



ANALYSIS OF GRADE VIII STUDENTS' ERRORS IN SOLVING TWO-VARIABLE LINEAR EQUATION SYSTEMS BASED ON NEWMAN'S PROCEDURE

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ABSTRACT

This study aims to describe the errors made by Grade VIII H students at SMP Negeri 2 Palu in solving word problems on systems of linear equations in two variables based on Newman's procedure. This study employed a descriptive qualitative design. The subjects consisted of three students selected purposively based on the frequency and variation of errors identified through written tests and teacher recommendations. Data were collected through written tests and interviews, while data credibility was ensured through member checking. The results showed that students experienced four dominant types of errors, namely comprehension, transformation, process skill, and encoding errors. These errors were mainly caused by students' difficulties in understanding problem information, constructing mathematical models, carrying out procedural calculations, and formulating final answers appropriately. The findings of this study provide important implications for mathematics learning, particularly in strengthening students' conceptual understanding, mathematical modeling skills, and systematic problem-solving abilities.

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1. INTRODUCTION

Mathematics is a fundamental science that has an important role in everyday life as well as in the development of science, and almost every human activity, whether simple or complex, cannot be separated from the use of mathematical concepts. According to Wahyuni et al., (2022) mathematics has a very important role in everyday life. This is in line with the opinion of Nuraeni et al., (2020) that mathematics is a science closely related to aspects of daily life and plays an important role in the development of science. Thus, it shows that mathematics is a very important part to be possessed by someone, because many activities certainly cannot be separated from mathematics. In the world of education, mathematics is one of the sciences that can help in solving various problems in life (Khidayati & Nuryami, 2023). Problems in life are often presented in the form of word problems, one of which is in the material a systems of linear equations in two variables.

System of linear equations in two variables is a set of two or more linear equations, each equation having the same two variables and being interrelated. Problems related to system of linear equations in two variables are generally represented in the form of word problems presented contextually, in accordance with the opinion of Yusuf & Fitriani, (2020) who stated that problems that often appear in system of linear equations in two variables material are presented in real or contextual form. Word problems according to Agustin et al., (2020) are problems presented in the form of stories or meaningful sentences related to situations experienced by students in everyday life, which contain mathematical concepts.

The purpose of using problems in everyday life is so that students can understand the benefits of mathematics in their lives. However, students still find it difficult to solve mathematical word problems because there are many stages involved in solving word problems, including understanding the problem, transforming the problem, performing calculations, and drawing conclusions (Hawa & Tsurayya, 2022). This often causes students to make mistakes in solving system of linear equations in two variables word problems. These mistakes often occur because students do not understand the material correctly, are too hasty in calculating, are unfocused, inaccurate, and write the wrong answers (Bouty et al., 2022). In addition to these mistakes, there are also errors in manipulating algebraic operations, errors in drawing conclusions, students only rely on sample problems given by the teacher, and errors in not working on the problems (Anggraini et al., 2021). Therefore, an effort is needed to identify students' errors thoroughly, starting from the stage of understanding the problem to writing the final answer, in order to obtain a more complete picture of students' errors in solving system of linear equations in two variables word problems.

One procedure that is widely used to analyze errors is Newman's procedure, because it provides systematic and structured stages of analysis. Compared to other error analysis methods such as Polya or Watson, Newman's procedure is more practical and focused in identifying errors that occur at each stage of solving word problems. Newman's procedure, proposed by Anne Newman (Cahyaningtyas et al., 2021), emphasizes five stages of errors that occur when students solve problems, namely reading errors, comprehension errors, transformation errors, process skills errors, and encoding errors.

Previous studies have shown the effectiveness of Newman's Procedure in analyzing students' errors, especially in system of linear equations in two variables word problems. Firdaus & Ihsanudin, (2024) showed the percentage of errors made by students in solving mathematical word problems using Newman's method were: (a) reading errors 10%, (b) comprehension errors 33.07%, (c) transformation errors 45.38%, (d) process skills errors 41.53%, and (e) encoding errors 42.3%. Mamonto et al., (2022) found that the most frequent error was encoding errors with a percentage of 49%. Meanwhile, Anisa et al., (2023) found

that process skills errors were the most common errors made by students (32%). The results of these studies indicate that Newman's procedure can be a solution to identify students' errors in solving system of linear equations in two variables word problems. However, previous studies generally only focused on the percentage of errors made by students without examining in depth the error patterns that appear in each individual. Meanwhile, this study identifies in detail the forms and patterns of students' errors in solving system of linear equations in two variables word problems based on Newman's procedure.

