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Analysis of Student Errors in Solving SPLDV Problems Reviewed from Critical Thinking Skills Based on Newman's Criteria

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Abstract:
This research aims to provide a clear mapping of errors frequently made by students in solving Systems of Linear Equations in Two Variables (SPLDV) problems, to examine students critical thinking skills using Newman's criteria, and to identify mathematical errors committed by eighth-grade students at the private Methodist El Shadday Junior High School in Perbaungan. This research uses descriptive qualitative research methods. The study involved a sample of five students who were administered a test instrument consisting of open-ended questions. The analysis results indicate that the average percentage of students' success in demonstrating critical thinking skills in solving problems is 42.109%, while the average error rate is 57.891%. These findings reveal that students' error rate in answering questions is higher than their success rate in answering questions. This suggests that students' problem-solving and critical thinking abilities remain relatively low. These results align with the research objective, which is to examine the extent to which students can think critically when solving problems, as measured by indicators of critical thinking skills. In light of these results, it is recommended that innovative instructional approaches such as problem-based learning, contextual learning, and interactive methods involving the use of technology be implemented to enhance students' understanding and foster the development of their critical thinking skills.

Abstrak:
Penelitian ini bertujuan untuk memberikan pemetaan yang jelas mengenai kesalahan-kesalahan yang sering dilakukan oleh siswa dalam menyelesaikan soal Sistem Persamaan Linear Dua Variabel (SPLDV), mengetahui kemampuan berpikir kritis siswa dengan menggunakan kriteria Newman dan mengecek kesalahan matematis siswa kelas VIII Sekolah Menengah Pertama swasta Methodist El Shadday Perbaungan. Penelitian ini menggunakan metode deskriptif kualitatif. Pada penelitian ini diambil sampel sebanyak 5 orang siswa yang kemudian diberikan instrumen tes untuk diselesaikan. Instrumen yang digunakan pada penelitian ini adalah berupa tes yang berisi soal-soal uraian. Hasil analisis menunjukkan bahwa rata- rata persentase keberhasilan kemampuan berpikir kritis siswa dalam menyelesaikan soal mencapai 42,109% sementara rata-rata persentase kesalahan siswa sebesar 57,891%. Temuan ini menunjukkan bahwa tingkat kesalahan siswa menjawab soal lebih tinggi dibandingkan tingkat keberhasilan. Hal ini mengindikasikan bahwa kemampuan

pemecahan masalah dan kemampuan berpikir kritis siswa masih tergolong rendah. Hasil ini selaras dengan tujuan penelitian, yaitu menganalisis sejauh mana siswa mampu berpikir kritis dalam menyelesaikan soal berdasarkan indikator kemampuan berpikir kritis dan Newman. Berdasarkan temuan tersebut, perlunya penggunaan pendekatan pembelajaran yang inovatif seperti pembelajaran berbasis masalah atau kontekstual serta pembelajaran interaktif dan menarik seperti menggunakan teknologi yang diharapkan dapat membantu siswa agar lebih memahami dan meningkatkan kemampuan berpikir kritis siswa.

Keywords:
Error Analysis, Critical Thinking Skills, Newman's Criteria

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INTRODUCTION

Critical thinking is an essential competency in mathematics education, particularly in solving problems that require logical analysis, such as systems of linear equations in two variables (SPLDV). However, in classroom practice, many students experience difficulties and often make errors when solving SPLDV word problems. These errors reflect a lack of critical thinking skills, especially in understanding problem contexts, connecting information with mathematical concepts, and translating them into appropriate solutions.

Critical thinking is a fundamental cognitive skill required in mathematical problem-solving. It includes the ability to interpret information, analyze situations, evaluate reasoning processes, and make informed decisions. According to Fitriyani and Nurhasanah (2020), critical thinking in mathematics enables students to understand complex problems, identify relevant data, and apply logical reasoning to reach valid conclusions. Developing critical thinking helps students move beyond rote procedures and fosters deeper mathematical understanding.

