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# ERROR ANALYSIS OF SENIOR HIGH SCHOOL STUDENT'S PROBLEM SOLVING ABILITY ON THREE VARIABLES LINEAR EQUATION SYSTEM

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## ABSTRACT

Mathematics is a lesson regarded regularly, logically, tiered from the easiest to the most complicated. Mastery and students' understanding of a material can be seen from student mathematical abilities. Analyze the student's error in completing the problem can know the students master a matter or not. This research has a goal to describe and analyze the student's error in completing the line of the linear equation system of three variables. The type of research using descriptive qualitative with the subject of research is a student of X SMAN 1 Pangalengan class. The sample for obtaining data is 6 students who represent high-level, high and low students who are classified from the average results of the test of the linear equivalent system of three variables. The data to be generated are the result of a description test. From the data can be generated by student difficulty analysis in completing the line of the linear equation system of three variables. The slaughter faced by students in the form of errors on conceptual, proseudral and technical. Meanwhile, the lack of understanding the concept of linear equation systems of three variables makes the error of the misman that occur going so that the factors cause the difficulty in the material.

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## INTRODUCTION

Mathematics is one of the subjects related to everyday life. As Khatimah, Sa'dijah & Susanto (2017) argue that mathematics is one of the basic sciences given from basic education to high school, where mathematics has a very important function in everyday life. According to Ahmad Susanto (2016) said that mathematics is one of the disciplines that can increase reason and argumentation, provide donations to solving everyday problems and in the world of work, and can be a support in the development of science and technology. it cannot be denied that

this was influenced by the role of mathematics as one of the branches of science that underlies the development of other sciences.

One of the subjects of mathematics is the material System of linear equations of three variables (SPLTV). This material is taught at the X grade high school level, this material is also considered to have a fairly difficult level. because on average this material reaches for models in everyday life, and the presentation of problems in this material is a lot in the form of story problems. The presentation of story-shaped problems is an attempt to provide stimulus to students, so that students can imagine the concept of this material in everyday life. The application of story problems is what then makes the material of the system of linear equations of three variables a fairly difficult material. Based on preliminary studies conducted by researchers on class X students at SMAN 1 Pangalengan, students were still found to make mistakes while solving the given SPLTV problems or problems. Jusniani (2018) Mistakes made, such as students failing to collect crucial issues contained in the problem, students making errors in generating mathematical examples, and students making mistakes when doing calculations.

According to Subaidah (Widodo, 2016) "errors in solving math problems can be divided into three types, namely concept errors, principle errors and operation errors". So, Subaidah argues that the first student error is an error in mathematical concepts, one of which is that students make mistakes in understanding the meaning of the problem. The second error means that students make errors in mathematical principles, for example students incorrectly use mathematical formulas and the last is operation errors, namely errors in calculations or laws of mathematical operations. The cause of these errors is students' lack of understanding of the prerequisite materials for three-variable linear equations, such as number operations and algebraic operations. Even though students have understood the prerequisite materials, students are less able to use their understanding to solve problems of linear equations of three variables, lack of understanding of the steps of solving equations and the inability of students to identify each term of the equation, students lack practice in completing problems related to the material of linear equations of three variables, especially problems with various forms, a less conducive classroom atmosphere that makes it difficult for students to understand the teacher's explanation when the teacher explains this material in class, and students do not re-correct every step of the solution that has been done.

One of the impacts of student errors is that they can hinder students in solving problems. As revealed by Untari (2013) that students who experience difficulties have the opportunity to be able to make mistakes in solving math problems on each subject matter in learning. therefore, an analysis of the mistakes made by students is expected, in order to find out the reasons why students make mistakes. Error analysis means a study carried out on the work of students using the aim of finding the reasons for the mistakes made. This error analysis is done not only to analyze the steps of students' work that are completely correct, partially valid, or wrong to find solutions. also is the best solution that can be used to improve learning.

Based on the background that has been described, researchers try to identify errors and look for factors that influence them. The types of errors made by students will be analyzed and described. thus similar errors can be minimized, resolved and focused more deeply on the learning process of the system of linear equations of three variables so that students' learning achievement increases, especially in mathematics subjects.

## **METHOD**

The type of research used is qualitative descriptive research. Qualitative descriptive (QD) is focused on answering research questions related to questions of who, what, where and how an

event or experience occurs until finally it is studied in depth to find patterns that appear in the event Kim, Sefcik & Bradway (2017). In summary, it can be explained that qualitative descriptive (QD) means a research method that moves on a simple qualitative approach with inductive flow. This inductive flow means that qualitative descriptive research (QD) begins with an explanatory process or incident that can finally draw a generalization which means a conclusion from the process or event. Qualitative descriptive research aims to describe fully and deeply the social reality that occurs. This research aims to describe and analyze student errors on the material of the system of linear equations of three variables.