Based on observations and interviews with mathematics teachers at SMP Negeri 2 Palu, it was found that class VIII H students still face various errors in solving system of linear equations in two variables problems, especially word problems. Common errors include errors in translating word problems into mathematical form, lack of understanding of basic algebraic concepts, and difficulties in performing calculations and determining the final solution. These errors are caused by weak mastery of basic mathematical concepts, lack of accuracy, and low ability of students to understand the meaning of the problem. This condition shows the need for a more in-depth analysis to systematically identify the types and locations of students' errors.

Based on the above background, this study aims to describe students' errors in solving system of linear equations in two variables word problems based on Newman's procedure. The results of this study are expected to contribute to the development of more effective learning strategies to minimize students' errors in solving mathematical word problems.

2. METHOD

This study uses a descriptive qualitative approach. This research was conducted at SMP Negeri 2 Palu in the odd semester of the 2025/2026 academic year. The subjects of this research are students of class VIII H SMP Negeri 2 Palu who have studied the SLETV material. The selection of research subjects was based on the results of a written test, then three students were selected who made the most errors, the errors made were varied, the errors made could represent the errors of other students, and the results of discussions with the mathematics subject teacher. The data collection techniques used were written tests and interviews. Before data collection, the written test and interview guidelines were validated by two mathematics education experts in terms of content relevance, language clarity, and construct suitability. The written test consisted of a single word problem on systems of linear equations in two variables, which was used to identify students' errors and to determine the research subjects. Meanwhile, the interview used was an unstructured interview aimed at obtaining more in-depth information regarding the errors made by students based on their work on the written test. The credibility test of the data in this study used member check which aims to ensure the suitability of the data with the information provided by the research subjects. The data analysis technique used in this study refers to the model of Miles, Huberman, and Saldana (Sumardi et al., 2022), namely data condensation, data display, and conclusion drawing/verification. The analysis of students' errors was carried out based on Newman's procedure indicators which are presented in the table 1.

The researcher identified and classified students' errors in solving the written test based on those indicators, then described the errors made by the research subjects in solving systems of linear equations in two variables word problems.

Table 1. Newman's Procedure Error Indicators

Stages of Errors	Indicators
1. Reading Errors	Students cannot read units or mathematical symbols in the problem Students misread units or mathematical symbols in the problem
2. Comprehension Errors	Students cannot understand the information contained in the problem Students write what is known and asked, but it does not match the information in the problem and do not understand what they wrote Students do not write what is known and asked and do not understand the information from the problem
3. Transformation Errors	Students cannot transform the problem into a mathematical model Students transform the problem into a mathematical model but the model created is incorrect Students do not write the mathematical model, but are able to mention it
4. Process Skills Errors	Students make mistakes in the calculation process Students do not know the steps to solve the problem Students know the steps to solve the problem, but are not able to complete it
5. Encoding Errors	Students do not include the answer with the appropriate unit Students cannot provide the correct final answer Students are able to write the final answer, but it is not correct

Adapted from Mauliddiana & Gozali, (2023)

3. RESULTS AND DISCUSSION

3.1. Results

The errors made by students are grouped into five stages of errors based on Newman's procedure, namely reading errors, comprehension errors, transformation errors, process skills errors, and errors in writing the final answer. The following are the results of the error analysis made by students in solving systems of linear equations in two variables word problems based on Newman's procedure, which are presented in table 2.

1. Reading Errors

Students are said to be wrong at the reading stage if they do not read or misread words, numbers, or symbols contained in the problem and cannot interpret the sentences in the problem correctly, so the initial information obtained is incorrect. Based on the results of the analysis in this study, errors at the reading stage did not occur in subjects MI, VC, and IDL, because they were able to read the units or symbols contained in the problem correctly and accurately

Table 2. Student Errors According to Newman's Procedure

Subject	Reading Errors	Comprehension Errors	Transformation Errors	Process Skills Errors	Encoding Errors
MI	-	-	✓	✓	✓
VC	-	✓	✓	✓	✓
IDL	-	✓	✓	✓	✓

