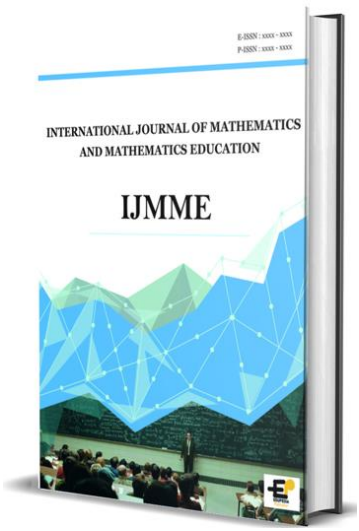

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Analysis of High School Students' Errors in Solving Story Problems on Systems of Linear Equations with Three Variables

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Analysis of High School Students' Errors in Solving Story Problems on Systems of Linear Equations with Three Variables

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Abstract

This research is motivated by the large number of students who make mistakes when working on questions, so it can be an indication of how well students understand the material. SPLTV material was chosen for this research because SPLTV has components that students must understand so that they can easily determine mistakes made by students. This research aims to reveal the facts, circumstances, phenomena, variables and circumstances that occurred when the research was conducted. This type of research is qualitative research with a quantitative descriptive approach. The research subjects were 34 class X students at SMAN 2 Tualang. The data collection techniques used in this research are: 1) written tests, and 2) interviews. Based on the results of data analysis, a conclusion was obtained which showed that students made mistakes in Newman's stages, namely: errors in reading were 23.53%, which means that the majority of students read the question instructions well. The large percentage of students making errors in understanding is 91.18%, and students making transformation errors with a percentage of 55.88%. In process skill errors, the number of students who made mistakes was 82.35%, and 88.23% of students made mistakes in writing/notation. Factors that cause errors include: not being careful, not being able to read the question, not understanding the problem, and not being able to carry out the procedures or steps that will be used to solve the question.

Introduction

Mathematics plays a very important role in everyday life. Mathematical knowledge is indispensable in schools in order to keep pace with the rapid development of science and technology (Noerhasmalina et al., 2021). This is because mathematics is the basis of all fields of science and technology. Through mathematics learning, students are expected to develop critical, logical, systematic, careful, effective, and efficient thinking skills in solving problems (Tang & Loban, 2023). The objectives of mathematics learning can be said to be achieved if one of them can be assessed by the success of students in

understanding mathematics and utilizing this understanding to solve mathematical problems and other sciences (Fauziyah & Pujiastuti, 2020). However, in reality, mathematics is still a subject that in the shadows of students is a heavy subject and difficult to understand. To learn mathematics at least students already can understand the concept first, because, with an understanding of this concept, students will be able to construct the intended meaning (Utami & Zukarnaen, 2019).

Problem-based mathematics learning involves math story problems, usually in the form of questions that contain contextual problems related to students' daily activities that can be solved using mathematics (Magfirah & Yusran Zakaria, 2023). According to Ansori & Mawaddah, (2019), Mathematical story problems are problems related to contextual problems, which understand what is known and asked in the problem and follow the right steps to get accurate results. Students are required to think more deeply to solve the problem. By using story problems in Mathematics learning, students are expected to develop problem-solving skills that can be used as a foundation for solving problems in everyday life (Madhuri, 2020).

But in reality, there are still many students who make mistakes in solving math problems, especially those related to everyday problems. According to Sara et al., (2020), Mistakes in working on story problems occur because working on story problems requires complex skills. In some cases, students may not be able to understand the meaning of a question, may not be able to interpret a story problem in a math text, or may lack attention when performing calculations when in fact they know how to answer the question (Yuliana et al., 2019).