Mathematics is a subject that provides space for the development of reasoning and analytical abilities. Critical thinking in mathematics involves evaluating problems, interpreting given data, and making well-justified conclusions (Sumarni & Herman, 2021). Critical thinking in mathematics includes evaluating problems, interpreting data, and drawing well-founded

conclusions (Susanti & Hartono, 2019). Critical students are able to formulate the core of a problem, uncover facts, identify relevant theorems, detect biases, and draw conclusions based on data interpretation and analysis (Nurdin, Rusli, Sappaile, Hastuty, & Meliyana, 2022). In solving systems of linear equations in two variables (SPLDV), students must not only perform calculations but also understand the relationships between variables and contextualize problems based on real-life situations.

The development of critical thinking skills is strongly linked to how well students can navigate word problems, select appropriate strategies, and evaluate the logic of their solutions (Afriani, Wahyudin, & Prabawanto, 2020). Through authentic learning, students are able to enhance their critical thinking skills, particularly in understanding problems (comprehension), selecting appropriate strategies, and evaluating as well as reflecting on the logic of their solutions (Dolapcioglu & Doganay, 2020). SPLDV problems, especially in story form, provide a good platform to assess these higher-order thinking processes.

Ideally, mathematics learning should develop students' abilities to analyze, evaluate, and solve problems systematically. However, a gap remains between these expectations and the actual performance of students, who still struggle with interpreting problems and applying relevant concepts. Difficulties are commonly found in reading and understanding problems, transforming information into mathematical forms, and carrying out solution procedures. These challenges are even more evident in story problems, which require multiple cognitive steps.

To identify and address these learning obstacles, error analysis can be used as a tool to uncover the stages where students most frequently make mistakes. One effective framework is Newman's Error Analysis, which outlines five stages of problem-solving: reading, comprehension, transformation, process skills, and encoding. Through this framework, teachers can obtain a clearer picture of students' thinking processes and determine the specific sources of error.

Analyze students' errors in solving SPLDV word problems based on Newman's criteria is the aim this research, with a focus on identifying the types and causes of mistakes that indicate low critical thinking skills. The findings are expected to support the development of more effective learning strategies to improve students' mathematical problem-solving ability.

Newman's Error Analysis (NEA) remains a reliable framework to investigate student difficulties in mathematical tasks. The model categorizes

errors into five stages: reading, comprehension, transformation, process skills, and encoding. A study by Sari and Hidayat (2021) demonstrated that NEA helps identify students' cognitive gaps at each stage and is effective for diagnosing misconceptions in algebra, particularly systems of linear equations.

Newman's Error Analysis (NEA) is a well-established diagnostic framework that helps identify at which stage students experience difficulties. According to Widada, Suyitno, and Lukman (2020), NEA is effective in revealing errors that are not only computational but also conceptual and interpretive. The five stages are closely aligned with critical thinking processes.

By analyzing students' work based on these stages, teachers can determine whether errors arise from misunderstanding the context (comprehension), incorrectly forming equations (transformation), or miscalculating (process skill). This structured diagnostic approach provides a foundation for targeted remediation.

Error analysis is not only about identifying mistakes, but also understanding how students think. As stated by Wulandari, Rachmadtullah, and Susilowati (2022), errors in mathematics reflect students' cognitive development, conceptual understanding, and problem-solving behavior. In SPLDV, common student errors include incorrect variable assignment, arithmetic mistakes, and incomplete final answers. Each of these errors indicates a different issue in the thinking process.

When errors are examined through the lens of critical thinking indicators—such as interpretation, analysis, evaluation, and conclusion-making—they provide insight into which aspects of thinking need to be strengthened (Hidayati, Anwar, & Ulya, 2022).

Recent studies emphasize the role of active learning models such as problem-based learning (PBL) in improving students' critical thinking. Research by Irawan and Wahyuni (2019) found that PBL encourages students to engage deeply with problem contexts, which improves their ability to analyze and evaluate solutions critically. PBL aligns with real-world mathematical applications and enhances error awareness.

Analyzing students' mathematical errors can serve as a tool for improving learning strategies. Yuliani, Kusumah, and Kartasasmita (2020) explained that error analysis is not merely about identifying mistakes, but about uncovering the underlying thinking process that leads to those mistakes. This insight is vital in designing tailored instruction to enhance student achievement.

METHODS

This research employed a qualitative approach with a descriptive method to analyze students' errors in solving mathematical problems using Newman's error analysis procedure. The subjects of the study were five eighth-grade junior high school students selected randomly from one class. Data were collected through diagnostic tests in the form of mathematical problem-solving tasks, semi-structured interviews, and observations of how students understood and solved the problems.