Note: (✓) error occurred

(-) no error occurred

2. Comprehension Errors

Students are said to be wrong at the comprehension stage if they can read the problem but fail to understand what is meant or instructed by the problem, so students do not write what is known and asked in the problem, write what is known but not in accordance with the information in the problem, and write what is asked but not in accordance with the instructions in the problem. Based on the results of the analysis in this study, comprehension errors did not occur in MI because the subject was able to write and explain the information in the problem. However, comprehension errors occurred in VC and IDL.

$$\begin{array}{r}
 2x + 3y = 80 \\
 2x + 4y = 90 \\
 \hline
 -1y = -10 \\
 y = \frac{-10}{-1} \\
 y = 10.000.00
 \end{array}$$

Figure 1. Subject VC's Error at the Comprehension Stage

The following is an excerpt from the interview related to the error:

P006 : So, do you know what is known from this problem?

VC006: I don't know

P009 : Then why didn't you write what is known and asked from the problem

VC009: I forgot, but it was in my scribbles

Figure 1. and the interview indicate that subject VC made comprehension errors, because she immediately applied the elimination process when solving the problem without first writing down the known and asked information. This error was caused by VC's inability to understand the essential information in the problem and forgetting to record his rough work on the answer sheet.

$$\begin{array}{l}
 \text{Dik: } 2 \text{ apel ditambah } 3 \text{ jeruk} = \text{Rp } 80.000.00 \\
 \quad 1 \text{ apel ditambah } 2 \text{ jeruk} = \text{Rp } 45.000.00
 \end{array}$$

Figure 2. Subject IDL's Error at the Comprehension Stage

Figure 2. and the interview indicate that IDL made comprehension errors because he wrote down what was asked in the problem, but it was incorrect. This error was caused by a lack of understanding in identifying the information from the problem, so IDL assumed that when writing down the known or given information, it should directly correspond to the formula that would be used

The following is an excerpt from the interview related to the problem:

- P005 : Why did you write what is known from the problem as 2 apples plus 3 oranges = Rp80,000.00, 1 apple plus 2 oranges = Rp45,000.00?
- IDL005 : Because yesterday I thought it was directly known, so I wrote it the same as the formula like $2x + 3y$, like that

3. Transformation Errors

Students are said to be wrong at the transformation stage if they cannot transform the problem into a mathematical model or if they can transform the problem into a mathematical model but with errors. Based on the results of the analysis in this study, errors at the transformation stage occurred in all subjects in this study.

$$\begin{array}{l} \text{Maka } 2x + 3y = 80.000 \\ \quad \quad \quad 1x + 2y = 45.000 \end{array} \quad \begin{array}{l} \times 1 \\ \times 2 \end{array}$$

Figure 3. Subject MI's Error at the Transformation Stage

The following is an excerpt from the interview related to the error:

- P009 : Try to explain how you made the mathematical form so it became $2x + 3y = 80,000$ and $1x + 2y = 45,000$?
- MI009 : At that time I saw in my math book there was a similar problem, only the question was different, but the way of solving it was the same, so I followed it

Figure 3. and the interview indicate that subject MI made an error at the transformation stage, namely not transforming what was asked in the problem into a mathematical form or equation. This error was caused MI made the mathematical model not based on his own understanding of the problem, but by imitating a similar example problem in his math book.

$$\begin{array}{l} 2x + 3y = 80 \\ 2x + 4y = 90 \\ \hline -1y = -10 \\ y = \frac{-10}{-1} \\ y = 10.000.00 \end{array}$$

Figure 4. Subject VC's Error at the Transformation Stage

The following is an excerpt from the interview related to the error:

- P010 : Try to mention the mathematical model from what you know in the problem?
- VC010: This is the mathematical model (while pointing to his answer) $2x + 3y = 80$, $2y + 4y = 90$, it should be written as 80,000
- P011 : Why didn't you write the currency (80,000)?
- VC011: Because I thought it was okay not to write the currency

Figure 4. and the interview indicate that VC made transformation errors because she did not construct a mathematical model of what was being asked in the problem and instead created a model from the given information, but it was inaccurate. This error can be seen from the equations written by VC (Figure 4), namely $2x + 3y = 80$ and $2x + 4y = 90$, whereas the correct equations are $2x + 3y = 80,000$ and $2x + 4y = 90,000$. This was caused by the subject's difficulty in converting the information in the problem into mathematical form,

lack of accuracy, and rushing, which led her to immediately apply elimination without constructing the correct model

$$\begin{aligned} R &= 2x + 3y = 80.000.00 \\ 1x + 2y &= 45.000.00 \end{aligned}$$

