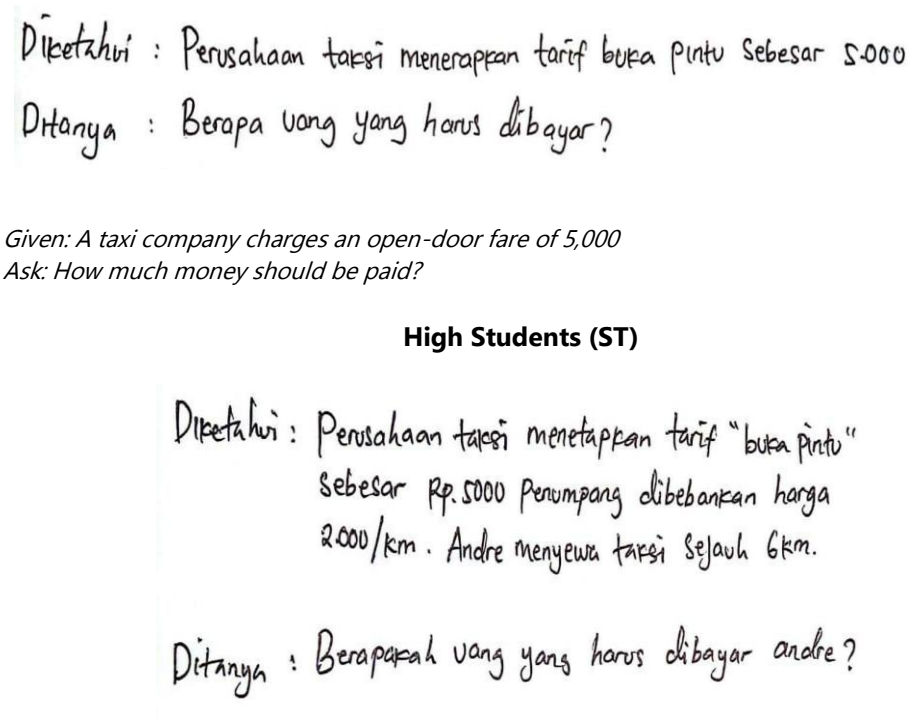
Category	Interval	Number of Students	Percentage (%)
High	$x > 55{,}43$	13	39,39
Medium	$25{,}77 \leq x < 55{,}43$	2	6,06
Low	$x < 25{,}77$	18	54,55

Table 3. shows that from the results of 33 students, it can be seen that many students fall into the category of low mathematical concept understanding, as many as 18 with a percentage of 54.55%. Meanwhile, some students fall into the high and medium categories. There are only 13 students who can understand

mathematical concepts, with a percentage of 39.39%, and in the moderate category, which amounted to 2, with a rate of 6.06%. The mathematical concept of understanding test results on linear function material is based on grouping in each category, namely high, medium, and low.

Based on the test results given to students, they have answers that researchers need to analyze in depth. When analyzing researchers' code students with ST, SS, and SR, these students received linear function material. The following sections are the test results from the students.

In the first problem, students are asked to solve a linear function problem: A taxi company sets a "flag drop" fare of Rp5,000, and passengers are charged Rp2,000/km. Andre rents a taxi for a distance of 6 km. How much money does Andre have to pay?



Given: A taxi company charges an open-door fare of 5,000
Ask: How much money should be paid?

High Students (ST)

Given: A taxi company charges an open-door fare of 5,000
passengers are charged 2,000/km
Andre hired a taxi for 6 km.
Ask: How much money should Andre pay?

Low Student (SR)

Fig. 1 - ST and SR's written results on problem 1 Indicator 1

In Figure 1, the answers of ST and SR are the indicators of understanding mathematical concepts. The answers above show that ST and SR have been able to write detailed information, such as answering story problems in general. If there is a problem in the form of a story, ST and SR can write what is known and what is asked in the issue. It can be seen in the answers of ST and SR a) that the taxi company applies an open door of 5,000, and passengers are charged a price of 2,000/km. Andre rented a taxi for 6km; b) asked how much money should be paid. This result is in line with Ramadhani & Aini's research (2020), which says that students can mention the relationship between what is asked and what is known and explain that what is known is enough to answer what is asked. ST has fulfilled the indicator of understanding mathematical concepts in linear function material.

