Analysis of Students' Error in Solving Problems on SPLDV Material Based on Newman's Theory

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ABSTRACT

This study aims to analyze students' errors in solving problem-solving problems on the material of two-variable linear equation systems based on Newman's theory. This study needs to be conducted in order to help find out what mistakes students make so that it will be easier to find solutions to minimize the occurrence of these errors in learning. The research method used is descriptive qualitative. The subjects in the study were 16 students of class X MA Cendekia Bangsa. The study was conducted in the 2024/2025 academic year, even semester. The data collection technique used by the researcher was using a test instrument in the form of two essay questions containing indicators of mathematical problem-solving abilities on the material of two-variable linear equation systems and interviews. The results of the analysis of students' errors in solving problem-solving problems on SPLDV material based on Newman's theory obtained 9.4 % reading errors (very low category); 28.1% understanding errors (low category); 40.6% transformation errors (sufficient category); 62.5% process skill errors (high category) and 21.9% answer writing errors (low category). The largest percentage of errors is in processing skills errors which are caused by many students still having problems with algebraic calculations and integer operations.

Keywords: newman error analysis; problem solving; SPLDV

INTRODUCTION

Mathematics is a key discipline that holds a significant place in the field of education. The government's decision to include mathematics as a core subject across all educational levels—from elementary school to university—reflects its importance. As such, greater attention must be given to mathematics instruction to help students grasp it more effectively. To succeed in mathematics, students need to develop several essential skills. According to the NCTM (2000), there are five process standards in mathematics: problem solving, reasoning and proof, communication, connections, and representation. Among these, problem solving is considered a fundamental skill necessary for learning mathematics (Hidayat & Sariningsih, 2018).

Problem-solving ability refers to a person's capacity to tackle problems when an immediate or obvious solution is not available (Suryani et al., 2020). Reaching an appropriate solution involves a series of steps, requiring strategies and approaches tailored to the problem. In mathematics education, the effective use of methods, procedures, and strategies is essential to solving problems (Rahmmatiya & Miatun, 2020). When students struggle with mathematical problem solving, their difficulties can often be traced back to errors in their approach. Analyzing these mistakes can help identify why their problem-solving skills are underdeveloped. Various factors contribute to students' challenges in

solving math problems, with one major factor being errors made during the problem-solving process (Sumartini & Lita, 2022).

According to experts such as Raudho et al. (2020) and Kristofora & Sujadi (2017), one commonly referenced model for problem-solving is proposed by Polya. His problem-solving process includes four key stages: (1) Understanding the Problem – at this stage, students must determine what information is given and what is being asked. (2) Planning a Solution – here, students devise a strategy by translating the problem into a mathematical model. (3) Executing the Plan – this involves carrying out the steps outlined in the plan. (4) Reviewing the Results – students are expected to verify their answers and ensure their solutions are correct before drawing conclusions (Yuwono et al., 2018).

Error analysis is a method frequently utilized by educators and researchers, involving several steps such as gathering data samples, identifying mistakes within those samples, explaining the errors made, categorizing them based on their causes, and assessing their severity. This process helps to distinguish the types of mistakes students make and understand why those errors occur (Meldawati & Kartini, 2021). In mathematics, identifying student errors is essential to understand the challenges they face when solving problems. Gaining insight into these mistakes can support the development of more effective teaching strategies and ultimately improve student achievement (Gumanti & Kartini, 2022).

To facilitate this, tools or methods are needed to accurately assess students' errors, especially when solving word problems. One detailed method is Newman's theory (Nugraha et al., 2023), which helps pinpoint where students go wrong by analyzing their answers (Amni & Kartini, 2021; Kamila, 2021). Newman's error analysis provides a structured approach to identify the root causes of students' difficulties in mathematical problem-solving. It also offers valuable guidance for educators to design instructional strategies that directly address students' misunderstandings (Karnasih in Setiawan et al., 2021).

This method, introduced by Anne Newman in 1977, is widely used in the field of mathematics education in Australia. Newman identifies five types of errors: reading errors, understanding errors, transformation errors, processing errors, and answer writing errors (Halawa & Heksa, 2021; Murtiyasa & Wulandari, 2020; Sunardiningsih et al., 2019). These errors can be observed during the problem-solving process, although reading errors are the only ones not identifiable within this context. The five types of errors according to Newman's theory are: 1) Reading Errors – where students make mistakes in reading and interpreting the given mathematical problems and their corresponding symbols; 2) Comprehension Errors – where students struggle to understand the problem presented; 3) Transformation Errors – when students fail to choose the appropriate mathematical methods or solutions to solve a problem; 4) Processing Skills Errors – when students know the correct formulas or operations but fail to apply them properly during problem- solving; and 5) Answer Writing Errors – where students make mistakes when expressing the final solution in written form, even after successfully solving the problem (Abdullah et al., 2017).