This research took place at SMAN 1 Pangalengan. The research subjects were class X students totaling 25 people. The sample for obtaining data on the difficulties of students is by selecting 6 people who represent high, medium and low ability students who are classified according to the average-homogeneous due to the test of the Linear Equation System three Variables. Data collection in this study was carried out by including what would happen from interviews, tests and documentation in the form of pictures. Interviews were conducted with 5 students who were taken randomly. The test in the form of a description is given to students a total of two questions and the estimated time given is 45 minutes to answer these questions. Here are the questions that researchers use:

**Isilah persoalan dibawah ini menggunakan metode gabungan!!!**

1. Tentukan nilai  $x,y,z$  dari sistem persamaan linear tiga variabel berikut.  
 $x + y + 2z = 9$ ..... (1)  
 $2x + 4y - 3z = 1$ ..... (2)  
 $3x + 6y - 5z = 0$ ..... (3)
2. Toko alat tulis pak rudi menjual alat tulis berisi buku, spidol, dan tinta dalam 3 jenis paket sebagai berikut. Paket A: 3 buku, 1 spidol, 2 tinta seharga Rp 17.200,00. Paket B: 2buku, 2 spidol, 3 tinta seharga Rp 19.700,00. Paket C: 1 buku, 2 spidol, 2 tinta seharga Rp 14.000,00. Hitunglah harga 1 buku + 1 spidol + 1 tinta.

**Figure 1: SPLTV Problem**

In determining percentage points, researchers refer to (Andriani & Aripin, 2019)

$$P = \frac{n}{N} \times 100$$

Description:

P = Percentage of errors in student results

n = number of students experiencing difficulties

N = Number of students who took the test

Criteria for the percentage of the number of errors taken from each type of error, the score conversion refers to Nurkanca & Sunarta (Andriani & Aripin, 2019)

Table 1. Error count score reference

Percentage	Criteria
$90,00 \leq P \leq 100$	Very High
$80,00 \leq P \leq 90,00$	High
$65,00 \leq P \leq 80,00$	Medium
$55,00 \leq P \leq 65,00$	Low
$P \leq 55,00$	Very Low

## RESULTS AND DISCUSSION

### Results

This research was conducted by giving 2 questions to 25 students of class X SMAN 1 Pangalengan. Based on the results of students' answers to the work on the problem of the system of linear equations of three variables, there are several mistakes of students in working on the problem. The percentages obtained from students' answers are as follows:

Table 2: Percentage of Student Answers

Number	Question Indicator	Percentage	Criteria
1	3.3.5 Determine the solution set of a system of linear equations of three variables using the mixed method.	60 %	Low
2	4.3.1 Determine contextual problems related to SPLTV	88 %	High

in the data that will occur the percentage above, it can be observed that in 25 students the location of errors on question piece 1 contains a percentage of 60% which is in the low category, question piece number 2 contains a percentage of 88% with a high category. The following is the documentation of student answers that will be analyzed.

Then the results of the action on high ability students:

The figure shows two pages of handwritten mathematical work. The left page is for problem 1, and the right page is for problem 2. Both solutions use the elimination method to solve systems of linear equations in three variables (SPLTV).

**Problem 1 (Left Page):**

Eliminasi x ke Pers (1) dan (2)

$$\begin{array}{r} x + y + 2z = 9 \quad | \cdot 2 | \quad 2x + 2y + 4z = 18 \\ 2x + 4y - 3z = 1 \quad | \cdot -1 | \quad -2x - 4y + 3z = -1 \end{array}$$

$$-2y + 7z = 17 \quad (4)$$

Eliminasi x ke Pers (1) dan (3)

$$\begin{array}{r} x + y + 2z = 9 \quad | \cdot 3 | \quad 3x + 3y + 6z = 27 \\ 3x + 6y - 5z = 0 \quad | \cdot -1 | \quad -3x - 6y + 5z = 0 \end{array}$$

$$-3y + 11z = 27 \quad (5)$$

Eliminasi y ke Pers (4) dan (5)

$$\begin{array}{r} -2y + 7z = 17 \quad | \cdot 3 | \quad -6y + 21z = 51 \\ -3y + 11z = 27 \quad | \cdot 2 | \quad -6y + 22z = 54 \end{array}$$