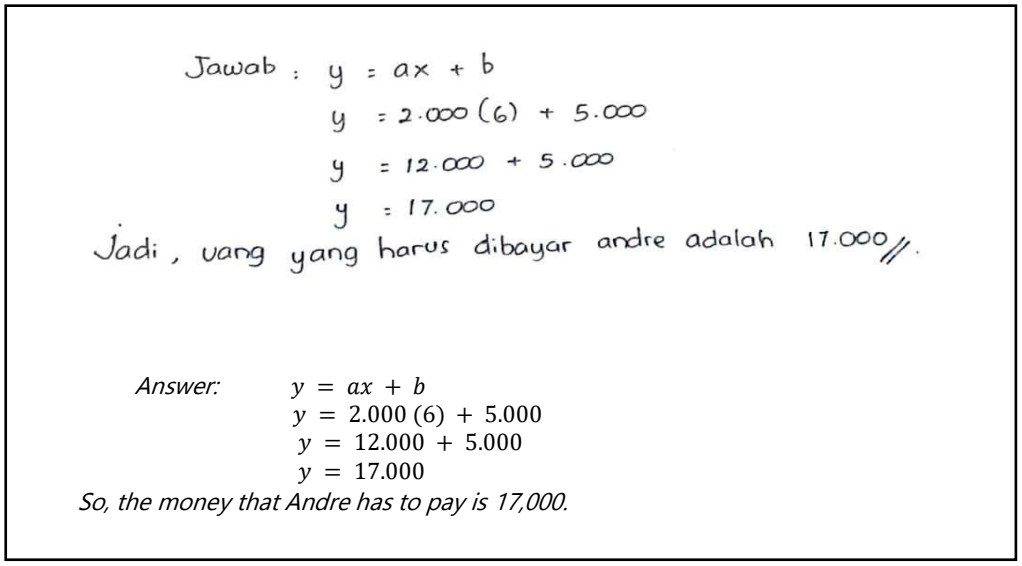


Fig. 2 - SS's written result on problem one indicator 1

Figure 2 results from SS's answer in the concept understanding category. The answer above shows SS cannot write detailed information by answering story problems. If there is a problem in the form of a story, SS must first write down what is known and asked in the issue so that SS does not immediately write the linear function formula, namely $y = ax + b$, to do the calculation operation. Based on the analysis of the answers above, SS still needs to fully meet the indicators in understanding mathematical concepts in linear function material. This result is in line with Yufentya et al. (2019), who said that students cannot correctly represent concepts from images to their mathematical models, meaning that SS still needs to fulfil the ability to understand mathematical concepts.