Building on the issues described above, the researcher conducted a study aimed at examining students' errors in solving problem-solving tasks using Newman's theory. This

study focuses on the material of the two-variable linear equation system (SPLDV) for class X students at MA Cendekia Bangsa during the even semester of the 2024/2025 academic year. The study is titled "Analysis of Students' Errors in Solving SPLDV Problems Based on Newman's Theory."

RESEARCH METHODS

This research is a qualitative descriptive study aimed at analyzing the errors made by students when solving problem-solving tasks related to two-variable linear equation systems. The study involved 16 students from class X at MA Cendekia Bangsa during the 2024/2025 academic year, conducted in the Even Semester. Data were collected using two methods: Written tests, where students were given a set of problem-solving questions consisting of two descriptive items that met the validity and reliability criteria based on Ilmiyana's work as cited in Rachmawati's article (2021). The students' responses were analyzed to identify the types of errors they made, following Newman's error theory; and Interviews, which took place after the test to gather information on the challenges students faced and the reasons behind their errors. The question instrument used had also been tested for both validity and reliability. The reasoning questions that were tested by the researcher with the students are presented in Table 1.

Table 1 . Instrument Question Problem Solving Material SPLDV

Number	Question Instrument
1	A rectangular garden has a perimeter of 44 cm. If its width is 6 cm shorter than its length, find the length and width of the garden!
2	The age difference between a father and his daughter is 26 years, while five years ago the sum of their ages was 34 years. Calculate the age of the father and his daughter two years from now….

Ilmiyana (2018)

The data obtained from the test results were analyzed qualitatively by referring to Newman's theory which includes types of errors such as reading errors, understanding errors, transformation errors, errors in the completion process and errors in writing the final answer. The analysis was carried out by describing the types of errors. Which done student based on category in theory Newman which is presented in Table 2 , then linked to the interview results to strengthen the interpretation.

Table 2 . Indicator Error based on Theory Newman

Types Error	Indicator
Reading Error	Student No read unit, or number or symbols correctly .
Comprehension Error	Student No write what Which known from the question.
	Student write What Which known from questions but do not match the question request.
	Student No write What just Which asked from the question.
	Students write down whatever is asked but it does not match the question request.

Types Error	Indicator
Transformation Error	Students are unable to create mathematical models from the information obtained.
	Students make mistakes in choosing the formula or method used to solve the problem.
Process Skill Error	Student Wrong do calculation.
	Student No continue to stages completion.
	Students do not write calculation stages in sequence.
Encoding Error	Student No write a conclusion.
	Student write conclusion however not exactly.
	Student Wrong write unit from answer end.

Thessa, et al (2023)

The analysis conducted is seen from the types of errors made by students according to Newman's Theory. Students' answers that have been assessed based on error indicators according to Newman's Theory, will then be processed with the help of Microsoft Excel using the following formula:

$$p = \frac{f}{N} \times 100\%$$

p = Percentage Figures
f = Error Frequency
N = Number of Errors

As for Table 3 following serve percentage interval the error that caused by students according to Newman.

Table 3 . Interval Percentage Error Level

Error	Information
$80\% \leq p \leq 100\%$	Very Tall
$60\% \leq p < 80\%$	Tall
$40\% \leq p < 60\%$	Enough
$20\% \leq p < 40\%$	Low
$0\% \leq p < 20\%$	Very Low

RESULTS AND DISCUSSION

The researcher analyzed the students' answers after the questions were given. To find out what mistakes students made using error analysis based on Newman's theory. Theresults of the calculations that have been carried out, obtained the average percentage of each stage of Newman's errors made by students from the 2 questions tested presented in Table 4.

Table 4. Average Percentage Error Students Based on Newman's Theory

Types of Errors	ercentage of Error
Reading Error	9.4%
Comprehension Error	28.1%
Transformation Error	40.6%

Process Skill Error	62.5%	
Encoding Error	21.9%	

Based on Table 4 , it can be seen that the errors made by students are mostly process skill errors and the fewest reading errors. To find out more clearly about the errors made by students will be described in the following discussion:

Reading Error

Percentage of student errors in reading errors presented in Table 5.