$$-z = -3$$

$$z = 3$$

**Problem 2 (Right Page):**

Eliminasi y ke Pers 1 dan 2

$$\begin{array}{r} 3x + y + 2z = 17.200 \quad | \cdot -2 | \quad -2x - 2y + 4z = -34.400 \\ 2x + 2y + 3z = 19.700 \quad | \cdot -1 | \quad -2x - 2y + 3z = -19.700 \end{array}$$

$$z = 19.200 \quad (9)$$

Eliminasi y ke Pers 2 dan 3

$$\begin{array}{r} 2x + 2y + 3z = 19.200 \\ x + 2y + 2z = 19.200 \end{array}$$

$$x + z = 5.700 \quad (5)$$

Eliminasi z ke Pers 1 dan 5

$$\begin{array}{r} 4x + z = 19.200 \\ x + z = 5.700 \quad | \cdot -3 | \quad -3x - 3z = -17.100 \\ 4x + z = 19.200 \quad | \cdot 4 | \quad 4(3000)z = 12.000 \\ 4x + z = 19.200 \quad | \cdot -4 | \quad -4(3000)z = -12.000 \\ 4x + z = 19.200 \\ -4x - 4z = -12.000 \\ -3z = 7.200 \\ z = 2.400 \end{array}$$

$x = 3000$

$x = 3000 \quad z = 2.700 \rightarrow 1$

$$3x + y + 2z = 17.200$$

$$3(3000) + y + 2(2.700) = 17.200$$

$$y = 17.200 - 9000 - 5.400$$

$$y = 2.800$$

$x = 3000 \quad y = 2.800 \quad z = 2.700 = 8.500$

Jadi harga 1 buku + 1 spidol + 1 tinta adalah Rp 8.500

Figure 2: Answers of high ability students

It can be seen in Figure 2, that in problem number 1, it was found that the high ability subjects made mistakes, namely not being careful in working on the problem and problem number 2 students were wrong in determining the results.

Explained that:

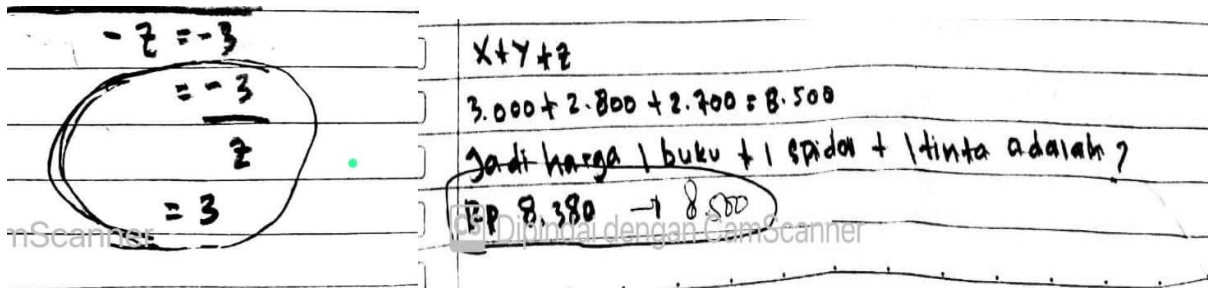


Figure 3: high ability students' mistakes

Seen in Figure 3, students make mistakes in operating the work.

The results of the action on the medium ability student subject :