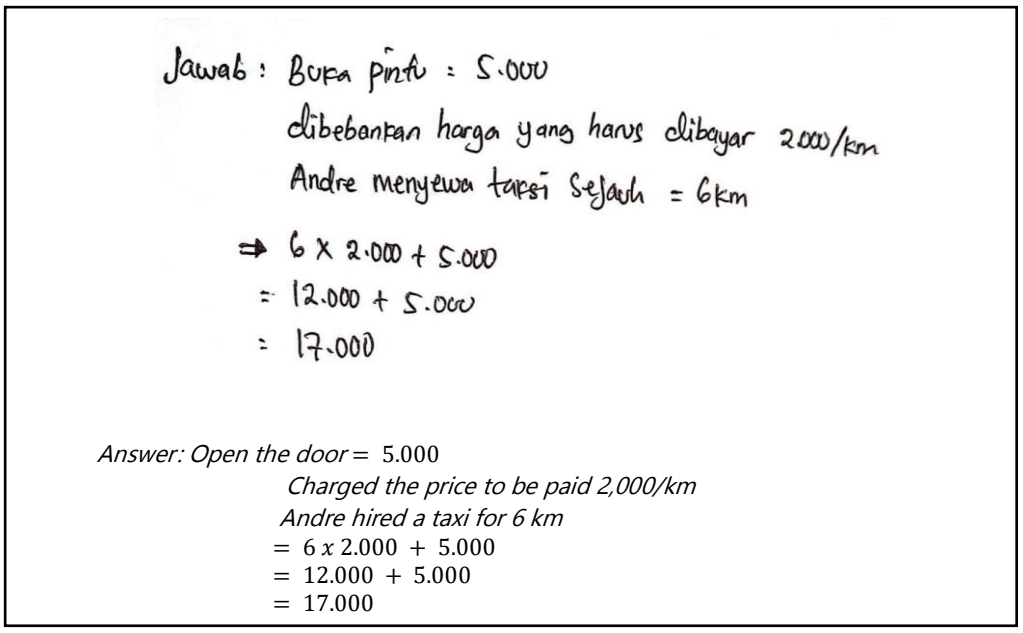
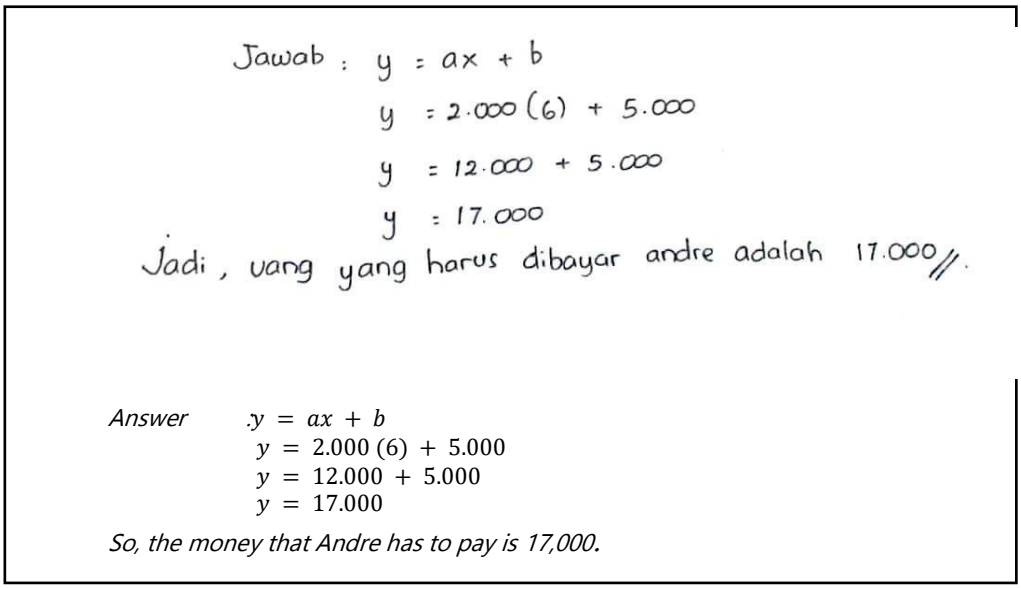


Fig. 3 - ST's written result on problem one indicator 2

Figure 3 is ST's answer in the indicator of using arithmetic operations. The answer above shows that ST has been able to write what is known and asked about in the problem. ST can write the linear function formula, namely $y = ax + b$. Then, ST explained the answer by inputting what he already knew. $6\ x\ 2.000/km\ +\ 5.000$

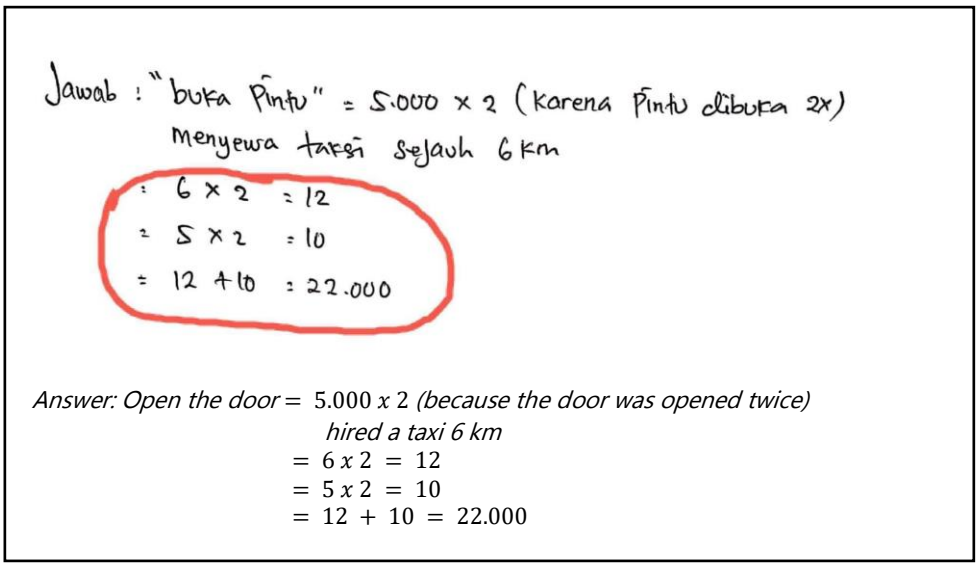
then ST multiplied first $6\ x\ 2.000/km = 12.000$ then to the sum$12.000 + 5.000 = 17.000/$ open the door. Based on the answer above, ST can solve the problem according to the understanding indicators obtained from the material learned and produce the correct final result. In line with Dewi & Waluya's research (2021), students' concept understanding is perfect, as evidenced by students being able to connect and represent the information obtained to solve problems smoothly.