Table 5. Percentage Reading Error

No. Question	Amount Student	Percentage Error	Average
1	2	12.5%	9.4%
2	1	6.25%	

Based on Table 5, it can be seen that the highest percentage of reading errors is in question number 1 , namely 12.5%. The low percentage of reading errors indicates that most students are able to recognize numbers, units, and symbols in the problem statements. However, a small number of students still make mistakes due to inaccuracy when reading or copying information. This type of error commonly occurs not because students lack conceptual understanding, but because they are careless, as highlighted by Halawa & Heksa (2021), who note that reading errors often stem from a lack of attention to detail.

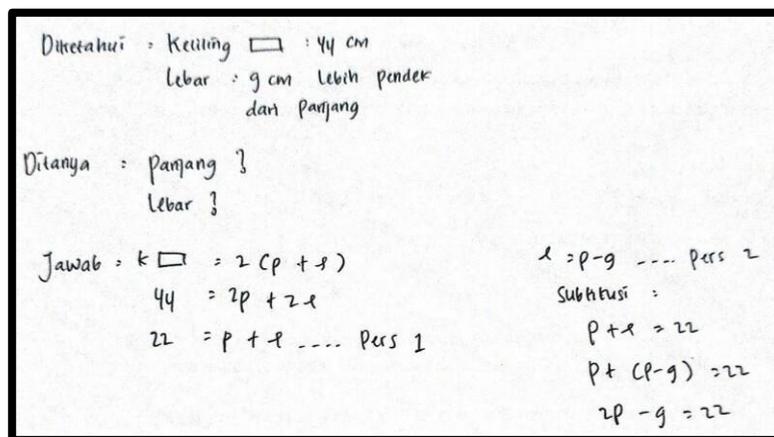Following example error Which done by students:

Figure 1. Results Student Work Questions Number 1

Students often make reading errors‖ or *reading errors* as seen in Figure 1 , namely: students make mistakes in writing the numbers in question no. 1. The answer that should be written is that the width is 6 cm shorter than the length, but students write the width as 9 cm shorter than the length. This error causes students to make mistakes in making mathematical models and in solving problems. This is due to the lack of student accuracy in reading and writing questions, this can be seen from the results of interviews with students:

Teacher   :Why did you write that the width is 9 cm shorter than the length?
                  Even though the question says 6 cm

Student   :Sorry mom, I saw the wrong number, I thought it was 9 but it turned
                            out to be 6.

Comprehension Error
The percentage of student errors in comprehension errors presented in Table 6 below :

Table 6. Percentage Comprehension Error

No. Question	Amount Student	Percentage Error	Average
1	4	25%	28.1%
2	5	31.25%	

Based on Table 6, it can be seen that the percentage of comprehension errors the highest is in question no. 2, which is 3 1.2 5%. Comprehension errors arise when students fail to identify what is known and what is asked in the problem. Many students misunderstand essential information, which leads to incorrect problem interpretation. According to Newman, the comprehension stage is crucial, and failures at this stage will disrupt subsequent stages of problem solving. This aligns with findings from Sunardiningsih et al. (2019), who state that students often misinterpret mathematical word problems due to weak reading comprehension skills.

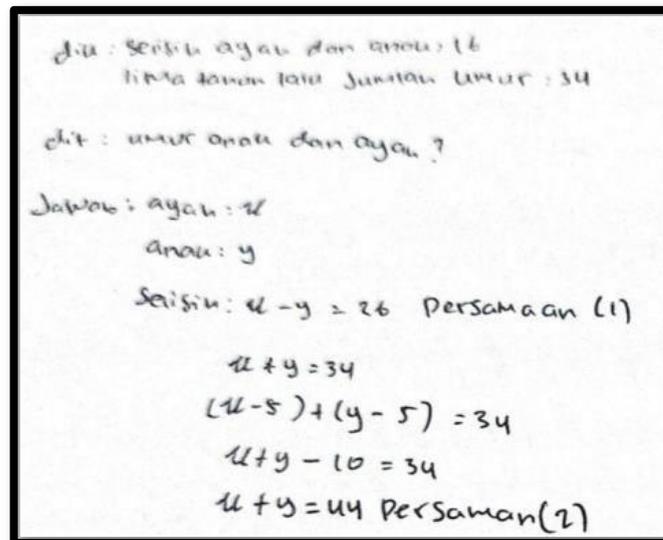Following example error Which done by students:

Figure 2. Results Student Work Questions Number 2

Students often make ―misunderstandings‖ or *comprehension error* seen on Picture 2 namely : students misunderstand the question, in the question what is asked is the age of the father and son 2 years in the future, students actually understand that what is asked is the age of the father and son. This is because students do not know what is actually being asked in the question and errors in capturing information so that students solve the question incorrectly, this can be seen from the results of interviews with students.