The Three Variable Linear Equation System (SPLTV) material is one of the mathematical materials that is usually presented in the form of story problems (Auliya & Lestariningsih, 2020). Students have difficulty turning story problems into mathematical models (Birrul Walidain & Martila Ruli, 2022). The average of this material takes examples in everyday life, and the presentation of many questions in this material is in the form of story problems. The presentation of questions in the form of stories is an effort to provide stimulus to students so that students can imagine the concept of this material in everyday life (Baskorowati, 2021). The application of this story problem then makes the material of the three-variable linear equation system a fairly difficult material. This makes it difficult for students to find solutions.

To find out the types and causes of errors in these students, a study was conducted that analyzed student errors in solving questions on the subject matter of SPLTV. The technique used to analyze student answer errors is to use Newman's theory. However, according to Zaekhah et al., (2021), Newman Errors Analysis is a capable way to carry out error analysis of mathematical problems because it is seen as more systematic than other methods. By analyzing student errors using the Newman method, the author hopes that the results of the analysis can help find the types of student errors and the factors that cause student errors in the Three Variable Linear Equation System (SPLTV) material based on the Newman stages. Therefore, the study focused on using Newman's theory to analyze students' errors in solving mathematical problems about three-variable linear equation systems (SPLTV).

According to Lelboy et al., (2021), There are five stages of work suggested by Newman in solving problems and from these stages can also be found the cause of students making mistakes when solving a problem including reading, understanding, transformation, process skills, and writing answers. Previous research conducted by class X SMAN 14 Bekasi obtained the results of error analysis according to (Mulyani & Haerudin, 2021)*Newman* A reading error of 0% was obtained which means that none of the students read the question incorrectly because all students read the question well, a misunderstanding error of 30.23% due to students not writing known and asked, a transformation error of 20.93% due to students not being able to transform the given question into a mathematical form so that they could not make a mathematical model, a process skill error of 24.42% due to lack of accuracy Students in doing calculations that resulted in errors, and errors in writing the final answer by 24.42% were caused by students being incomplete when making conclusions. The research conducted by the researcher is related to the story problem on this SPLTV material at SMAN 2 Tualang school, for that the purpose of this study is to analyze students' errors in doing story problems on SPLTV material according to *Newman*.

Based on the description above, this study aims to describe students' errors in solving story problems on the Three Variable Linear Equation System (SPLTV) material using the Newman method and what factors cause these errors. The location of the error is where the student goes wrong at the problem-solving stage (Kuswanti et al., 2018). On the other hand, the nature of errors the concept of error and problem-solving when performing calculations can use students' intellectual abilities to solve problems and identify which factors caused their mistakes (Mulyani & Haerudin, 2021). The location, nature, and factors that cause student errors can later be a reference for educators to choose the right learning method to improve learning in the classroom and avoid these mistakes (Ariska & Rahman, 2020).

Method

This research is qualitative research with a quantitative descriptive approach. Qualitative research is research on research that is descriptive and tends to use analysis, process and meaning (subject perspective) more highlighted by qualitative research (Delvia & Cut, 2018). This research requires information in the form of descriptive data. The purpose of this study is to reveal facts, circumstances, phenomena, variables and circumstances that occurred when the research was conducted. In this case, the focus is on students' errors in solving story problems on the material of the three-variable linear equation system.

The subjects of the study were 34 students of grade X of SMAN 2 Tualang as many as 34 students. Data collection techniques used in this study are: 1) written tests, and 2) interviews. In this case, the test aims to determine the location of student errors based on the stages of Newman's analysis, in the form of a 5-point description test question containing Three Variable Linear Equation System questions. The interview aims to strengthen and check the validity of the data. The SPLTV story test questions are done for 40 minutes and will be analyzed based on the Newman error indicator in Table 1 as follows.

Table 1. Error Indicators According to the Newman Procedure 1

No	Error	Error indicator	
1.	Reading error	1.1	Errors in reading terms or symbols in SPLTV questions.
2.	Comprehension error	2.1	Mistakes in understanding what is known completely and what is asked about the SPLTV questions.
3.	Transformation error	3.1	Error in converting SPLTV questions into mathematical model form.
		3.2	Errors in determining strategies for solving SPLTV questions
4.	Process Skill error	4.1	Errors in carrying out mathematical calculation operations
5.	Encoding error	5.1	Errors in writing conclusions.

