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Students' Critical Thinking Ability in Solving Story Problems of Three-Variable Linear Equation System

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ABSTRACT

This study aims to describe how the critical thinking process of students in solving math problems in the form of story problems of the Three-Variable Linear Equation System (SPLTV). This type of research is descriptive and uses qualitative methods. The subjects in this study were 6 students of class X 5 SMA Batik 1 Surakarta with high, medium, and low categories. Data collection techniques used tests and interviews, which have been declared valid by validators. Indicators of students' critical thinking abilities in research include clarification, assessment, strategy and inference. The results of this study are high category students can fulfill all indicators of critical thinking aspects, namely clarification, assessment, strategies, and inference. Medium category students are only able to fulfill three indicators, namely clarification, assessment, and strategies or only two indicators, namely clarification, and assessment. Low category students are only able to fulfill one critical thinking indicator, namely clarification, while other subjects cannot fulfill any critical thinking indicators.
Keywords: *critical thinking, math story problems, SPLTV.*

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INTRODUCTION

Critical thinking is a systematic process that is organized to strengthen students' thinking skills that aim to formulate thinking processes and test their own opinions (Purnamasari, Pramudya, & Kurniawati, 2017). One of the efforts that educators usually make to see or know how students' critical thinking process is when students do math problem solving. Usually, mathematical problem solving activities carried out are by solving math story problems. Mathematical problem solving is generally in the form of a story problem method and many are related to everyday life. Story problem is a problem in mathematics in which solving it requires good reading skills because it is one of the requirements in order to understand the contents of the problem. In working on story problems students must be able to understand the contents of the story problem first. Then draw conclusions about the problems in the problem that must be solved, and in solving it using mathematical notation (Laely, 2019).

Based on the results of previous research, it is felt that the ability to think and solve math problems in students is still low. The biggest difficulty faced by students in solving problems is not understanding the problems in the problem, especially in the system of linear equations of three variables (Nur, 2022). The material is a material that is rather difficult for students to solve when they do not understand the problems in the problem. Based on the results of previous studies, it is stated that most students experience errors when interpreting story problems into mathematical models (Neneng, Zulfitri & Dewi, 2022). Another mistake often made by students in working on story problems is not understanding the desired concept (Anita, Veronica & Yovita, 2022). This is due to differences in thinking and different levels of intelligence of students. For this reason, teachers need to pay more attention in choosing methods that are suitable for learning, because this can affect student learning motivation.

Therefore, researchers are interested in conducting research related to the critical thinking process carried out by students, in understanding and translating math story problems that were originally in the form of story sentences into numeracy. This study aims to describe and illustrate how the critical thinking process of students in solving mathematical problems in the form of story problems of the Three Variable Linear Equation System (SPLTV). Based on the background of the problem above, the researcher is interested in examining the research material with the title "Analysis of Students' Critical Thinking Ability in Solving the Three-Variable Linear Equation System Story Problem in Class X Students of SMA Batik 1 Surakarta".

METHOD

This research uses descriptive research and uses qualitative methods. Qualitative research is research that produces descriptive data in written or oral form from sources that have been observed. The subjects in this study were students of class X 5 SMA Batik 1 Surakarta totaling 42 students to conduct a HOTS story problem test on SPLTV material, which was then taken 6 students based on the high, medium, and low categories. Data collection activities aimed at describing students' critical thinking skills were carried out with tests and interviews. The test questions and interview guidelines have gone through a validation process and

were declared valid by 2 validators.

To obtain data on students' mathematical critical thinking skills, an assessment of students' answers to each item was carried out. The results of student test scores were then classified into three categories, namely high, medium, and low based on the categorization formula described by (Azwar, 2014: 149). After that the researcher chose 2 subjects from each category to be interviewed. The six subjects were selected based on the following table 1.

Table 1. Category of Students' Critical Thinking Ability

Value	Category
$X \geq 77,4$	High
$37 \leq X < 77,4$	Medium
$X < 37$	Low

RESULTS AND DISCUSSION

In this study, students' critical thinking skills were analyzed using Jacob & Sam's (2008) critical thinking indicators which state that there are 4 stages in the critical thinking process, namely: (1) Clarification (formulating the problem precisely and clearly), (2) Assessment (using the information obtained to find alternative solutions), (3) Strategies (finding the solution strategy used to solve the problem), and (4) Inference (making conclusions). Table 2 below shows the results of the analysis of students' critical thinking skills in solving two HOTS-based SPLTV story problems.