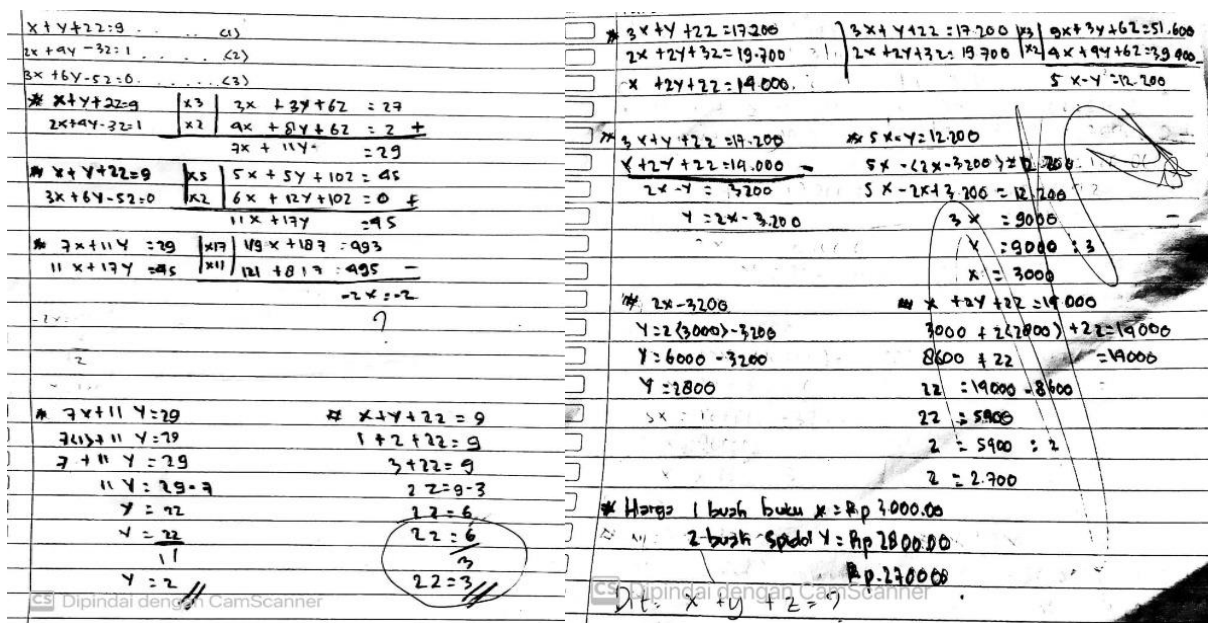


Figure 4: Answers of medium ability students

It can be seen in Figure 4, that in question number 1, it was found that the subject with moderate ability made mistakes, namely not clear in mentioning the answer and number 2 students were not careful in working on the problem.

Explained that:

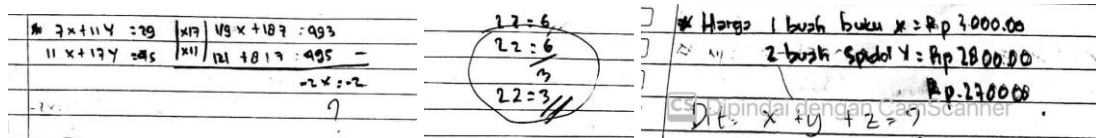


Figure 5: Medium ability student's error

In Figure 5, the student made a mistake in determining one of the variables.

The results of the action on low ability student subjects :



Jawaban  
 \* Eliminasi  $x$  ke pers 1 dan 2  
 $x + y + 2z = 9$  | 2 |  $2x + 2y + 4z = 18$   
 $2x + 4y - 3z = 1$  | 1 |  $2x + 4y - 3z = 1$  -  
 $-2y + 9z = 17$   
 \* Eliminasi  $x$  ke pers 1 dan 3  
 $x + y + 2z = 9$  | 3 |  $3x + 3y + 4z = 27$   
 $3x + 6y - 5z = 0$  | 1 |  $3x + 6y - 5z = 0$  -  
 $-3y + 11z = 27$   
 \* Eliminasi  $y$  ke pers 1 dan 5  
 $-2y + 9z = 17$  | 3 |  $-6y + 27z = 51$   
 $-3y + 11z = 27$  | 2 |  $-6y + 22z = 54$  -  
 $-z = -3$   
 $z = 3$   
 tentukan nilai  $x$  dan  $y$  nya mana?  
 2 a.  $3x + 4y + 2z = 17.200$   
 b.  $2x + 2y + 3z = 19.700$   
 c.  $1x + 2y + 7z = 14.00$   
 \* Eliminasi  $y$  ke pers 1 dan 2  
 $3x + y + 2z = 17.200$  | 2 |  $6x + 2y + 4z = 34.400$   
 $2x + 2y + 3z = 19.700$  | 1 |  $2x + 2y + 3z = 19.700$  -  
 $x + 1z =$   
 Dipindai dengan CamScanner

Figure 6: Low ability students' answers

Seen in Figure 6, it can be seen that in question number 1 and number 2 it was found that the low ability subjects made mistakes working on the problem.

### Discussions

Based on the results of the written test in the form of descriptions, the location of student difficulties in learning the subject matter of the system of linear equations of three variables is obtained, where in problem number 1 students are required to determine the solution set of a problem in accordance with indicator 3.3.5 Determine the solution set of the system of linear equations of three variables using mixed methods. And where in problem number 2 students are required to be able to implement a problem related to contextual problems which is in accordance with indicator 4.3.1 Determine contextual problems related to SPLTV. Then the results obtained are that students make conceptual, procedural and technical errors. The following is an explanation of the results of student answers to be analyzed.