Source: modified from That & Ismail (2023)

Newman's analysis technique is used to analyze the location of students' errors in solving problems, which consist of errors: in *reading, comprehension, transformation, process skill, and encoding*. The test answer results are corrected based on the answer key. The researcher gave a little briefing on the process. When the test is given, students are given the freedom to do it according to their abilities.

In data analysis, researchers will analyze the test data from all students who took the written test taken by 5 students as research subjects, the results obtained from the written test will be analyzed to find out student errors. Then the answers analyzed are the wrong answers and the ones that do not answer. Students who did not write the answer directly had made a maximum error of 5 indicators of error based on the stages of Newman's analysis.

Results

From the results of the analysis of student answers, based on the Newman method error procedure, various forms of errors made by students are known, namely reading errors, comprehension errors, transformation errors, process skill errors, and final answer writing errors (Putri & Nur, 2022). The following is the result of students' work in solving SPLTV material problems based on the Newman method presented in Table 2.

Table 2. Description of Student Mistakes 2

Error Type	Number of Students Making Mistakes	Percentage	Question Items
Reading	8	23,53%	1
Comprehension	31	91,18%	2
Transformation	19	55,88%	3

Process Skill	28	82,35%	4
Encoding	30	88,23%	5

Based on Table 2, a large percentage is obtained for mistakes made by students in solving SPLTV questions, namely students who make mistakes in reading, which is 23.53%, which means that most students read the question commands well. The percentage of students making mistakes in understanding is 91.18%, and students make transformation errors with a percentage of 55.88%. In process skill errors, the number of students who made mistakes was 82.35%, and students who made mistakes in writing the final answer by 88.23%.

The questions given to students consist of 5 questions including:

1. A cake shop provides cakes in 3 sizes, namely small, medium and large. The price of 3 small cakes and 1 medium cake is Rp. 136,000. The price of 1 small cake and 2 large cakes is Rp. 239,000. And the price of 2 medium cakes and 3 large cakes is Rp. 539,000. Set a cake price for each size!
2. A number consists of three numbers which when added together give 9. The old number is three more than the number tens. If the number hundreds and tens are swapped, the same number is obtained. Determine the number!
3. Mifta, Jannah, and Anna go together to the fruit shop. Mifta bought 1 kg of apples, 2 kg of grapes, and 1 kg of oranges for Rp. 175,000.00. Jannah bought 2 kg of apples, 1 kg of grapes and 3 kg of oranges for Rp. 167,000.00. Anna bought 1 kg of apples, 1 kg of grapes, and 1 kg of oranges for Rp. 110,000.00. How much do 1 kg of apples, 4 kg of grapes, and 3 kg of oranges all cost?
4. Five years ago, the ages of Nida, Tia and wrestling when added together were 65 years old. Now, Nida's age is 4 years less than Gusti's, while Tia's age and Gusti's age when added together are 42 years. If it is now 2024, what year was Nida born?
5. A shopping centre in Pekanbaru City provides several parking lots that contain car units, motorcycle units and two-wheeled motorcycle units. The number of the three types of vehicles is 89 units. The number of two-wheeled cars and motorcycles is 77 units. The number of three-wheeled cars and motorcycles is 38 units. Determine the number of car units! xyz

Discussion

Based on the results of the research above, there are 5 types of errors known based on the Newman method, the following the results of the answers obtained regarding the question will be described as follows:

Reading Error

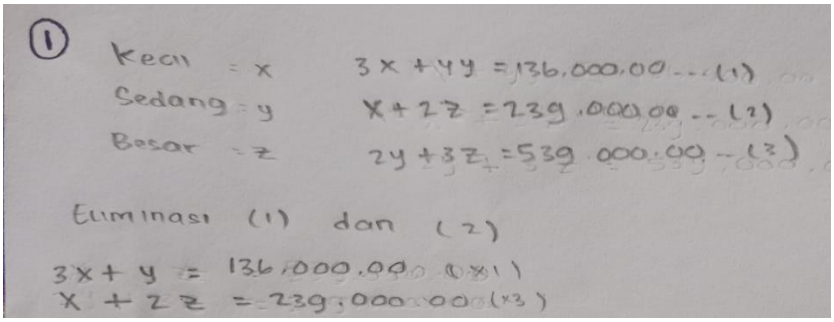

Figure 1. Student errors in reading

The students' answers in Figure 1 above, show that S-1 students are less careful in reading the information written on the questions. This is shown by the answers of S-1 students it can be seen that students made the wrong mathematical model because the information in the question is 3 small cakes and 1 medium cake for 136,000 rupiah, but the student instead wrote 3x + 4y = 136,000. Therefore, the answer stated that the S-2 student was wrong in reading the information on the question. From this, it can be concluded that students make mistakes at the stage of reading the information written in the questions caused by students are less careful and rush in reading the questions, resulting in students having difficulty understanding the problems contained in the questions. The following is an excerpt from an interview with an AP subject related to question number 1 reading stage error.

P: Is the story understandable?

AP: Yes, sis, the questions can be understood easily

P: Then why are you wrong in writing what you know?

AP: Sorry sis, it's just that I wasn't careful enough to capture that information. That's why I wrong in writing the mathematical model

Comprehension Error

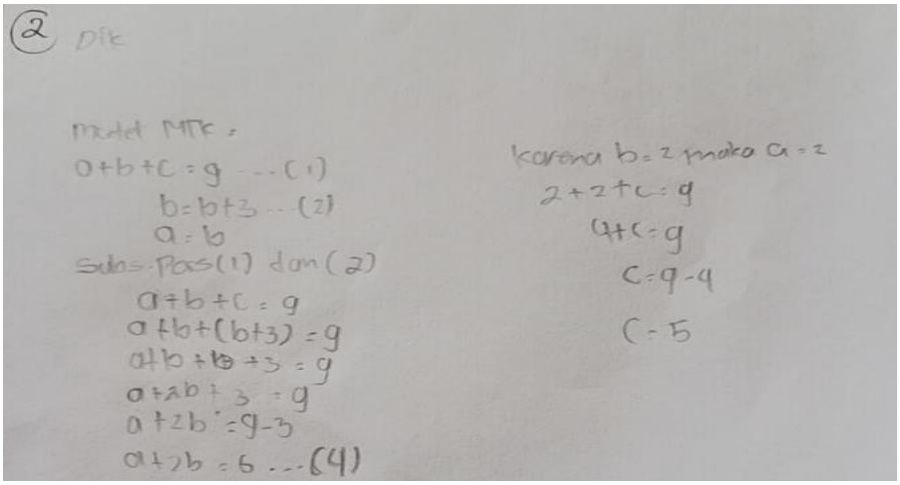

Figure 2. Student errors in understanding

The students' answers in Figure 2 above, show that S-2 students have difficulty in understanding the problem. This is shown by the answers of S-2 students who write sober only make mathematical models, which shows that it is known to be incomplete and students do not write down what is asked from the questions so students will find it difficult to continue answering the questions. Therefore, the student's answer stated that the student had difficulty understanding the problem on the problem. It can be stated that one of the causes of *comprehension errors* is that students cannot know what is known completely from the problem. The following is an excerpt of an interview with the MA subject related to question number 2 reading stage error.

P: Why don't you write down the things you know and ask on the answer sheet?

MA: Yes sis, I have a very difficult time understanding the matter and that's why I Just write down the answer without anyone knowing completely what is asked. I was also in a hurry because of a lack of time In doing the problem, sis.