Jawab : $y = ax + b$
$y = 2.000\ (6) + 5.000$
$y = 12.000 + 5.000$
$y = 17.000$
Jadi, uang yang harus dibayar andre adalah 17.000//.

Answer $y = ax + b$
$y = 2.000\ (6) + 5.000$
$y = 12.000 + 5.000$
$y = 17.000$
So, the money that Andre has to pay is 17,000.

Fig. 4 - SS's written result on problem one indicator 2

Figure 4 is SS's answer in the indicator of using counting operations. The answers above show that SS could not write what was known and asked about in the problem. This is in line with Agustini & Pujiastuti (2020), who state that the subject needs help converting story form problems into mathematical sentences due to a need for more reading to understand what is asked in the issue. But SS can write the linear function formula, namely $y = ax + b$, then SS explained his answer by entering $2.000\ (6) + 5.000$ then SS multiplied first $2.000\ (6) = 12.000$ then to the addition $12.000 + 5.000 = 17.000/$ open the door so that it produces the correct final result.


Jawab : "buka Pintu" = 5.000 x 2 (karena Pintu dibuka 2x)
Menyewa taksi sejauh 6 km
: 6 x 2 = 12
: 5 x 2 = 10
: 12 + 10 = 22.000

Answer: Open the door = $5.000\ x\ 2$ *(because the door was opened twice)*
hired a taxi 6 km
$= 6\ x\ 2 = 12$
$= 5\ x\ 2 = 10$
$= 12 + 10 = 22.000$

Fig. 5 - SR's written result on problem one indicator 2

Figure 5 is SR's answer in the indicator of using arithmetic operations. The answer above shows that SR has been able to write what is known and asked about in the problem. However, when entering the formula, SR experienced calculation operation errors that resulted in the wrong answer. $12 + 10 = 22.000$, which resulted in SR's mistake in producing the wrong answer. The correct result of the calculation operation is $12.000 + 5.000 = 17.000$. Following the interview results, SR made a mistake in the operation, so SR should have paid for the steps that should be followed according to the formula. This result is in line with the research of Kanduli et al. (2018), which suggests that the factors that cause errors in understanding the basic concepts of algebra itself are due to students' low understanding ability, lack of mastery of the material, and lack of thoroughness in the completion process.

In the second problem, students are asked to work on a linear function problem, namely when investigating the length of a candle after burning; *it is known that the length becomes 10 cm after 4 minutes to 7 cm after 10 minutes of burning. Suppose the candle shortens at a constant rate. Answer the following questions.*