The instrument used in this study consisted of a test sheet containing problem-solving questions, which were used to measure students' critical mathematical thinking skills in the material of SPLDV. Data analysis was conducted based on Newman's five categories of error. The results of the analysis are presented descriptively to illustrate the pattern of errors and provide diagnostic information for improving mathematics instruction.

RESULTS AND DISCUSSION

Newman's Error Analysis (NEA**)** is an approach developed by Donald Newman to analyze the errors made by students in solving problems in a mathematical context. This theory helps identify certain stages of difficulty experienced by students so that teachers or researchers can provide appropriate interventions.

Errors based on Newman's type are divided into five types of errors, namely (Rahayu & Pujiastuti, 2018):

(a) Reading errors: These errors occur when students fail to read the question correctly or are unable to identify important information in the question. This can be caused by Difficulty recognizing mathematical symbols or technical terms used in the question, or misreading important numbers or words in the question, which can lead to misunderstanding.

(b) Misunderstanding; This error occurs when students are unable to understand what is being asked within the question, even though the question has been read correctly. This can be caused by difficulty in identifying relevant information in the question or a lack of understanding of the concept or situation described in the question.

(c) Transformation error; This type of error occurs when the students are unable to transform the given problem into a form that can be processed using the appropriate mathematical method. This can be caused by students' difficulty in determining the right method or strategy to solve the

problem, or students experiencing confusion in connecting the mathematical concepts or operations that must be used with the problem at hand.

(d) Process skill errors; These errors occur when students make mistakes in applying the correct procedures or steps to solve a mathematical problem. This can be caused by errors in calculations or applying the correct procedure, or a lack of student understanding in carrying out the systematic steps needed to solve problems.

(e) Answer Writing mistake; This error occurs when students write the answer incorrectly, even though the calculation process or previous solution steps are correct. This can be caused by errors made by students in copying the calculation results or writing the correct answer but in the wrong format, or confusion among students in writing the final answer correctly, for example, writing numbers in the wrong order or writing the wrong units.

The following is a table of critical thinking ability indicators related to Newman's error analysis.

Table 1. Critical Thinking Ability Indicators

Critical Thinking Ability Indicators	Assessment Rubric	Score
Interpretation (Errors in Reading and Understanding Questions)	Not writing what is known and what is asked	0
	Writing what is known and what is asked incorrectly	1
	Write only what is known correctly or only what is asked correctly.	2
	Write what is known from the question, but it is incomplete.	3
	Write what is known and asked in the question accurately and completely	4
Analysis (Transformation Error)	Not creating a mathematical model of the given problem.	0
	Create a mathematical model from a given problem, but it is not correct	1
	Create a mathematical model of a given problem correctly, without giving an explanation	2
	Create a mathematical model of the given problem correctly, but there is an error in the explanation	3

Critical Thinking Ability Indicators	Assessment Rubric	Score
	Create a mathematical model of the given problem correctly and provide a correct and complete explanation.	4
Evaluation (Process Skills Error)	Not using strategies in solving problems	0
	Using inappropriate and incomplete strategies in solving problems	1
	Using the right strategy in solving the problem, but not completely, or using an incorrect but complete strategy in solving the problem	2
	Using the right strategy in solving the problem, but making mistakes in calculations or explanations	3
	Using the right strategy in solving problems, complete and correct in carrying out calculations/explanations.	4
Interference (Error in Making Final Conclusions)	Don't draw any conclusions	0
	Making conclusions that are inappropriate and not following the context of the question	1
	Making incorrect conclusions, even though they are adjusted to the context of the question	2
	Make appropriate conclusions, appropriate to the context, but not complete	3
	Make conclusions correctly, according to the context of the question, and complete	4

Scoring is done in table 1 made by researchers, with the highest score of 4 if students answer correctly and completely. Scoring is adjusted to the level of difficulty of the questions and the stages of work according to the specified Newman criteria. Researchers can set scoring and adjust it to the level of difficulty of the questions, so it does not always have a maximum score of 4 (four), but the maximum score can also be 6 (six) or 10 (ten). Questions are arranged from easy, medium, and difficult questions to see students' critical thinking skills and the student errors that occur when working on questions.