Transformation Error

Selected subject S-3 students as an example of mistakes made by students. The error in question point number 3 was made by several students. Based on the student's answers to question number 3, some students make mistakes, namely errors in transforming the problem into the mathematical form contained in the problem. Here are the results of the students' answers.

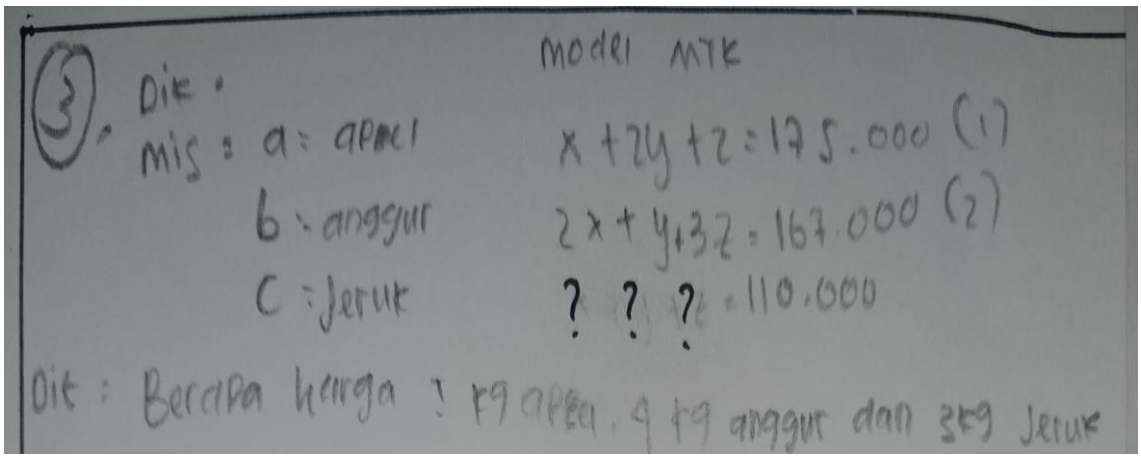

Figure 3. Student errors in the transformation

The students' answers in Figure 3 above, show that S-3 students have not been able to transform the problem into mathematical form. The mistake of S-3 students is not to convert the information on the problem into a mathematical model in the third statement. Therefore, in the answer, it was stated that S-3 students were unable to transform the problem into mathematical form. It can be stated that transformation errors occur when students understand what is desired from the question but cannot identify the operations or lines of operations needed to solve the problem. Another possible cause of transformation errors is that students are less careful in determining information about what is known and asked in the problem and are unable to translate question sentences into mathematical sentences

(models). The following is an excerpt of an interview with subject JM related to question number 3 of reading errors.

P: Why don't you write down the mathematical model completely?

JM: I forgot to make the third mathematical model because I was in a hurry to fill in The answer is first, sis.

Process Skill Error

Selected subject S-4 students as an example of mistakes made by students. The error in question point number 4 was made by several students. Based on the student's answers in question point number 4, some students make mistakes, namely student errors in process skills when working on the questions. Here are the results of the students' answers.

