Jurnal Perspektif
Vol. 10 No. 1 Mei 2026
Page 223-236

Analysis of Conceptual Errors in Mathematical Solutions Through Problem-Based Learning Models for Students on the Material of Two-Variable Linear Equation Systems

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Received: 02 April 2026; Accepted: 07 Mei 2026; Published: 11 Mei 2026

DOI: 10.15575/jp.v10i1.459

Abstrak

Penelitian ini bertujuan untuk mengidentifikasi kesalahan, proses jawaban alternatif, dan aktivitas pembelajaran berbasis masalah siswa. Penelitian deskriptif kualitatif dengan metode Huberman ini dilakukan di SMP Negeri 27 Medan, kelas VIII, tahun ajaran 2025/2026. Penelitian ini melibatkan 29 siswa. Kesalahan yang paling dalam penelitian ini adalah kesalahan perhitungan dan tidak menulis kesimpulan akhir, sehingga model pembelajaran berbasis masalah dapat meningkatkan pemahaman konseptual siswa tetapi belum sepenuhnya meminimalkan kesalahan pada tahap proses dan keterampilan pengkodean. Oleh karena itu, ketelitian prosedural dan keterampilan komunikasi matematika harus ditekankan untuk meminimalkan kesalahan siswa. Secara keseluruhan, penelitian ini menunjukkan bahwa pendekatan Newman dapat mengungkap kesalahan siswa dalam menangani masalah SPLDV. Model pembelajaran berbasis masalah juga dapat meningkatkan pemahaman konseptual dan aktivitas pembelajaran siswa.
Kata Kunci: *Analisis Kesalahan, Konsep, Model Pembelajaran Berbasis Masalah.*

Abstract

This study seeks; To identify errors, alternate answer processes, and student problem-based learning activities. This qualitative descriptive miles huberman research was conducted at SMP Negeri 27 Medan, class VIII, in 2025/2026. This study included 29 students. The most common errors in this study are calculation errors and not writing the final conclusion, so problem-based learning models can improve students' conceptual understanding but have not completely minimized errors in the process and coding skills stage. Therefore, procedural accuracy and mathematical communication skills must be emphasized to minimize student errors. Overall, the study shows that the Newman approach can reveal student errors in handling SPLDV problems. Problem-based learning models can also improve conceptual understanding and student learning, reducing mathematical errors.

Keywords: Error Analysis, Concept, Problem-Based Learning Model.

A. Introduction

A mathematical concept is an abstract idea that allows us to classify objects or events within that abstract idea (Hudojo, 2018). To master conceptual understanding, students must be able to distinguish between one object and another, and one event from another (Trianto., 2017). Based on the definitions above, it can be concluded that in this study, the concept is defined as an abstract idea that groups objects into an abstract idea, thus generating a theorem. In response to the Merdeka curriculum, which emphasizes students' freedom to be creative and to choose their preferred methods for solving problems. (Purba, 2023) says, "To achieve competency, curriculum implementation requires an educational climate that fosters an intellectual and scientific spirit in every educator, from home, school, and the community." This change in the teacher's role from instructor to learning facilitator is significant. (Belen, 2023) define an error as a divergence from what is correct or agreed upon. Positive errors are essential to learning. Errors can also lower students' problem-solving confidence and skill, particularly when they lead to repeated mistakes that reinforce negative self-perceptions about their abilities. (Eviyanti, Y. C., Surya, E., Syahputra, E and Simbolon, 2017) defines an error as a systematic, consistent, or inadvertent divergence from correctness. Incidental errors are not caused by student competency, but systematic errors are.

Such an approach approach makes kids focus on math issues. (Herawati, 2022) said, "Eight countries' creativity assessments show Indonesian pupils have low creative thinking skills. As seen above, students' cognitive growth and learning results depend on their creative mathematical thinking skills. (Hernawan, 2021) says, "Educational outcomes are not only about the future but essentially about fostering critical individuals with high levels of creativity." According to (Saragih, S. & Habeahan, 2014), in fact, mathematics learning in Indonesia tends to be limited to mastery of the subject matter or rely on low-level cognitive aspects that are unable to develop student creativity." This limits Indonesian learning to subject mastery or low-level cognitive skills, reducing student creativity. Hierarchical learning keeps kids engaged and avoids boredom.