The results of this study are expected to not only provide insight for students but also be a guide for teachers in designing more effective learning strategies to reduce errors in solving problems in real contexts. Teachers as educators can use the results of this analysis to design specific interventions, such as providing gradual exercises, using problem-based learning methods, or

integrating more interesting learning media. Thus, this study contributes to efforts to improve the quality of mathematics learning, especially in the material of the system of linear equations in two variables (SPLDV), so that students can master the concept better and be confident in solving the mathematics problems presented.

Based on the research, the questions given are questions about the system of linear equations in two variables (SPLDV) in everyday life. In this case, the questions were tested on 5 students. After being analyzed, it was found that there were students who answered correctly, some answered incorrectly, some answered less precisely, and some did not answer the questions, which were then analyzed further using the Newman criteria.

The students' critical mathematical thinking ability test sheet consists of 5 SPLDV story questions in everyday life. However, because for the fourth question all students answered correctly and met Newman's criteria, only 4 questions will be discussed to see students' errors in answering questions based on Newman's criteria.

The researcher presents images of students' work and the results of the analysis of students' answers to question number 1 as follows.

Question 1

At a market, a buyer purchases 2 kg of rice and 3 kg of sugar for a total of Rp 60.000. If the price of 1 kg of rice is Rp5.000 cheaper than the price of 1 kg of sugar, determine the price per kilogram of rice and the price per kilogram of sugar.

Student's Answer

Answer:

Given: x = price of rice

y = price of sugar

Asked: Determine the price of rice and sugar?

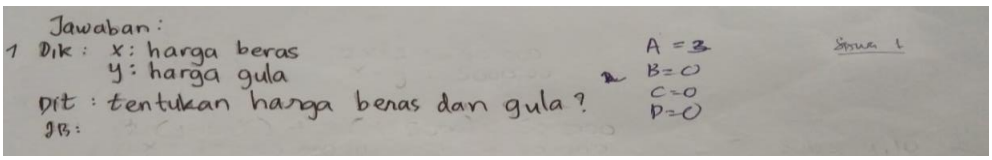

Figure 1. First Student's Answer

The first student wrote what is known from the question correctly, but incompletely, so the researcher gave a score of 3 (three) according to the predetermined indicator criteria. Then the student did not make a mathematical

model to solve the given question, so the researcher gave a score of 0 (zero) according to the predetermined indicator. In working on the question, the student did not use a problem-solving strategy, as seen from the student not continuing the process of working to get the appropriate results, so the researcher gave a score of 0 (zero). In the final working stage, the student also did not conclude the story questions given, so the researcher gave a score of 0 (zero).

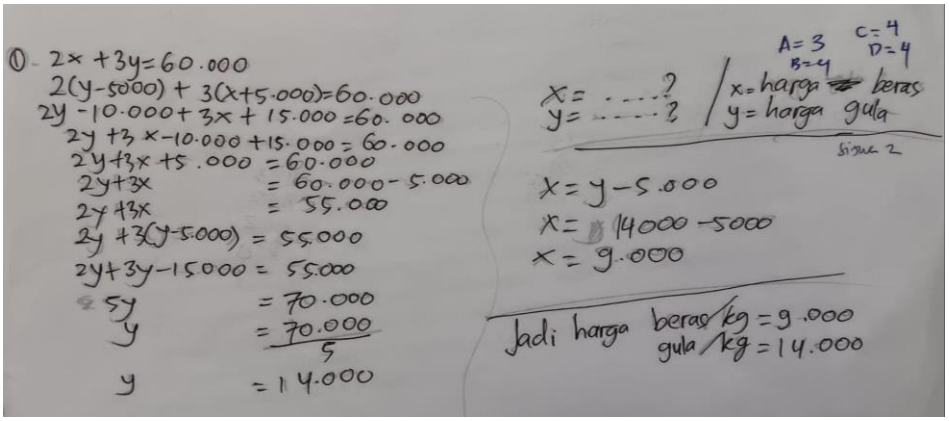

Figure 2. Second Student's Answer

The second student wrote what was known from the question more precisely, but was still incomplete; for this, the researcher gave a score of 3 (three). Furthermore, students were able to make a mathematical model. From the questions given correctly and providing correct and complete explanations, the researcher gave a score of 4 (four). Students have also used the right strategy in solving the questions completely and correctly in carrying out calculations/explanations. In this case, the researcher gave a score of 4 (four). Students conclude at the end of the work on the problem correctly and following the complete context of the problem, so the researcher gave a score of 4 (four).