Table 2. Critical Thinking Ability of Students

Category	Subject	Number	Indicator			
			(1)	(2)	(3)	(4)
High	1	1	✓	✓	✓	✓
		2	✓	✓	✓	✓
	2	1	✓	✓	✓	✓
		2	✓	✓	✓	✓
Medium	3	1	✓	✓	✓	-
		2	✓	✓	-	-
	4	1	✓	✓	✓	-
		2	✓	✓	-	-
Low	5	1	✓	-	-	-
		2	✓	-	-	-
	6	1	-	-	-	-
		2	-	-	-	-

a. High Category Students

- **Subject 1 (S1) question number 1**

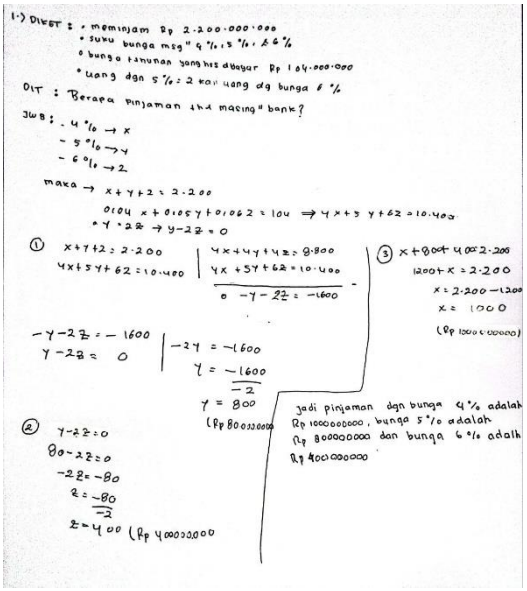


Figure 1. The results of the answers to the story problems of Subject 1 question number 1

The results of this student work are supported by the results of the interview presented in the following excerpt.

P : "What information is obtained from question number 1?"

S1 : "Here it is known that there are borrowing about 2 billion 200 million with interest rates of 4%, 5%, and 6% respectively. Then it is also known that the annual interest to be paid is 104 million, and the money with 5% interest is equal to twice the money with 6% interest".

P : "Then what other information is there?"

S1 : "Asked about the loan to each bank?".

P : "How do you find out the information?".

S1 : "To find out the information, I read the problem carefully, explained it one by one"

P : "Is the information from problem number 1 enough to solve the problem in the problem and in what way to process the information?".

S1 : "It is clear enough to solve the problem in the problem, it only needs to be read carefully, from the problem then I make the equation and the mathematical model".

P : "What strategy did you use to solve the problem in question number 1?".

S1 : "I used the elimination, substitution strategy to solve the problem".

P : "How do you conclude from the answer to question number 1?".

S1 : "I concluded according to the answer of the problem I did".