1. Find the length of the candle before it burns

2. How many minutes did the candle burnout take?

Students' answers to the second problem: First indicator

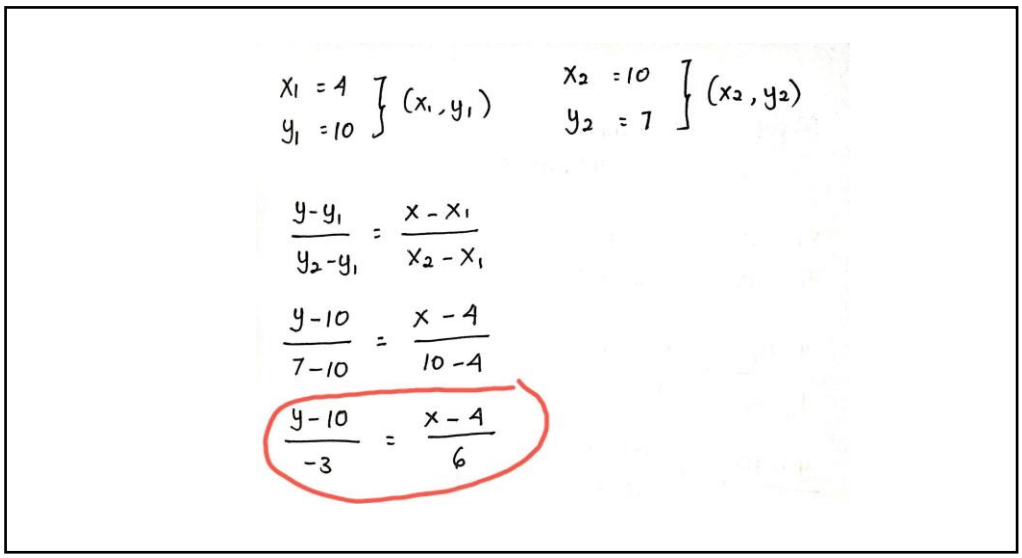


Fig. 6 - ST's written result on problem 2 Indicator 1

In Figure 6, ST's answer indicates understanding mathematical concepts. Based on the answer above, it is correct. In work, ST has done according to the correct steps. Namely, ST determines first that will be generalized as x_1, x_2 dan y_1, y_2. ST wrote the formula for the equation of the line, $\frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$ correctly. After ST entered all the variables into the formula, it produced the line equation $\frac{y-10}{-3} = \frac{x-4}{6}$. Based on the interview results, ST began to experience errors when applying arithmetic operations; when continuing to the next stage, ST could only work until the result of the line equation. $\frac{y-10}{-3} = \frac{x-4}{6}$. The mistake caused ST to produce an incorrect answer. It can be seen in Figure 6. that the student has understood the problem given and can choose the calculation operation, namely memorizing the value of the first variable and determining it into the formula. ST is careless when operating the calculation and experiences errors when solving the problem. This result is in line with Gusmania & Agustyaningrum's research (2020), which states that in the calculation process, if there is an error, it will result in an incorrect solution.