It can be seen in Figure 2, that in problem number 1 it was found that the high ability subject encountered an error, namely not being careful in working on the problem, this can be seen in the incorrect operation. it can also be seen in the second problem that it was found that the high ability subject also encountered an error, namely not being careful in working on the problem, this can be seen in what will happen that the students get less than perfect, presumably because they are in a hurry to complete the problem. but high ability subjects do not encounter other difficulties and can work on the problem until it is completed. In line with research conducted by Hariyani, Ningsih & Fayeldi (2019) that someone makes a mistake that has an impact when he miscalculates the value in the calculation operation. It was explained that students made mistakes in operating the work. Lack of accuracy is a factor from students.. Where the student writes  $-z = -3$ , =  $\frac{-3}{z}$  It should be  $-z = -3$  menjadi  $z = \frac{-3}{-1}$ ,  $z = 3$ . As the idea of Ilmiyah, Purnama, Mayangsari (2018) Conceptual error means an error that occurs as a result of misinterpreting or using a word and concept. And where in question number 2 students are wrong in determining the results which cause errors in the final answer. As the idea of Hariyani, Ningsih & Fayeldi (2019) calculation errors made by students in solving a dilemma, especially in mathematics, can be distinguished as 3, namely: (1) in solving, students perform operations that are not synchronized; (2) students are wrong in involving a calculation; (3) students are wrong in using the solution procedure.

It can also be seen in Figure 4, that in problem number 1, it was found that the medium ability subject encountered errors that were not obvious in mentioning the answer. This can be seen in the subject who is not sure of determining the answer and is still mistaken in placing constant and variable operations and is wrong in moving the segments. In line with what

Hariyani, Ningsih & Fayeldi (2019) said When students make mistakes in writing variables or constants, it is included in technical errors, it can also be seen in question number 2 that the medium ability subject also encountered errors, namely not being careful in working on the problem, this can be seen in determining the final answer that the subject did not work on the problem as instructed, presumably because he was in a hurry to complete the problem. However, the subject of moderate ability did not encounter other difficulties and managed to work on the problem to completion. In line with Kuswanti (2018), the most common mistakes students make when working on SPLTV problems are transforming the problem and writing the final answer because students do not understand the important information in the problem. It is explained that students experience errors in determining one of the variables. The subject does not understand the operation performed where one of the examples should be  $2z = 6, z = \frac{6}{2}, \text{ and } z = 3$  but subject write  $2z = 6, 2z = \frac{6}{3}, \text{ and } 2z = 3$ . This error includes procedural errors. And seen in problem number 2 where students have not managed to solve the problem completely. In line with what Damayanti & Firmansyah (2019) said that when students do not continue working on problems or even do not solve problems based on perfect and correct steps, these students make procedural errors.

In addition, in Figure 6 it can be seen that in problem number 1 it was found that the low ability subjects made mistakes working on the problem, it can be seen that the subject did not solve the problem completely. it can also be seen in problem number 2 that it was found that the low-ability subject also made mistakes in working on the problem, it can be seen that the subject had difficulty so that the subject could not solve the problem completely. According to Albadawi, Zulfa & Sumani (2018) when learning in class students still do not understand the discourse of basic concepts, if the initial concept is still not understood then for the next students it is difficult to work on problems.

To deepen the analysis of the tests that have been carried out, researchers conducted interviews with five students who have difficulty in the material of the system of linear equations of three variables. As for what will happen in the interview the researcher used 5 students. It can be concluded that the statement about math being difficult makes limitations on their thinking, so that when they learn math, whatever the material, when in their minds it is difficult then they consider it difficult. Lack of motivation to learn because they think that math teachers always teach in a conservative style so that students lack concentration and are easily sleepy when learning. The material of the system of linear equations of three variables has a fairly long way of solving so that students are still confused. Students are not familiar with story problems so that students like simple problems that are directly known to the mathematical model rather than story problems that must make the mathematical model first. Therefore, students' lack of understanding of the material of the system of linear equations of three variables. In addition, students tend to be less careful and in a hurry when working on problems, students rarely review what has been learned so that sometimes the material is forgotten on that day, as a result students sometimes fill in problems with the lure that the crucial is not too empty. Westwood (2008) argues that learning difficulties refer to obstacles that limit access to participation and results in a learning plan. In line with this, Anni (2009) defines learning difficulties as a situation that causes students to be unable to learn as they

should. Learning difficulties are synonymous with students' difficulties in receiving or absorbing lessons at school. Furthermore, Rumini (Irham & Wiyani, 2013) views learning difficulties as a condition where students experience exclusive obstacles in following the learning process to achieve optimal learning.

## CONCLUSION

According to the results and discussion that have been presented above, it can be concluded that there are several mistakes made by students which include conceptual errors, namely students are mistaken in operating a system of linear equations of three variables such as determining a mathematical model, still mistaken in addition, subtraction, multiplication and division, procedural errors, namely students mistakenly write problems and are not complete in working on the problem of a system of linear equations of three variables, while technical errors are students still making errors in writing constants and variables.

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