Figure 5. Subject IDL's Error at the Transformation Stage

The following is an excerpt from the interview related to the error:

- P007 : Try to mention the mathematical model from what you know in the problem?
 IDL007 : $2x + 3y = 80,000$, $1x + 2y = 45,000$
 P008 : What is the meaning of $2x$, $3y$, and $80,000$?
 IDL008 : $2x$ is 2 kg of apples, $3y$ is 3 kg of oranges, and $80,000$ is the total price of 2 kg of apples and 3 kg of oranges
 P009 : Try to mention the mathematical model from what is asked?
 IDL009 : $4x + y$

Figure 5. and the interview indicate that IDL made transformation errors because he did not write the mathematical form of what was being asked, although the interview results revealed that IDL was actually able to construct a mathematical model of what was asked.

4. Process Skills Errors

Students are said to be wrong at the process skills stage if they make mistakes in the calculation process, do not know the steps to solve the problem, or know the steps to solve the problem but are not able to complete it. Based on the results of the analysis in this study, errors at the process skills stage occurred in all subjects in this study.

$$\begin{aligned} &\begin{array}{r} 2x + 3y = 80.000 \\ 2x + 4y = 90.000 \\ \hline 0 + -1y = -10 \\ y = \frac{10}{-1} \\ y = 10 \end{array} \qquad \begin{array}{l} 3 \times 10.000 = 30.000 \\ 80.000 - 30.000 = 50.000 \end{array} \end{aligned}$$

Figure 6. Subject MI's Error at the Process Skills Stage

The following is an excerpt from the interview related to the error:

- P017 : From this equation, when entering the elimination process you subtracted $80,000 - 90,000 = -10$, why not $-10,000$?
 MI017 : Because as I said earlier, once I got to this part I didn't understand anymore
 P018 : Here you already obtained the value of y , so why didn't you continue your work to find the value of x ?
 MI018 : At that time I wanted to continue, but the time was almost up so I was confused and couldn't do anything anymore
 P019 : Then here you wrote $3 \times 10,000 = 30,000$, $80,000 - 30,000 = 50,000$, why did you write it like this?
 MI019 : As I said earlier, I didn't understand anymore, and for this answer my friend next to me told me to just write it like that, so I just copied my friend's work

Figure 6. and the interview indicate that MI made process skill errors, namely during the elimination process the subject subtracted $80,000 - 90,000$ but wrote the result as -10 , whereas the correct result is $-10,000$. Furthermore, the subject was unable to continue the solution even though one of the variable values had already been obtained. This error was caused by the subject's lack of understanding in carrying out the subsequent steps of problem solving.

Handwritten work for Figure 7:

$$\begin{array}{r} 2x + 3y = 80 \\ 2x + 4y = 90 \\ \hline -1y = -10 \\ y = 10.000.00 \end{array}$$

$$\begin{array}{r} 2x + 3y = 80.000.00 \\ 2x + 3(10.000.00) = 80.000.00 \\ x + 30.000.00 = 80.000.00 \\ \hline x = 80.000.00 - 30.000.00 \\ x = 50.000.00 \\ \hline x = 25.000.00 \end{array}$$

uang yang perlu dibuktikan Riza untuk membayar 9kg Apel dan 1kg jeruk adalah ... 110.000.00

Figure 7. Subject VC's Error at the Process Skills Stage

The following is an excerpt from the interview related to the error:

- P021 : After you obtained the values of x and y, what did you do next so that you got the result 110,000?
 VC021: Added
 P022 : Added how?
 VC022: Added like for example if we want to buy 2 kg of oranges and 3 kg of apples, then added like that

Figure 7. and the interview indicate that VC made process skill errors because she was inconsistent in using units, even though she did not make calculation mistakes. However, during the elimination process VC did not write down her working steps, which resulted in the equation $2x + 4y = 90$. In the substitution process, there were numbers that she did not write, and she was unable to explain how the steps were carried out, which eventually led to the result of 110,000