Teacher   :What is your reason for writing that what is asked is age and
                    children?

Student   :Because the question asked is the age of the father and son in 2 years, ma'am, so it starts with the question of how old the father and son are, ma'am.

Transformation Error

The percentage of student errors in transformation errors is presented in Table 7 . the following :

Table 7. Percentage Transformation Error

No. Question	Amount Student	Percentage Error	Average
1	6	37.5%	40.6%
2	7	43.75%	

Based on Table 7, it can be seen that the highest percentage of transformation error is in question no. 2, which *is* 43.75 % . The moderate percentage of transformation errors shows that students have difficulty converting verbal information into appropriate mathematical models or equations. This indicates weaknesses in representing and structuring problems. Polya's theory states that the planning stage where transformation occurs is often challenging for students who lack experience in modeling real-world situations mathematically. Nugraha et al. (2023) also found that many students struggle to construct correct equations from story problems, leading to transformation errors.

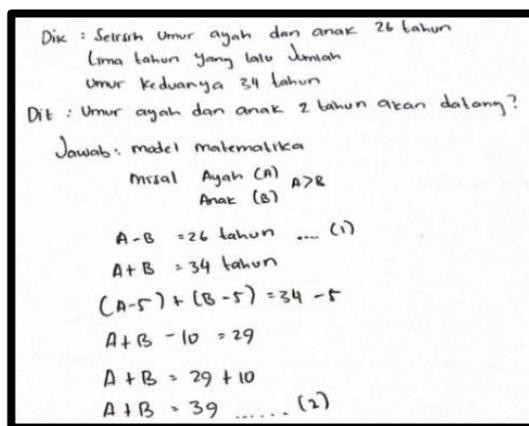Following example error Which done by students:

Figure 3. Results Student Work Questions Number 2

Students often make transformation errors‖ or *transformation errors* as seen in Figure 3, namely: students make mistakes in making mathematical models or equations from the second statement, namely ―five years ago the sum of their ages was 34 years‖ which should have started by making an equation $(x - 5) + (y - 5) = 34$, students actually wrote $(x - 5) + (y - 5) = 34 - 5$. This is because students are not precise in making mathematical models in solving the problem, this can be seen from the results of interviews with students.

Teacher   :Why did you start the second equation with $(x - 5) + (y - 5) = 34 - 5$?

Student	:Because the question states the age of the father and son 5 years ago, ma'am, so I subtracted 5.
Teacher	:But why did you also subtract 5 from the number 34?
Student	:Because I reduced the left side by 5, the right side is the same, ma'am.

Process Skill Error

Percentage of student errors in process skill errors are presented in Table 8 the following :

Table 8. Percentage Process Skill Error

No. Question	Amount Student	Percentage Error	Average
1	11	68.75%	62.5%
2	9	56.25%	

Based on Table 8, it can be seen that the percentage of process skill most The highest is in question number 1, which is 68.75%. This is the highest type of error observed in the study. Students frequently make mistakes in performing algebraic operations, manipulating equations, or carrying out step-by-step calculations. According to Newman, process skill errors are common because they involve technical computational skills that require strong mastery and practice. The high percentage indicates that many students are not proficient in basic algebra and integer operations. This finding is consistent with Sumartini & Lita (2022), who reported that errors in SPLDV problems are often caused by students' weak arithmetic and algebraic skills.
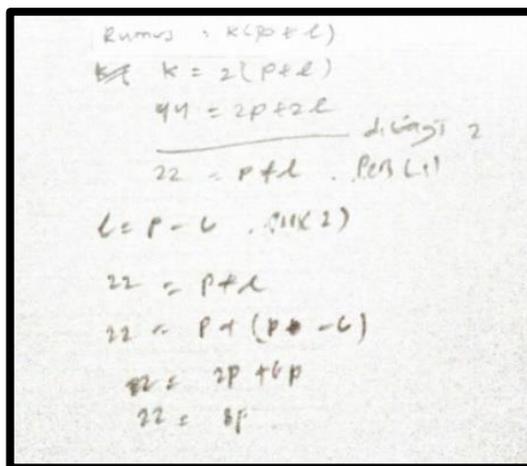
Following example error Which done by students:

Figure 4. Results Student Work Questions Number 1

Students often make process errors‖ or *process skill errors* as seen in Figure 4 , namely: students make mistakes in doing algebraic calculations, the answer that should be $2p - 6$, students actually write $2p + 6p$, so because of this error students cannot solve this problem. This is because students are not careful and not proficient in algebraic and integer calculations, so that the results written contain errors, this can be seen from the results of

interviews with students.