Such an approach makes children uncomfortable learning arithmetic directly and makes them fear it, making it hard to learn. Because students have inadequate creative thinking skills, they can't uncover learning concepts, and solving issues creatively in the classroom is difficult, learning is still teacher-centred (Hendrikson R Panjaitan, 2023). Few pupils remember creative thinking skills. In addition, classroom mathematics learning is meaningless and does not prioritize student understanding, resulting in inadequate conceptual understanding, which further exacerbates the issue of students struggling to apply mathematical concepts in real-world situations. The preliminary research for grade VIII at State Junior High School 27 Medan includes a conceptual thinking ability test consisting of the following questions:

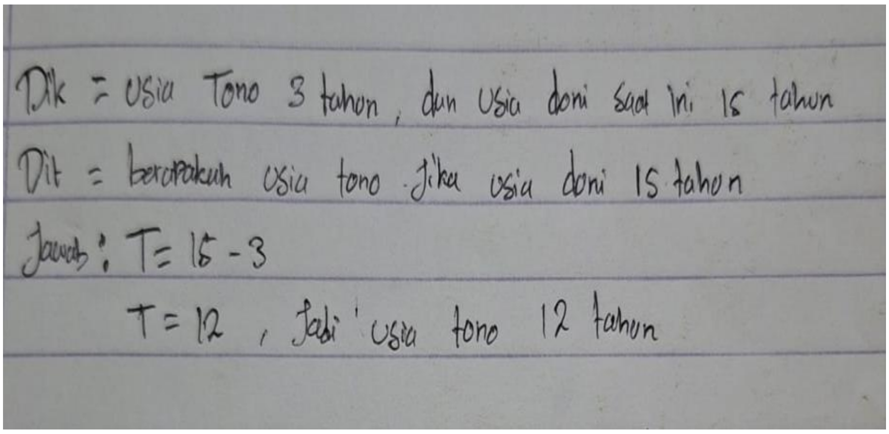

Figure 1.Student's wrong answer in an example of a conceptual error in solving mathematics

A preliminary investigation of conceptual mistake tests in mathematics problem-solving found low conceptual comprehension and innovative thinking in students. Students have limited conceptual comprehension and creative thinking in mathematics for several reasons, including their capacity to understand and assimilate instruction. (Kusuma, 2022) states, "Some students are fast at numbers, some are average, and some are very slow at solving problems." Thus, their understanding of the same information or lesson varies . Teachers' lack of adequate and varied modelling and learning material and monotonous or non-student-centred instruction contribute to pupils' low conceptual understanding. In addition, classroom learning is meaningless, preventing pupil comprehension (Marweli, 2024). Thus, students' conceptual grasp is poor. According to (Sinaga, 2007), "Teachers still adopt teacher-dominated or teacher-centred learning approaches." Teachers' lectures and question-and-answer sessions hinder student learning."

According to observations and conversations with SMP Negeri 27 Medan mathematics teachers, pupils make conceptual errors throughout math instruction. Students struggle with multiplication, division, and fractions. Teachers ignore pupils' learning methods. Teachers don't optimize students' learning styles, making it hard for them to understand mathematical concepts and leading to persistent struggles with multiplication, division, and fractions. Teachers reported not having time to assess students' mathematical solutions for conceptual flaws. Thus, teachers provide routine homework without assessing students' mathematical skills, including conceptual flaws in their responses.

These interviews show that teachers use a problem-based learning methodology, but students lack basic operational knowledge and don't consider their learning preferences, resulting in conceptually poor mathematics solutions. Thus, modifications are needed. Improving arithmetic problem-solving principles with learning models. Alternatives include problem-based learning. (Marweli, 2024) says, "The problem-based learning paradigm encourages higher-order thinking in pupils. " Barker (2007:214) says, "This improves students' learning cycles and styles. Problem-based learning benefits from learning styles." Teachers must establish a strategy that encourages autonomous learning to improve students' mathematical conceptual comprehension and creativity, such as incorporating problem-based learning techniques that cater to various learning styles. Understanding that each student learns differently is crucial. According to (Pasaribu, M., & Amry, 2024), "A selected group will have high, medium, and poor abilities.