Handwritten work for Figure 8:

$$\begin{array}{r} \text{Diketahui: } 2x + 3y = 80.000.00 \quad | :2 \rightarrow 2x + 3y = 80.000.00 \\ 1x + 2y = 45.000.00 \quad | :2 \rightarrow 2x + 4y = 90.000.00 \\ \hline -1y = 10.000.00 \\ y = 10.000.00 \end{array}$$

$$\begin{array}{r} y = 10.000.00 \text{ maka} \\ 1x + 2y = 45.000.00 \\ 1x + 2(10.000.00) = 45.000.00 \\ 1x + 20.000.00 = 45.000.00 \\ \hline 1x = 45.000.00 - 20.000.00 \\ 1x = 25.000.00 \\ x = 25.000.00 \end{array}$$

$$x = 25.000.00 \quad y = 10.000.00$$

Figure 8. Subject IDL's Error at the Process Skills Stage

The following is an excerpt from the interview related to the error:

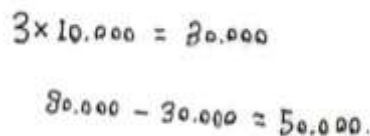
- P013 : So $80,000 - 90,000$, what is the result?

- IDL013 : $-10,000$
- P014 : Then why didn't you write the negative sign? Did you already multiply it by -1 or how?
- IDL014 : I think I was not careful, because in my scribbles there was a negative sign, and $y = 10,000$ was because it was divided, negative met negative so the result became positive
- P015 : After you got the value of y , what did you do next?
- IDL015 : I looked for the value of x by substituting the value of y into the second equation
- P016 : Why after you substituted $y = 10,000$ into the second equation $1x + 2(10,000) = 45,000$, you wrote again the variable y so it became $1x + 20,000y = 45,000$?
- IDL016 : Because I was not careful

Figure 8. and the interview indicate that IDL made process skill errors. These errors occurred during the elimination process, where IDL incorrectly subtracted a smaller number from a larger one, which should have resulted in a negative value, but he wrote it as a positive value ($80,000 - 90,000 = 10,000$). In addition, during the substitution process, when IDL had already substituted $y = 10,000$ into the second equation $1x + 2y = 45,000$, he mistakenly wrote the variable y again, resulting in $1x + 20,000y = 45,000$.

5. Encoding Errors

Students are said to be wrong at the final answer writing stage if they do not include the answer with the appropriate unit, cannot provide the correct final answer, or are able to write the conclusion but incorrectly. Based on the results of the study, final answer writing errors occurred in all research subjects.



$$3 \times 10.000 = 30.000$$

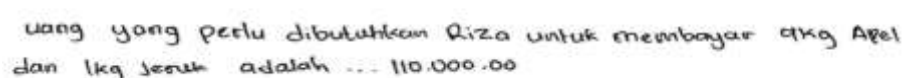
$$80.000 - 30.000 = 50.000$$

Figure 9. Subject MI's Error at the Final Answer Writing Stage

The following is an excerpt from the interview related to the error:

- P020 : What can you conclude from your work?
- MI020 : So I couldn't answer this problem until the end, I could only get this far, and even then I didn't really understand how I got $y = -10$
- P021 : Was your answer in accordance with the question?
- MI021 : No, because I didn't fully answer the problem

Figure 9. and the interview indicate that MI made errors at the stage of encoding because the subject was unable to produce a final response. This occurred because MI did not complete the written test until the final stage, so the answer provided did not correspond to the instructions of the problem



uang yang perlu dibutuhkan Riza untuk membayar 9kg Apel dan 1kg jeruk adalah ... 110.000.00

Figure 10. Subject VC's Error at the Final Answer Writing Stage

The following is an excerpt from the interview related to the error:

- P025 : Was your answer in accordance with the question?

VC025: Yes, but there were still some mistakes or errors in my answer

Figure 10. and the interview indicate that VC made errors at the stage of encoding, as she wrote a final response but it was incorrect. This error was caused by the subject's lack of accuracy in solving the problem, so the final answer did not correspond to the instructions of the problem

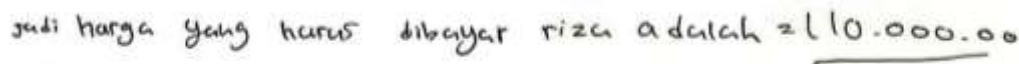


Figure 11. Subject IDL's Error at the Final Answer Writing Stage

The following is an excerpt from the interview related to the error:

P018 How do you determine the price of 4 kg of apples and 1 kg of oranges from the results you obtained?

IDL018 : By substituting the values of x and y into the equation $4x + y$

P019 : Then why didn't you write the steps of your work in the equation $4x + y$?