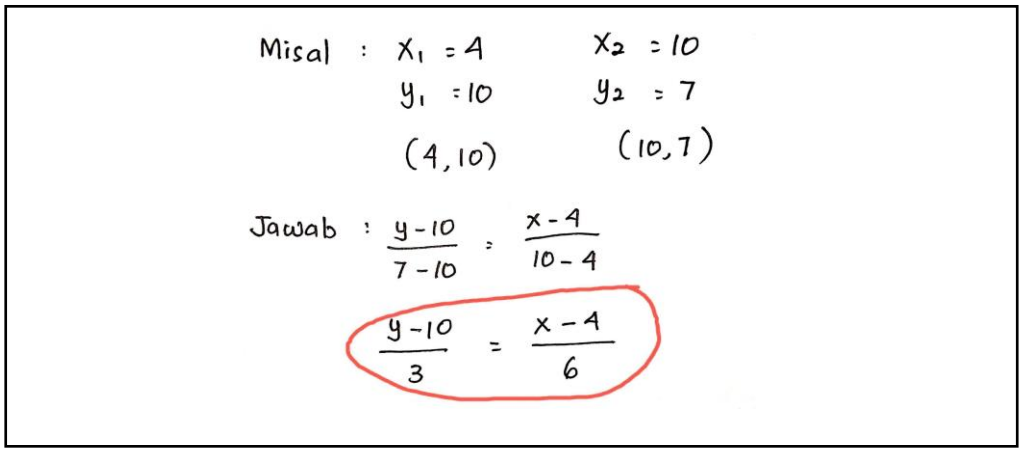


Fig. 7 - SS's written result on problem 2 Indicator 1

In Figure 7, it can be seen that SS can present the form of the problem into its mathematical model, and SS has worked according to the correct steps; namely, SS first determines what will be generalized as x_1, x_2 dan y_1, y_2. SS did not write the line equation formula $\frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$ First, SS directly puts the variables into the formula correctly. However, during the working process, SS made mistakes when applying calculation operations. The mistake was made during the calculation operation $\frac{y-10}{3} = \frac{x-4}{6}$, resulting in students experiencing errors and producing incorrect answers. The correct result for the calculation operation is $y - 10 = -\frac{1}{2} + 2$. Ased on the interview results, SS experienced errors when calculating cross-multiplication. It can be seen in Figure 7, which shows that students can only solve problems up to the calculation operation stage because they experience errors in answering. Hence, the answers produced by these students are less precise. The mistakes made by students are when calculating the problems given, so students are wrong in finding the results obtained (Ratri & Azhar, 2022). Kanzunuddin and Wanabuliandri (2018) stated that one of the things that affect the lack of understanding of mathematical concepts is students who can only solve one of the problems in the indicator.

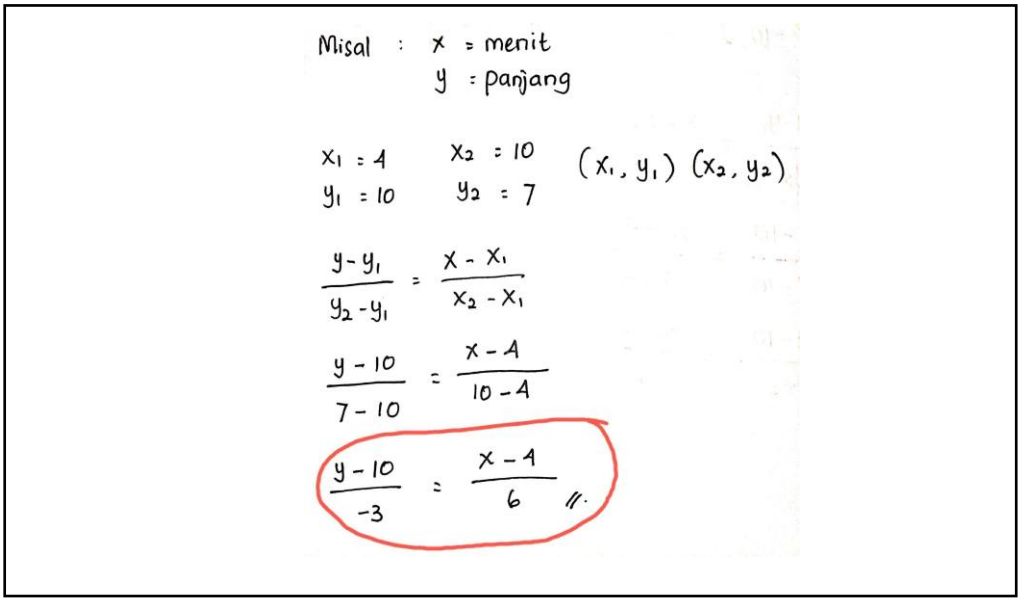


Fig. 8 - SR's written result on problem 2 Indicator 1

Figure 8 shows that SR can change the problem into a mathematical model, such as memorizing x_1, x_2 dan y_1, y_2, and SR can write the line equation formula, namely $\frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$ correctly. However, while working, SR experienced errors during the calculation operation $\frac{y-10}{-3} = \frac{x-4}{6}$, which caused the student to experience mistakes, resulting in an incorrect answer. The correct result for the calculation operation is $y -$

$10 = -\frac{1}{2} + 2$. Based on the interview results, SR had difficulty solving the problem when applying the calculation operation. This can be seen in Figure 8, which shows that students experience errors when working on calculation operations that result in the resulting answers being less precise. In line with the research of Saputri, (2019), errors occur due to the lack of students' ability to perform calculation operations, which is caused by students' lack of accuracy in performing calculations, resulting in incorrect answers.