Teacher   :What is your reason for writing $2p - 6$?

Student   :Because p it is multiplied by the 6 in the brackets. Isn't the number in the brackets multiplied?

Teacher   :No kid, the numbers in brackets before the brackets have a sign +or −they are not multiplied. Then why the sign +?

Student   :Because before the brackets there is a + sign, ma'am

Encoding Error

The percentage of student errors in encoding error are presented in Table 9 the following :

Table 9. Percentage of Encoding Error

No. Question	Amount Student	Percentage Error	Average
1	3	18.75%	21.9%
2	4	25%	

Based on Table 9, it can be seen that the percentage of errors in encoding error most The height is in question no. 2, which is 25%. Encoding errors occur when students do not write the final answer correctly or fail to provide a conclusion that matches the problem's requirements. Although students may successfully determine the variable values, they often stop before interpreting the results in the context of the question. Abdullah et al. (2017) explain that encoding errors typically occur when students are not habituated to writing complete and accurate mathematical conclusions.Following example error Which done by students:
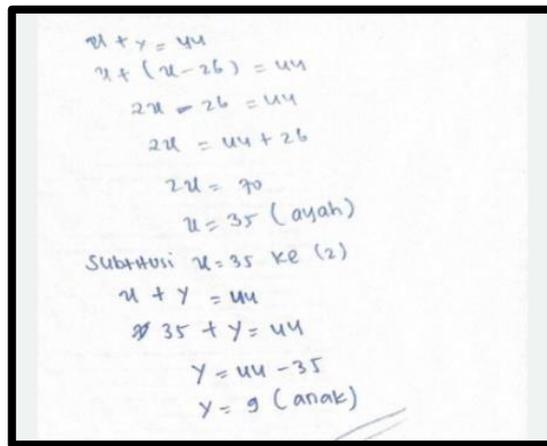

Figure 5. Results Student Work Questions Number 2

Students often make —answer writing errors‖ or *encoding errors* as seen in Figure 5 , namely: students make mistakes in writing the final answer. The question asked is the age of the father and son 2 years in the future. Students have obtained the age of the father and son, but because it has not been added 2 years later, the student's answer is wrong because it only ends with the age of the father and son. This is because students are careless or not

careful enough in concluding answers that are in accordance with mathematical sentences and students do not make final answers to what is asked, this can be seen from the results of interviews with students.

Teacher	:Why did you only finish at the age of the father and son? Why didn't you calculate their ages 2 years ahead?
Student	:Yes ma'am, I wrote the answer wrong, but I just need to add 2, right ma'am?
Teacher	:Yes, exactly

Based on the research results above, we can understand the types of errors made by students in solving problem-solving questions based on Newman's theory. However, these results do not fully represent the overall condition of students' abilities. To gain a more comprehensive understanding of the error patterns that emerge, it is important to consider several limitations of the study that may affect the interpretation of the findings. Some limitations of this study are that it involves a relatively small sample size, with only 16 students from one school, making the results difficult to generalize widely. In addition, the test instrument consists of only two problem-solving questions, which may limit the variety of error types that can be identified. This study also uses a qualitative descriptive approach without statistical analysis to examine deeper relationships between the types of errors and their causal factors. Considering these limitations, the findings of this study still provide an important contribution but should be interpreted with caution.

CONCLUSION

Based on the results of the research conducted on tenth-grade students at MA Cendekia Bangsa, it can be concluded that students still make various types of errors when solving SPLDV problems according to Newman's analysis. The percentages of errors identified include reading errors at 9.4% (very low), comprehension errors at 28.1% (low), transformation errors at 40.6% (moderate), process skill errors at 62.5% (high), and encoding errors at 21.9% (low). The highest percentage occurs in process skill errors, indicating that many students still struggle with algebraic operations and integer calculations, which leads to incorrect solution steps and inaccurate final answers. These findings highlight the need for strengthening students' foundational understanding of algebra, improving accuracy in computational processes, and providing structured practice to help reduce errors and enhance overall mathematical problem-solving abilities.

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