- **Subject 1 (S1) question number 2**

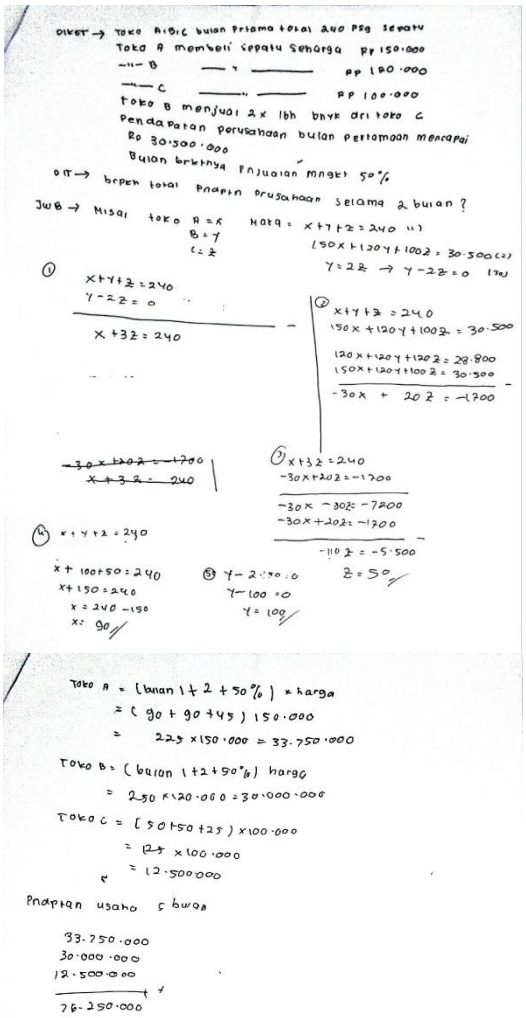


Figure 2. The results of the answers to the story problems of Subject 1 question number 2

The results of this student work are supported by the results of the interview presented in the following excerpt.

P : "What information is obtained from question number 2?"

S1 : "It is known that stores A, B, C in the first month sold a total of 240 pairs of shoes. With Shop A bought shoes for 150 thousand, shop B bought shoes for 120 thousand, shop C bought for 100 thousand. Then store B sold 2 times more than store C. The company's revenue in the first month reached 30 million 500 thousand. The next month sales increased by 50%. What is the total revenue of the company for 2 months?".

P : "How do you find out the information?".

S1 : "By reading the problem carefully".

P : "Is the information from problem number 2 enough to solve the problem in the problem and in what way to process the information?".

S1 : "It is enough, then from the information in the problem I make the equation and the mathematical model".

P : "What strategy did you use to solve the problem in question number 2?".

S1 : "Using elimination, and substitution to solve it then calculate the revenue of each store for 2 months and add up the results".

P : "How do you conclude from the answer to question number 2?".
S1 : "By looking at the answer to the problem that I have done".

- **Subject 2 (S2) question number 1**

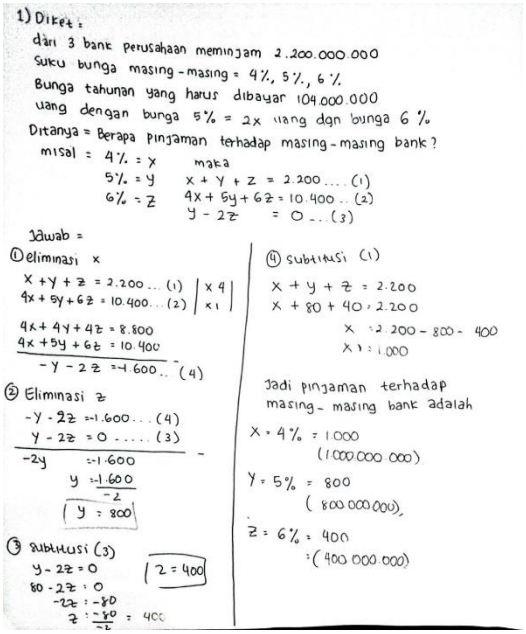


Figure 3. The results of the answers to the story problems of Subject 2 question number 1

The results of this student work are supported by the results of the interview presented in the following excerpt.

P : "What information is obtained from question number 1?"
S2 : "The information is that from 3 banks the company borrows 2 billion 200 million, after that there is an annual interest to be paid of 104 million, then the interest rates from the banks are 4%, 5%, and 6%, respectively, and the money with 5% interest is equal to 2 times the money with 6% interest.".
P : "What is that usually called in problems?".
S2 : "The known aspect".
P :"Any other information?".
S2 : "It asks how much is the loan to each bank?".
P : "How do you find out the information?".
S2 : "First read the question from beginning to end, then write known and asked".
P : "Is the information from problem number 1 enough to solve the problem in the problem and in what way to process the information?".
S2 : "Enough, processing the information by generalizing from what is known then making a mathematical model".
P : "What strategy did you use to solve the problem in question number 1?".
S2 : "The first is by using the substitution and elimination formula because it searches by using equations".
P : "How do you conclude the answer to question number 1?".
S2 : "Writing down the conclusion of what is asked".