Students' answers to the second problem of the second indicator

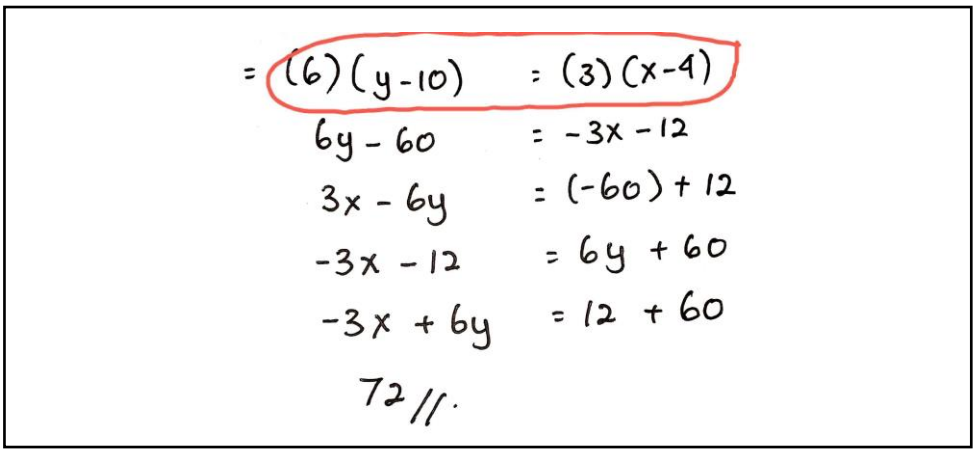


Fig 9 - ST's written result on problem 2 Indicator 2

In Figure 9, the student's work regarding the indicator of using arithmetic operations is shown, indicating that ST cannot perform calculations accurately, resulting in less precise final calculations. ST should have continued the first step in the first indicator, which was to simplify the form of the $\frac{y-10}{-3} = \frac{x-4}{6}$ to produce $y - 10 = -\frac{1}{2} + 2$. based on the analysis, it can be seen that ST lacks an understanding of algebraic concepts. ST experienced calculating errors from the interview results, resulting in the wrong answer. In line with the research of Jingga, Mardiyana, & Setiawan, R. (2017), which states that calculation errors include students making mistakes in giving or writing signs of mathematical operations, students making mistakes in performing calculation operations in mathematics, such as adding, subtracting, multiplying, and dividing.

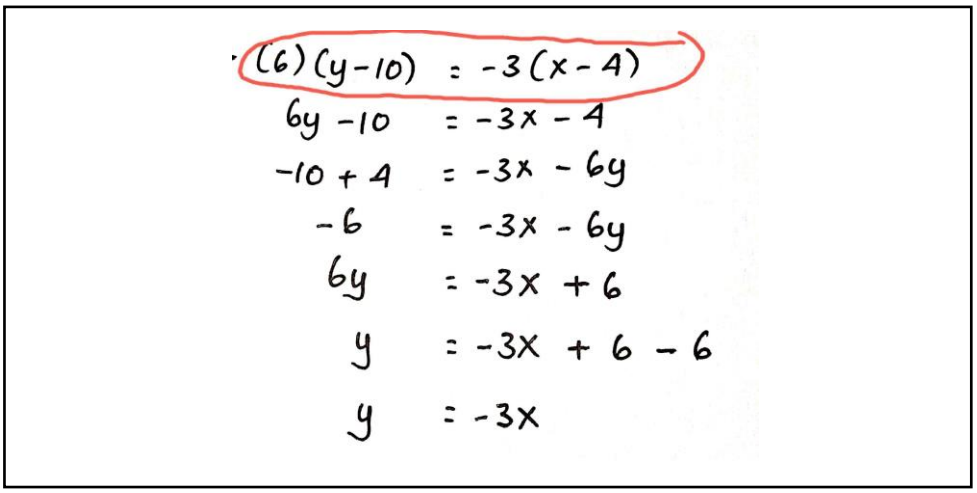


Fig. 10 - SS's written result on problem two indicator 2

In Figure 10. SS can use and select the operation to be used. However, SS needed help applying the calculation operation during the process, resulting in the wrong answer. OpenOpen$(6)(y - 10) = -3(x - 4)$ parens eresultedinthe wrong answer. The correct answer on the indicator of applying the calculation operation is $1 - 10 = -\frac{1}{2}$x + 2. When determining the value of x, the next step is to change it into the y variable so that

$y = -\frac{1}{2}x + 2 + 10$, $y = -\frac{1}{2}x + 12$ (line equation) because what is asked is the length of the candle before it burns, then replace x with 0. become $y = -\frac{1}{2}x + 12$, $y = -\frac{1}{2}(0) + 12$. The correct result for the calculation operation is $y = 12$. Based on the interview results, in the first step, SS did not have difficulty changing the problem to a mathematical model. Still, SS needed help applying the calculation operation, producing an incorrect answer in line with research conducted by Gusmania, & Agustyaningrum, (2020), which states that in the initial calculation process, errors in calculation operations will result in incorrect solution results.