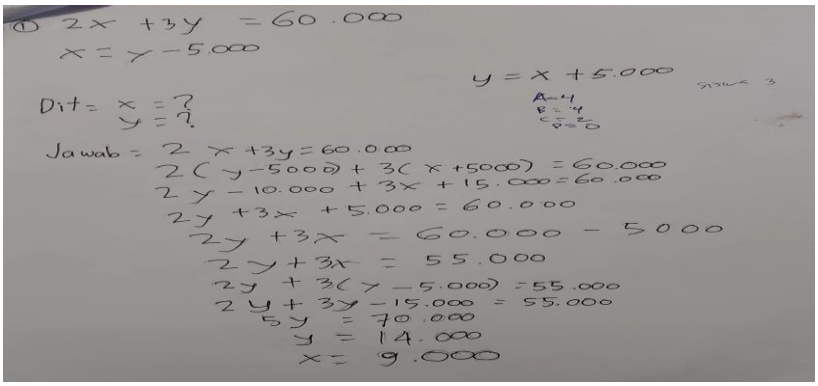

Figure 3. Third Student's Answer

After being analyzed, the third student can write what is known and asked in question number 1 correctly and completely, so the researcher gives a score of 4 (four). The student has been able to make a mathematical model from the given question correctly and provide a correct and complete explanation, so that a score of 4 (four) is given. Next, the student uses the right strategy in solving the problem, but it is still incomplete because the student did not complete the calculation, so the researcher gave a score of 2 (two). In the final stage, the student did not conclude, so the researcher gave a score of 0 (zero).

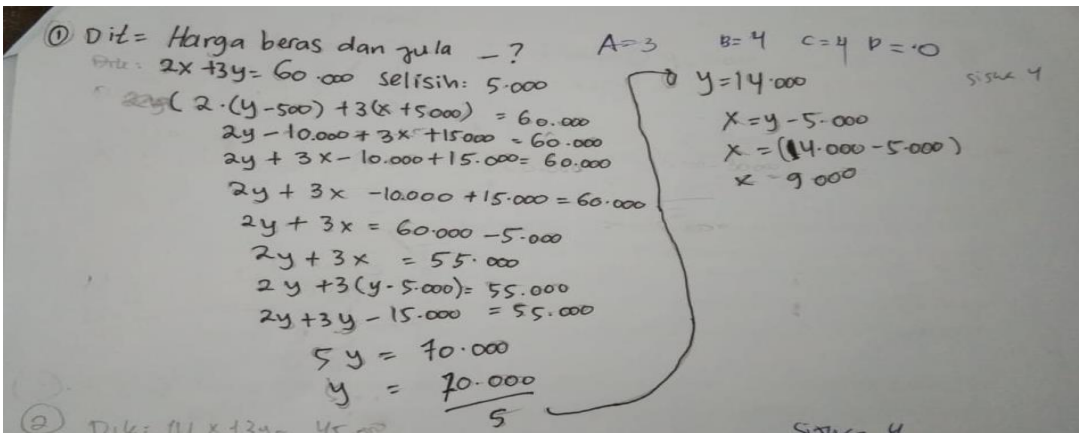

Figure 4. Fourth Student's Answer

After observing and analyzing, the fourth student's answer only writes what is known from the question correctly, but incompletely, then the researcher will give a score of 3 (three) according to the indicators that have been determined. Then the student has made a mathematical model of the given problem correctly and provided a correct and complete explanation, then the researcher gave a score of 4 (four). The fourth student used the right strategy in solving the problem completely and correctly in making calculations/explanations, then he was given a score of 4 (four). In the final stage, students do not conclude then in this case, a score of 0 (zero) is given.