- **Subject 2 (S2) question no 2**

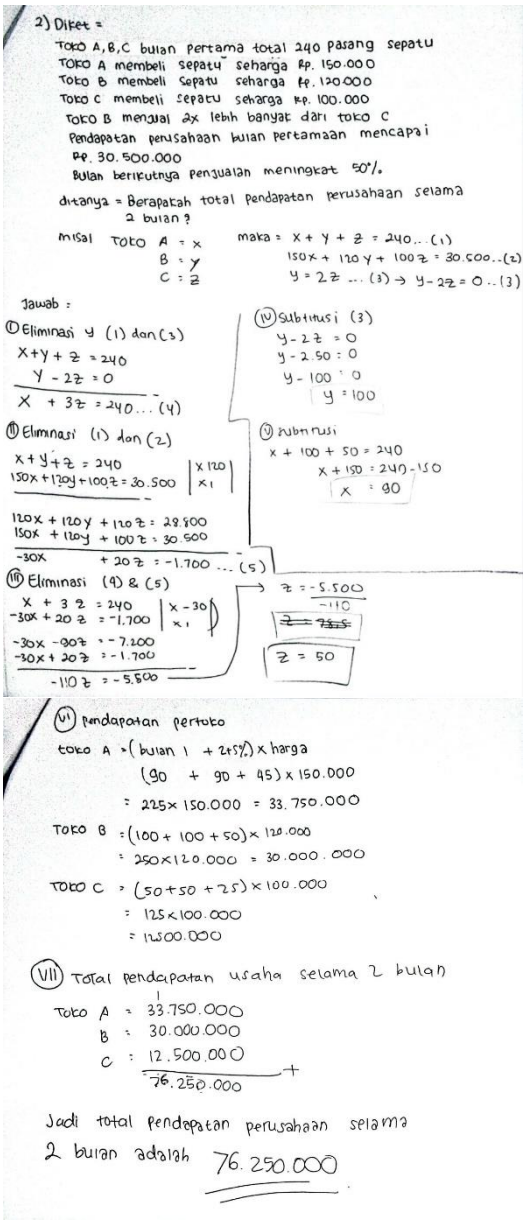


Figure 4. The results of the answers to the story problems of Subject 2 question number 2

The results of this student work are supported by the results of the interview presented in the following excerpt.

P : "What information is obtained from question number 2?"

S2 : "It is known that stores A, B, C in the first month sold a total of 240 pairs of shoes. Store A bought shoes for 150 thousand, store B bought shoes for 120 thousand, store C bought for 100 thousand. It is also known that store B sold 2 times more than store C. Then the revenue earned by the company in the first month was 30 million 500 thousand. The next month sales increased by 50%. Then asked what is the total revenue of the company for 2 months?".

P : "How do you find out the information?".

S2 : "Read the whole question and write down what is known and asked".

P : "Is the information from problem number 2 enough to solve the problem in the

problem and in what way to process the information?".
S2 : "It's enough, by generalizing and making a mathematical model".
P : "What strategy did you use to solve the problem in question number 2?".
S2 : "Using the substitution and elimination formula after the results are obtained then calculate the revenue of each store for 2 months and add up the results of the calculation of the revenue of 3 stores".
P : "How do you conclude from the answer to question number 2?".
S2 : "The conclusion is adjusted to what is asked".

Based on the results of the story problem test and interviews on subject 1 and subject 2 above, it is known that subject 1 and subject 2 are able to fulfill all indicators of critical thinking according to Jacob & Sam (2008), the first is subject 1 is able to explain and write down the problems in the problem precisely and clearly, it can be seen from the explanation of what is known and asked in the problem. Then from the existing information, subject 1 made the permissiveness and mathematical model, in order to find alternative solutions. Furthermore, subject 1 also used the correct solution strategy, namely the elimination and substitution method to solve the problem, and made the conclusion correctly and in accordance with what was asked in the problem. So it can be concluded that High Category Students (HCS) are able to fulfill the four indicators of critical thinking aspects according to Jacob & Sam (2008), namely clarification, assessment, strategies, inference, so it can be said that High Category Students have critical thinking skills.