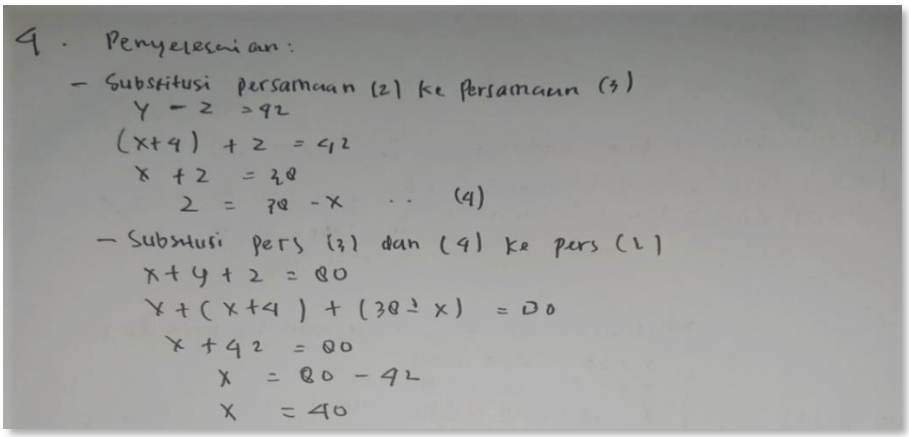

Figure 4. Student errors in process skills

The student's answer in Figure 4 above, shows that S-4 students are weak in process skills because students are wrong in writing down the results obtained from the equation that has been written before, the answer to x should be 38 but instead answered 40. The mistake of S-4 students is not being able to perform the reduction operation process correctly. Therefore, the answer stated that S-4 students are weak in process skills. This shows that *this process skills error* is due to students making misconceptions, lack of background knowledge and reasoning, and errors in basic operation calculations. The following is an excerpt of an interview with the subject of KA related to question number 4 reading stage error.

P: Do you know how many x are on the question?

KA: This is Kak (pointing to the answer).

P: Try counting it again, is it true that the answer is 40?

KA: Oh it turns out that I answered wrong sis, the answer should be 38 sis. I Too hasty to answer because time is running out sis, and the answer is not I correct it Back.

Encoding Error

Selected subject S-5 students as an example of mistakes made by students. The error in question point number 5 was made by several students. Based on the student's answers in question point number 5, some students make mistakes, namely student errors in conclusions from the answers students get. Here are the results of the students' answers.

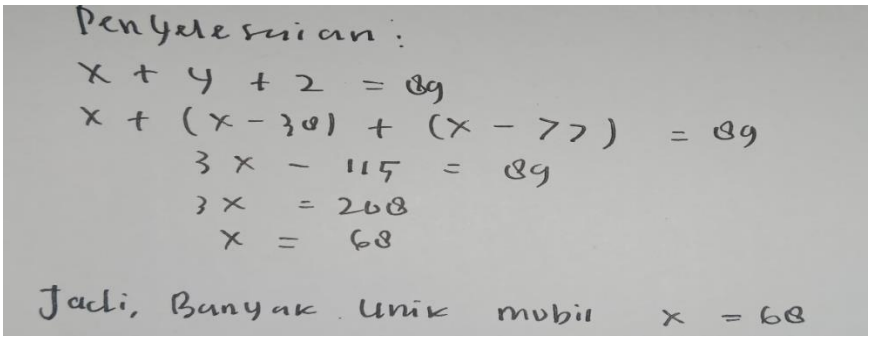

Figure 5. Student errors in writing/notation

The students' answers in Figure 5 above, show that the S-5 students were wrong in concluding the final result. This is shown by the answers of S-5 students who wrote the final answer. The answer is wrong in summing up the final result. Therefore, S-5 students are still unable to conclude the final result intended by the question. From the results of the research that has been done, it can be said that students make final answer errors, because students do not write down the final results according to the procedures or steps used. The following is an excerpt of an interview with DS subject regarding question number 5 reading stage error.

P: Is the conclusion you made correct?

DS: I think it's already sis, because I know it's just like that, sis.

P Is there a lesson during learning to make conclusions correctly?

DS: There is sis, but I am very different about it so I doubt how to conclude again sis.

Conclusion

Based on the results of students' answers, it can be concluded that, students' errors in solving SPLTV questions are error in reading, which is 23.53%, which means that most students read the question commands well. The percentage of students making mistakes in understanding is 91.18%, and students make transformation errors with a percentage of 55.88%. In process skill errors, the number of students who made mistakes was 82.35%, and students who made errors in writing/notation by 88.23%. The majority of students make mistakes in understanding and writing/notation.

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