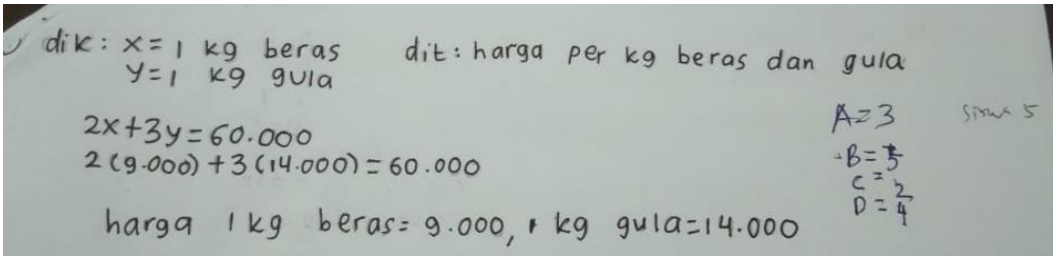

Figure 5. Fifth Student's Answer

The observation result for the fifth student is that the student only wrote what was known from the question correctly, but incompletely, so the researcher gave a score of 3 (three). The student made a mathematical model of the given question correctly, but there were still errors in the explanation, so the researcher gave a score of 3 (three). In the next indicator, the student used the right strategy in solving the question, but it was still incomplete, so a score of 2 (two) was given. At the conclusion stage, the student still made a conclusion correctly, according to the context of the question, and completed so the researcher gave a score of 4 (four).

Based on observations and the scores that have been given to each student for question number 1, they are presented in the following table.

Table 2. Score Obtained for Question 1

No	Student Name	Interpretation (Errors in reading and understanding)	Analysis (Transformation error)	Evaluation (Process Skills Errors)	Interference (Error in concluding)
1	Student 1	3	0	0	0
2	Student 2	3	4	4	4
3	Student 3	4	4	2	0
4	Student 4	3	4	4	0
5	Student 5	3	3	2	4

Based on table 2 regarding the score obtained for question number 1, the percentage per indicator of critical thinking ability with the combined Newman criteria of the five students is obtained. The table calculation can be obtained using the following formula.

$$\text{The average score} = \frac{\text{Total error score per student}}{\text{Maximum score per indicator}}$$

$$\text{Percentage per indicator} = \frac{\text{Average score}}{\text{Maximum score per indicator}} \times 100\%$$

The calculation results are presented in the table below.

Table 3. Results of Error Analysis for Question Number 1

Critical thinking ability indicators with the Newman Criteria	Average Correct Score	Max Correct Score per Indicator	Percentage correct per Indicator	Percentage Error Per Indicator
Interpretation (Errors in reading and understanding)	3.2	4	80%	20%
Analysis (Transformation error)	3	4	75%	25%
Evaluation (Process Skills Errors)	2.4	4	60%	40%
Interference (Error in concluding)	1.6	4	40%	60%
Average Total			63.75%	36.25%

Based on table 3, the results of the error analysis on question number 1 show that the percentage of student success for critical thinking skills and Newman's combination in general resulted in an achievement of 63.75% (average indicator calculation). In the percentage results based on the first indicator of critical thinking and Newman's stages, it can be shown that the interpretation indicator (reading and understanding) reaches a percentage of 80%, and the error is 20%. Indicator The second is the analysis (transformation) of students' ability to analyze correctly, reaching a percentage of 75% and 25% of errors. The next indicator is evaluation (process skills), with the percentage of success in evaluating reaching 60% and errors at 40%. The lowest success indicator is shown in interference (writing the conclusion), with a percentage of 40% and errors reaching 60%, much higher than the other error indicators.

Thus, the researcher continued the analysis until the fifth question and presented it in the following table:

Table 4. Scores for Question 2

No	Student Name	Interpretation (Errors in reading and understanding)	Analysis (Transformation error)	Evaluation (Process Skills Errors)	Interference (Error in concluding)
1	Student 1	3	0	0	0
2	Student 2	3	4	1	0
3	Student 3	3	2	2	0
4	Student 4	3	2	1	0
5	Student 5	4	4	1	2

Table 5. Results of Error Analysis for Question Number 2

Critical thinking ability indicators with the Newman Criteria	Average Correct Score	Max Correct Score per Indicator	Percentage correct per Indicator	Percentage Error Per Indicator
Interpretation (Errors in reading and understanding)	3.2	4	80%	20%
Analysis (Transformation error)	2.4	4	60%	40%
Evaluation (Process Skills Errors)	1	4	25%	75%
Interference (Error in concluding)	0.4	4	10%	90%
Average Total			43.75%	56.25%

Based on table 5, the results of the error analysis on question number 2 show that the percentage of student success for critical thinking skills and Newman's combination in general resulted in an achievement of 43.75% (average indicator calculation). In the percentage results based on the first indicator of critical thinking and Newman's stages, it can be shown that the interpretation indicator (reading and understanding) reaches a percentage of 80%, and the error is 20%. Indicator The second is the analysis (transformation) of students' ability to analyze correctly, reaching a percentage of 60% and errors of 40%. The next indicator is evaluation (process skills), with the percentage of success in evaluating reaching 25% and errors of 75%. The lowest success indicator is shown in interference (writing the conclusion) with a percentage of 10%, and the error reaches 90%, much higher than the other error indicators.