b. Medium Category Students

- **Subject 3 (S3) Question Number 1**

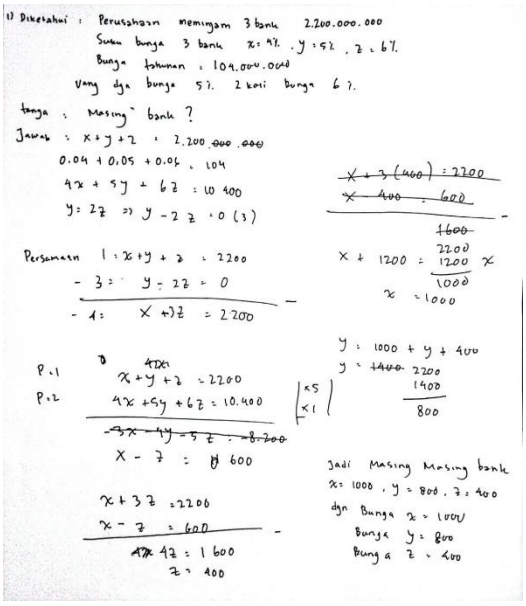


Figure 5. The results of the answers to the story problems of Subject 3 question number 1

The results of this student work are supported by the results of the interview presented in the following excerpt.

P : "What information is obtained from question number 1?"
S3 : "It is known that the company borrowed 3 banks 2 billion 200 million with

interest rates for the 3 banks of 4%, 5%, and 6%. The annual interest is 104 million, then the money with 5% interest is equal to twice the money with 6% interest. Ask the loan of each bank?".

P : "How do you find out the information?".

S3 : "Read the problem first, then scrutinized".

P : "Is the information from problem number 1 enough to solve the problem in the problem and in what way to process the information?".

S3 : "It's enough, processing the information by making permissiveness and writing the mathematical model".

P : "What strategies do you use to solve problems in problem number 1?".

S3 : "Using the substitution method, and elimination".

P : "How do you conclude from the answer to question number 1?".

S3 : "For the conclusion I wrote from the answer".

- **Subject 3 (S3) Question Number 2**

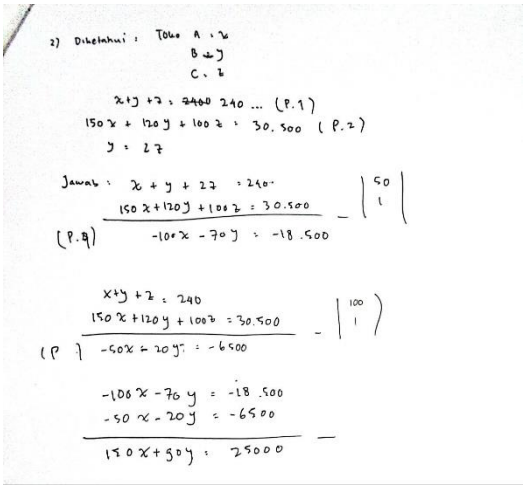


Figure 6. The results of the answers to the story problems of Subject 3 question number 2

The results of this student work are supported by the results of the interview presented in the following excerpt.

P : "What information is obtained from question number 2?"

S3 :" It is known that stores A, B, C in the first month sold a total of 240 pairs of shoes. Shop A bought shoes for 150 thousand, shop B bought shoes for 120 thousand, shop C bought for 100 thousand. Store B sold 2 times more than store C. The company's revenue in the first month reached 30 million 500 thousand. The next month sales increased by 50%. Ask what is the total revenue of the company for 2 months?".

P : "How do you find out the information?".

S3 : "Read the problem carefully".

P : "Is the information from problem number 2 enough to solve the problem in the problem and in what way to process the information?".

S3 : "It's enough, the first step is to make an assumption and then write the math model".

P : "What strategies do you use to solve problems in problem number 2?".

S3 : "Same as number 1, using the substitution method, and elimination, but I haven't gotten the results because I haven't completed the math operation".

- **Subject 4 (S4) Question Number 1**

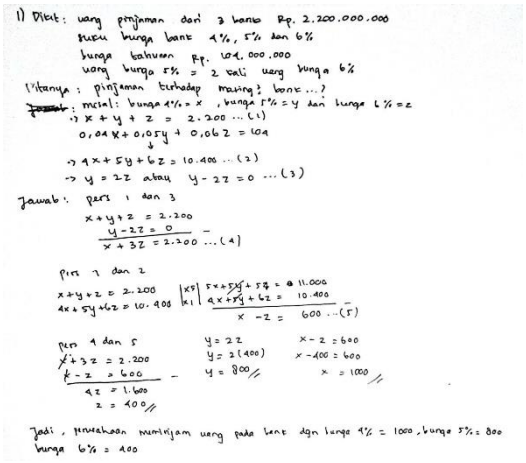
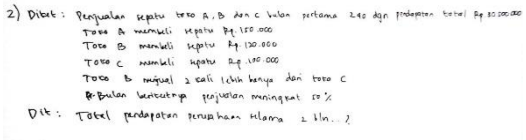


Figure 7. The results of the answers to the story problems of Subject 4 question number 1

The results of this student work are supported by the results of the interview presented in the following excerpt.