IDL019 : Because I thought I didn't need to use the formula anymore, so I didn't write the equation

Figure 11 and the interview indicate that IDL made errors at the stage of encoding, as he wrote a final response but it was incorrect. This error occurred because IDL thought it was no longer necessary to use formulas or equations when producing the final answer.

3.2 Discussion

1. Reading Errors

The reading errors not found in all subjects indicating that students were able to recognize and read symbols, units, and mathematical terms quite well. This finding is consistent with Fitry et al., (2022) that reading errors are indeed rare, as students' reading ability is generally sufficient, even though their comprehension of the problem content may not always be entirely accurate. This condition suggests that learning does not need to be overly focused on the reading aspect, but should instead be directed toward the stages of comprehension and mathematical modeling.

2. Comprehension Errors

The comprehension errors found in subjects VC and IDL, where VC did not write down what was known and asked, while IDL wrote down information from the problem but not in accordance with its context. This indicates that students were not yet able to identify and interpret the essential information in the problem accurately. Such a condition suggests that students tend to rush in solving problems without first understanding the intent of the question. This finding is consistent with Jun et al., (2022) that students did not write down what was known and asked in the problem, and is further supported by Labibah et al., (2021) that students wrote down the known and asked information, but incompletely, due to a lack of carefulness in reading the problem. Therefore, this finding implies that instruction should emphasize the ability to thoroughly understand problems, particularly through practice in identifying key information, habituating students to write down what is known and asked, and improving accuracy in reading and interpreting word problems.

3. Transformation Errors

The transformation errors found in all subjects, indicating that students have not yet developed adequate mathematical modeling skills. This suggests that students tend to imitate previously given examples rather than construct mathematical representations independently. This finding is consistent with Hariyani & Aldita, (2020) that students were unable to create mathematical models from the information provided, and is further supported by (Febryana et al., 2023) that transformation errors occurred because many

students did not write down the mathematical form in solving the given problems. Therefore, this finding implies that classroom instruction should place greater emphasis on mathematical modeling activities as well as exercises in translating contextual problems into mathematical form.

4. Process Skill Errors

The process skill errors found in all subjects, indicating that although students had understood the initial steps of problem solving, they did not yet possess strong procedural skills to complete the problems thoroughly. This condition suggests weaknesses in mastering arithmetic operations as well as a lack of accuracy during the solving process. It also shows that students were unable to apply problem-solving procedures consistently and systematically. This finding is consistent with Tanzimah & Sutrianti, (2023) that errors occurred due to insufficient understanding of arithmetic operation concepts, and is further supported by Khaerunnisa et al., (2024) that process skill errors arose from students' lack of accuracy in performing calculations. Therefore, instruction needs to emphasize practice problems that focus on accuracy, systematic solution steps, and the habituation of writing the complete problem-solving process.

5. Encoding Errors

The encoding errors found in all subjects, either in the form of not writing an answer or providing an incorrect one. This indicates that students were unable to connect the results of their calculations with the requirements of the problem, so the solving process stopped at computation without drawing an appropriate conclusion. This finding is consistent with Lubis et al., (2025) that students only wrote numerical results that appeared to be guesses or simple calculations without explaining the meaning of those numbers, and is further supported by Sunardiningsih et al., (2019) that errors occurred due to students' inability to formulate conclusions in accordance with the problem context. In general, the cause of encoding errors is the failure to state conclusions based on the obtained results (Anisa et al., 2023). Therefore, instruction should emphasize the ability to interpret results and draw accurate conclusions, as well as habituating students to perform final verification of their answers.

CONCLUSION

Based on the results of the study, it can be concluded that the errors made by Grade VIII H students of SMP Negeri 2 Palu in solving word problems on systems of linear equations in two variables, according to Newman's procedure, include comprehension errors, transformation errors, process skill errors, and final answer errors. These errors occur because students still experience difficulties in understanding the information in the problem and converting it into an appropriate mathematical model. This leads to further mistakes at the calculation stage and in determining the encoding, which does not align with the context of the problem. In addition, low accuracy and the lack of habit in systematically writing down solution steps are also major causes of these errors, resulting in students being unable to solve systems of linear equations in two variables word problems correctly and completely. Therefore, the learning process needs to emphasize conceptual understanding, the ability to model word problems, and the habituation of writing solution steps systematically up to the final stage.

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