Table 6. Score Obtained for Question 3

No	Student Name	Interpretation (Errors in reading and understanding)	Analysis (Transformation error)	Evaluation (Process Skills Errors)	Interference (Error in concluding)
1	Student 1	0	0	0	0
2	Student 2	0	2	4	0
3	Student 3	0	1	1	0
4	Student 4	3	2	2	0
5	Student 5	0	2	4	4

Table 7. Results of Error Analysis for Question Number 3

Critical thinking ability indicators with the Newman Criteria	Average Correct Score	Max Correct Score per Indicator	Percentage correct per Indicator	Percentage Error Per Indicator
Interpretation (Errors in reading and understanding)	0.75	4	18.75%	81.25%
Analysis (Transformation error)	1.4	4	35%	65%
Evaluation (Process Skills Errors)	2.2	4	55%	45%
Interference (Error in concluding)	0.8	4	20%	80%
Average Total			32.1875%	67.8125%

Based on table 7, the results of the error analysis on question number 3 show that the percentage of student success for critical thinking skills and Newman's combination in general resulted in an achievement of 32.1875% (average indicator calculation). In the percentage results based on the first indicator of critical thinking and Newman's stages, it can be shown that the interpretation indicator (reading and understanding) reached a percentage of 18.75%, and the error was 81.25%, much higher than the other error indicators. Indicator The second is the analysis (transformation) of students' ability to analyze correctly, reaching a percentage of 35% and errors of 65%. The next indicator is evaluation (process skills), with the percentage of success in evaluating reaching 55% and errors of 45%. The success indicator for interference (writing the conclusion) is 20%, and the error rate reaches 80%.

Table 8. Score Obtained for Question 5

No	Student Name	Interpretation (Errors in reading and understanding)	Analysis (Transformation error)	Evaluation (Process Skills Errors)	Interference (Error in concluding)
1	Student 1	2	3	1	0
2	Student 2	3	2	2	0
3	Student 3	2	1	2	0
4	Student 4	0	0	0	0
5	Student 5	0	2	1	2

Table 9. Results of Error Analysis for Question Number 5

Critical thinking ability indicators with the Newman Criteria	Average Correct Score	Max Correct Score per Indicator	Percentage correct per Indicator	Percentage Error Per Indicator
Interpretation (Errors in reading and understanding)	1.4	4	35%	65%
Analysis (Transformation error)	1.6	4	40%	60%
Evaluation (Process Skills Errors)	1.2	4	30%	70%
Interference (Error in concluding)	0.4	4	10%	90%
Average Total			28.75%	71.25%

Based on table 9, the results of the error analysis on question number 5 show that the percentage of student success for critical thinking skills and Newman's combination in general resulted in an achievement of 28.75% (average indicator calculation). In the percentage results based on the first indicator of critical thinking and Newman's stages, it can be shown that the interpretation indicator (reading and understanding) reaches a percentage of 35%, and the error is 65%. Indicator The second is the analysis (transformation) of students' ability to analyze correctly, reaching a percentage of 40% and errors of 60%. The next indicator is evaluation (process skills), with the percentage of success in evaluating reaching 30 % and errors of 70%. The success indicator for interference (writing the conclusion), with a percentage of 10% and errors reaching 90%, is much higher compared to other error indicators.

From the results of the analysis of questions 1 to 5, it was obtained that the average overall percentage for students' critical thinking skills achieved success of 42.109%, and the average percentage of students' error rate in answering questions was 57.891%. The results of the study showed that students with low critical thinking skills tended to make more mistakes in the early stages, while students with high critical thinking skills tended to make mistakes in the final stages, such as the skill process and writing answers. Students with high critical thinking skills were able to analyze and evaluate question information well, so they made fewer mistakes in the early stages, but accuracy remained a challenge for students, especially in writing the final answer.