P : "What information is obtained from question number 1?"
S4 : "It is known that the loan money from 3 banks is 2 billion 200 million, then the bank interest rates are 4%, 5%, and 6% with an annual interest of 104 million, money with 5% interest is equal to 2 times the money with 6% interest. What is the loan to each bank?".
P : "How do you find out the information?".
S4 : "Read the whole question".
P : "Is the information from problem number 1 enough to solve the problem and how do you process the information?".
S4 : "Already, processing the information by generalizing after that it is written in the mathematical model".
P : "What strategy did you use to solve the problem in question number 1?".
S4 : "What I used to solve the problem is the elimination method, and the substitution method".
P : "How do you conclude the answer to question number 1?".
S4 : "By adjusting it to the answer I got".

- **Subject 4 (S4) Question Number 2**



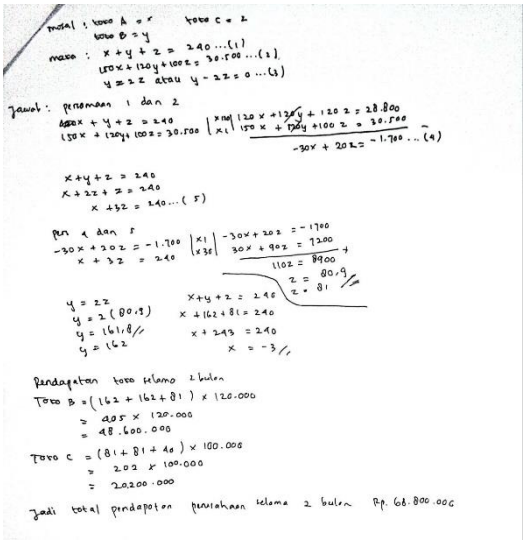


Figure 8. The results of the answers to the story problems of Subject 4 question number 2

The results of this student work are supported by the results of the interview presented in the following excerpt.

P : "What information is obtained from question number 2?"

S4 : "It is known that the sales of shoes in stores A, B, C in the first month were 240 pairs with a total income of 30 million 500 thousand. Store A bought shoes for 150 thousand, store B bought shoes for 120 thousand, store C bought for 100 thousand. Store B sold 2 times more than store C. The next month sales increased by 50%. What is the total revenue of the company for 2 months?".

P : "How do you find out the information?".

S4 : "Read the problem thoroughly".

P : "Is the information from problem number 2 enough to solve the problem in the problem and in what way to process the information?".

S4 : "Enough, by making an equation and writing the mathematical model".

P : "What strategy did you use to solve the problem in question number 2?".

S4 : "Using the substitution and elimination method after that calculating the revenue of each store for 2 months, then if the results have been obtained, the next step is to add up the revenue results of all stores for 2 months".

P : "How do you conclude the answer to question number 2?".

S4 : "Write down what is asked and adjusted to the answer obtained".

Based on the results of the story problem test and interviews on subject 3 and subject 4 above, it is known that subject 3 and subject 4 are only able to fulfill three or two indicators of critical thinking, in problem number 1 subject 3 did not write what was known but he was able to explain the problem in the problem, namely what was known and asked in the problem. While subject 4 was able to explain and write the problem in the problem precisely and clearly. Then from the information available, subject 3 and subject 4 make a permutation of what is known then make a mathematical model, in order to find an alternative solution. Furthermore, for problem number 1, subject 3 and subject 4 have used the right solution strategy, namely using the elimination and substitution method in order to solve the problems in the problem, but at the conclusion stage subject 3 and subject 4 made a mistake because they did not include 0 which was stored at the beginning of the

operation to facilitate the calculation operation. In problem number 2, subject 3 made a mistake when starting the calculation operation when writing equation 1 to perform the elimination process to x + y + 2z = 240 should be x + y + z = 240 and did not complete the math operation. While subject 4 made a mistake in the elimination process of equations (4) and (5) which should have obtained the answer 110z = 5,500, so that it made the results obtained wrong and produced the wrong conclusion as well. So it can be concluded that Medium Category Students are only able to fulfill three or two indicators of critical thinking aspects.