3.2. Discussion

Based on the results of analyzing student answers from two problems related to the ability to understand mathematical concepts in the first and second problems, it is obtained overall that each student's ability to understand mathematical concepts has a different level. There are 13 students in the high category (ST), meaning that students have been able to solve problems with the correct answers. Students have high concept understanding ability. ST understands the problem given and can choose the calculation operation used; when performing calculation operations, students experience errors. This result is in line with the research of Ratri & Azhar (2022), which states that the mistakes made by students who incorrectly know the procedures or steps used in solving the problem and mistakes make students unable to find the correct final answer.

Furthermore, two students in the moderate category (SS) show that SS has yet to understand mathematical concepts based on the indicators of understanding mathematical concepts. While SS can only understand the problem or task given, and at the stage of doing calculations, students need help answering the questions provided. In line with Pujiati's research Kanzunnudin & Wanabuliandari (2018) state that one of the things that affect the lack of understanding of mathematical concepts is students who are only able to solve one of the problems the indicator. At the same time, 18 students in the low category (SR) showed that they needed help to fulfil the indicators of understanding mathematical concepts. SR solved the problem given in the situation, but SR had difficulty continuing the problem when doing calculations. This result is in line with the research of Hakim, & Daniati, (2014), which says that these difficulties occur due to students' need to understand mathematical concepts, especially in counting operations.

The above findings are relevant to previous research conducted by Gultom, & Tambunan, (2022), which states that understanding of mathematical concepts in expressing student functions is still low, according to Devi Liana (2020), which states that the things that become factors in not achieving the mathematical understanding ability test on each indicator used to result in less than the maximum mathematical understanding ability of students. It can be seen in students' mathematical errors when solving problems. Refinanda et al. (2021) stated that the subject's error lies when operating the arithmetic work, so the subject needs a higher understanding.

Student difficulties in understanding problems can be overcome by using engaging learning media such as PowerPoint presentations (Bawamenewi, et al., 2023), and interactive multimedia-based learning (Angraini & Fitri, 2023). Additionally, recommendations that can be given in this study include developing teaching materials that are tailored to the needs of mathematical understanding abilities. The practicality test results of teaching materials based on mathematical understanding abilities show that teaching materials need to be prepared to achieve mastery of students' mathematical understanding abilities (Rosita, Nopriana & Dewi, 2017).

4. Conclusion

Based on the results of the research and discussion described above, students in grade VIII of junior high school in one of Cirebon City showed that mathematical concept understanding there were 13 students (39.39%) showing high understanding, 2 students (6.06%) showing moderate understanding, and 18 students (54.55%) showing low understanding, with an average score of 40.60. ST was able to fulfil all indicators, while SS fulfilled the indicators but needed to be more precise in the final result. SR needed to fulfil the indicators, resulting in difficulty in solving the problem. The cause of students' low understanding is that they need to be more precise in solving problems and experience many mistakes, especially in choosing calculation operations and applying concepts. This means that students' understanding of mathematical concepts when solving

problems still needs to improve. Therefore, understanding mathematical concepts needs to be related to problems in the form of stories.

5. Recommendations

Based on the data analysis and discussion results, it is evident that students' concept understanding skills still require improvement. The findings of this study serve as crucial information for prospective teachers and current educators, highlighting the need to better understand students' grasp of mathematical concepts. Concept understanding is fundamental in mathematics learning; therefore, teachers are encouraged to design learning activities that enhance students' comprehension of mathematical concepts. To address this need, it is recommended that future researchers develop or design learning approaches that are straightforward to comprehend. This will enable the implementation of problem-based learning activities that engage students with the concepts they are studying. Additionally, ensuring that students have a solid understanding of basic concepts before advancing to more complex ones is essential for fostering a deep and lasting understanding of mathematics.

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