To deepen the error analysis, interviews and classroom observations were conducted for each student. The goal was to explore the underlying causes of errors, the students' thought processes, and to identify at which stages their thinking did not align with Newman's criteria. The results are summarized as follows:

a. Student 1 showed weaknesses in understanding the problem context. During the interview, the student stated confusion about the meaning of the statement "the price of rice is Rp5.000 cheaper than sugar," which led them to skip constructing any equations. Observational data showed that the student paused for an extended period during reading and made no effort to formulate a strategy. This indicates failure at the comprehension, transformation, and process stages. The student's thinking process was limited to identifying known values, without attempting to solve or conclude.
b. Student 2 demonstrated strong critical thinking and mathematical skills. From the interview, it was clear that the student was familiar with similar problems and employed a systematic approach by sketching a diagram before solving. Observations confirmed that the student moved confidently through each step, from identifying variables to constructing equations and drawing correct conclusions. All stages of Newman's criteria were fulfilled.
c. Student 3 succeeded in interpreting the question and formulating equations but failed to complete the solution process. The interview revealed that the student understood the elimination method but lacked confidence and chose to stop. Observations indicated hesitation and repeated corrections, reflecting uncertainty. The failure was mainly at the process skills and encoding stages. This student's thinking was analytical, yet incomplete due to procedural insecurity.
d. Student 4 constructed correct equations and solved them accurately, but did not provide a written conclusion. According to the interview, the student believed that the numeric answer was sufficient and did not understand the importance of communicating a final statement. This suggests a misunderstanding of mathematical communication. The student failed at the encoding stage, despite success in earlier stages.
e. Student 5 attempted to solve the problem by creating equations but gave incomplete explanations and calculations. From the interview, the student expressed understanding of the concepts but admitted to forgetting how to apply the solution methods. Observations showed attempts to refer to notes

but an inability to connect them effectively. The student struggled with evaluation and partial transformation stages, demonstrating conceptual knowledge but limited procedural fluency.

These analyses confirm that errors are not only the result of computational mistakes but also stem from misunderstandings, lack of confidence, incomplete strategies, and weak mathematical communication. Therefore, combining Newman's framework with qualitative data provides a clearer picture of students' thought processes and helps identify targeted interventions for each type of error. These results are in line with Newman's (1977) study, which states that mistakes at each stage of solving questions reflect students' thinking skills. In addition, these findings support the study of Sugiman (2020), which emphasizes the importance of a problem-based learning approach to improve students' critical thinking skills.

CONCLUSION

Based on the results of the study, it can be concluded that the findings of this study regarding the analysis of students' critical thinking skills based on Newman's Criteria in solving SPLDV are presented as follows: Students were generally successful in interpreting, reading, and understanding the questions. However, some students were less careful in recording the information requested in the questions. There are still students making analytical errors and using inappropriate strategies, especially in calculations when analyzing and carrying out transformations. Some students had not yet carried out calculation operations when evaluating and solving problems. Many students feel that it is enough to do calculation operations without concluding and re-checking, so that most only get the final result without making conclusions from the questions presented.

This means that Based on the analysis results, it was obtained that the average overall percentage for students' critical thinking skills achieved success of 42.109%, and the average percentage of students' error rate in answering questions was 57.891%. The percentage of errors was higher than the percentage of students' correctness in answering questions. Error analysis based on Newman's criteria can help identify the types of errors that students often make, so that teachers, as educators, can design effective learning strategies. The importance of improving students' critical thinking skills through innovative learning approaches, such as problem-based or contextual learning. Teachers also need to pay special attention to the development of students' mathematical

communication skills to reduce errors in the final stages of solving problems. It is recommended that this error analysis be carried out on other mathematical materials and involve a larger number of samples. Thus, the results of the study can provide a more comprehensive picture of the relationship between critical thinking skills and types of student errors in solving mathematical problems.

Teachers can use various instructional strategies, such as implementing differentiated instruction based on students' abilities, to reduce errors in analysis and thereby enhance students' critical thinking skills. It trains students more by doing exercises to solve problems using systematic steps and trains them to double-check and conclude their work. We, as educators, can also teach effective reading strategies, such as looking at keywords in the problem. Then, teachers can train students to manage their time in solving problems and to be calm. It can also be done by using an interactive learning approach so that students are more actively involved and understand the material better.

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