c. Low Category Students

- **Subject 5 (S5) Question Number 1**

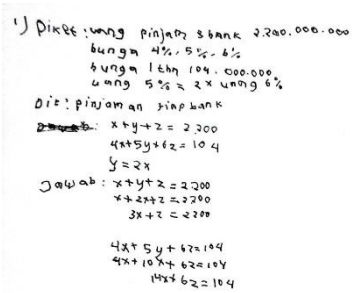


Figure 9. The results of the answers to the story problems of Subject 5 question number 1

The results of this student work are supported by the results of the interview presented in the following excerpt.

P : "What information is obtained from question number 1?"
S5 : "It is known that the money borrowed from 3 banks is 2 billion 200 million with 4%, 5%, and 6% interest. The interest that must be paid is 104 million. The 5% interest money is equal to 2 times the 6% interest money. Asked about the loan for each bank?".
P : "How do you find out the information?".
S5 : "I read the problem thoroughly".
P : "Is the information from problem number 1 enough to solve the problem and in what way do you process the information?".
S5 : "It's enough, by writing x, y, z".
P : "What strategy did you use to solve the problem in question number 1?".
S5 : "With the substitution method, but I couldn't finish until the end because I didn't know what to do next if the numbers were different".

- **Subject 5 (S5) Question Number 2**

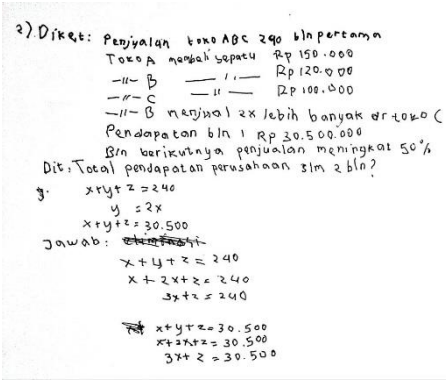


Figure 10. The results of the answers to the story problems of Subject 5 question number 2

The results of this student work are supported by the results of the interview presented in the following excerpt.

P : "What information is obtained from question number 2?"

S5 : "It is known that stores A, B, C sold 240 shoes in the first month. Store A bought shoes for 150 thousand, store B bought shoes for 120 thousand, store C bought shoes for 100 thousand. The revenue of the first month is 30 million 500 thousand. The next month sales increased by 50%. Ask the total revenue of the company for 2 months?".

P : "How do you find out the information?".

S5 : "Read the whole problem".

P : "Is the information from problem number 2 enough to solve the problem in the problem and in what way to process the information?".

S5 : "It's enough, write down the x, y, z".

P : "What strategy did you use to solve the problem in question number 2?".

S5 : "Substitution method, but I can't continue the next step because the numbers are different".

- **Subject 6 (S6) Question Number 1**

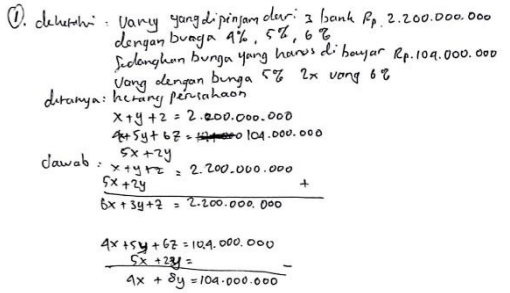


Figure 11. The results of the answers to the story problems of Subject 6 question number 1

The results of this student work are supported by the results of the interview presented in the following excerpt.

P : "What information is obtained from question number 1?"

S6 : "It is known that the money borrowed from 3 banks is 2 billion 200 million with 4%, 5%, and 6% interest. Then the interest to be paid is 104 million, it is also known that the money with 5% interest is equal to twice the money with 6% interest. What is the company's debt?".

P : "How do you find out the information?".

S6 : "By reading the problem".

P : "Is the information from problem number 1 enough to solve the problem in the problem and in what way to process the information?".
S6 : "Not yet because it is insufficient".
P : "What strategy did you use to solve the problem in problem number 1?".
S6 : "By eliminating the equation, but I can't solve it because I don't understand".

- **Subject 6 (S6) Question Number 2**

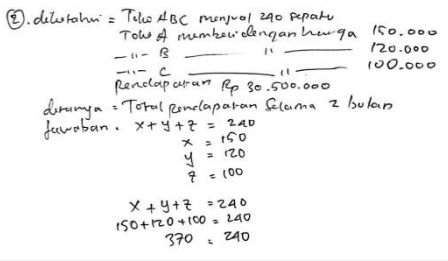


Figure 12. The results of the answers to the story problems of Subject 6 question number 2

The results of this student work are supported by the results of the interview presented in the following excerpt.

P : "What information is obtained from question number 2?"
S6 : "It is known that shops A, B, C sell 240 shoes. Store A bought at a price of 150 thousand, store B bought at a price of 120 thousand, store C bought at a price of 100 thousand. Revenue 30 million 500 thousand. Asked the total revenue for 2 months?".
P : "How do you find out the information?".
S6 : "By reading the problem".
P : "Is the information from problem number 2 enough to solve the problem in the problem and in what way to process the information?".
S6 : "I think it is enough".
P : "What strategy did you use to solve the problem in problem number 2?".
S6 : "Putting the values of x, y, and z into another equation but I think my answer is wrong".

Based on the results of the story problem tests and interviews on subject 5 and subject 6 above, it is known that subject 5 is only able to fulfill one critical thinking indicator, while subject 6 is not able to fulfill the critical thinking indicators at all. In problems number 1 and 2, subject 5 can write and explain the problems in the problem, while subject 6 in problem number 1 is only able to write and explain what is known while what is asked, subject 6 has an error. But in problem number 2, subject 6 was correct in writing and explaining the problem only incomplete. Then from the information in the problem, subject 5 and subject 6 made it into a mathematical model but

the resulting mathematical model was not correct. For the solution strategy carried out by subject 5 using the substitution method, but because there was an error in modeling the previous mathematics and subject 5 could not continue the calculation operation because he did not understand the next step to do. As for subject 6, he answered that the strategy used for problem number 1 was substitution but the substitution was not correct, and for problem number 2, subject 6 only rewrote the mathematical model he made and added it up. Subject 5 and subject 6 could not complete the calculation operation due to a lack of understanding of the material of the system of linear equations of three variables, so they did not get a conclusion.

The results of this study are in line with some previous research results, such as research by (Safitri, 2018) which states that students' critical thinking profiles do differ in solving HOTS problems. At the stage of formulating the problem, High Category Students and Medium Category Students can express what is known and asked in the problem in detail. High Ability Students can also mention relevant information and are able to use it to obtain alternative solutions and find a solution strategy. Meanwhile, Low Category Students only reached the clarification stage.

Another study by (Adinda, 2016) states that someone thinks critically means being able to analyze existing information and identify relevant and irrelevant information, identify and evaluate assumptions, apply strategies, make decisions according to assessment standards. Critical thinking makes people evaluate their own thoughts to ensure that they can decide on the best conclusion. However, people who do not think critically, cannot decide what to think, and how to act. Critical thinking is one of the higher-level thinking and not all children can reach this level well, so it requires teachers to provide assistance to students.

CONCLUSION

Based on the results of the study, it can be concluded that High Category Students can fulfill all indicators of critical thinking aspects, namely clarification, assessment, strategies, and inference. Medium category students are only able to fulfill three indicators, namely clarification, assessment, and strategies or only two indicators, namely clarification, and assessment. And in the Low Category Students are only able to fulfill one critical thinking indicator, namely clarification while other subjects cannot fulfill any of the critical thinking indicators.

Based on the above conclusions, the suggestion from the researcher is that the teacher must be able to convey the material well so that students can understand what the teacher is saying. And provide more examples of varied problems so that students can learn from different problems and not get bored. And pay more attention to students who are in the low category because there are still those who do not understand at all about the problems in the problem, let alone the right solution strategy.

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