This is supported by problem-based learning. (Surya, E., & Syahputra, 2017),"This model is a learning approach that integrates students into real-world problems, enabling them to construct their own knowledge, develop higher-level skills and inquiry, empower students, and foster confidence in them. The teacher only facilitates student-centred, priority-based learning (PBL). PBL is real-world learning that helps students think creatively, solve problems, learn, and understand topic concepts. (Posner, G., Strike, K., Hewson, P., & Gertzog, 2021) says, "Contextual problems can motivate students, create enthusiasm, increase student activity, and focus learning on problem-solving."

The thesis by Asril Rais Sirait, titled "Analysis of Creative Thinking Ability in Mathematics Reviewed from Learning Styles through Problem-Based Learning in Students of SMP Negeri 42 Medan" (Putra, A. D., & Lestari, 2023) published by Medan State University, found that problem-based learning increased students' thinking variety but hindered originality. (Pasaribu, M., & Amry, 2024) found that the cooperative learning model can help students understand concepts, but most still struggle to restate and apply them. This study confirms SMP Negeri 27 Medan's findings that most class IX pupils struggle to develop mathematical models and provide diverse problem-solving concepts. Observations during learning demonstrate that pupils are passive and rely more on lecture methods; therefore, they are less equipped to understand concepts or solve issues creatively. According to discussions with mathematics teachers, problem-based learning is hindered by pupils' poor core knowledge and lack of learning modifications to different learning styles. This led the researcher to title this study " Analysis of Conceptual Errors in Mathematical Solutions Through Problem-Based Learning Models for Students on the Material of Two-Variable Linear Equation Systems.

B. Research Method

This study employed descriptive qualitative research. descriptive qualitative research type with the Miles and Huberman Model aims to describe students' difficulties in understanding concepts and creative mathematical thinking when applying them to problem-based learning (PBL) (Miles, B. M., Huberman, M. A., & Saldana, 2014). The data generated from this study consisted of words or utterances obtained through interviews. This study was conducted at SMP Negeri 27 Medan, grade VIII students, during the 2025/2026 academic year.

The subjects of this study were 29 students from grade VIII of SMP Negeri 27 Medan, who were implementing the problem-based learning model in the even semester of the 2025/2026 academic year. Can be seen in table 1:

Table 1. Characteristics of Mathematical Abilities

No	Code	Total	Mark
1	001	80	100
2	002	48	60
3	003	80	100
4	004	80	100
5	005	80	100
6	006	80	100
7	007	44	55
8	008	80	100
9	009	80	100
10	010	36	45
11	011	80	100

12	012	80	100
13	013	80	100
14	014	80	100
15	015	36	45
16	016	80	100
17	017	52	65
18	018	80	100
19	019	80	100
20	020	80	100
21	021	48	60
22	022	40	50
23	023	80	100
24	024	40	50
25	025	80	100
26	026	80	100
27	027	80	100
28	028	40	50
29	029	80	100

From the table1 above, the overall average score was 85.52, indicating that the majority of individuals in this data set performed very well. This indicates that the majority of respondents achieved very high scores, with over 67% (20 of 29) earning the maximum score of 100. These data show very positive results, with most individuals performing well, although some may need further assistance to achieve better performance.

The object of this study was conceptual errors in mathematical problem-solving of students who were exposed to the problem-based learning model on the SPLDV topic. The research objects were obtained from the results of a test on conceptual errors in mathematical problem-solving of students and through interviews.

The data collection process in this study involved entering the research location and collecting research data. The research methods used in this study included a test on conceptual errors in mathematical problem-solving of students, interviews with students and teachers, observation by observers, and documentation.

Data analysis activities using the Miles and Human Model include data reduction, data display, and data conclusion drawing/verification. Furthermore, Sugioyno (2009:363) states that the data analysis techniques provided by Miles and Huberman and Spradley complement each other. In each stage of the research, Miles and Huberman used the steps of data reduction, data display, and verification. These three steps can be carried out in the qualitative research process: description, focus, and selection.

The statement above indicates that the two methods complement each other, but Spradley's method starts from the general, focuses, and expands (Sugiyono, 2009:347). This is shown in the following diagram.

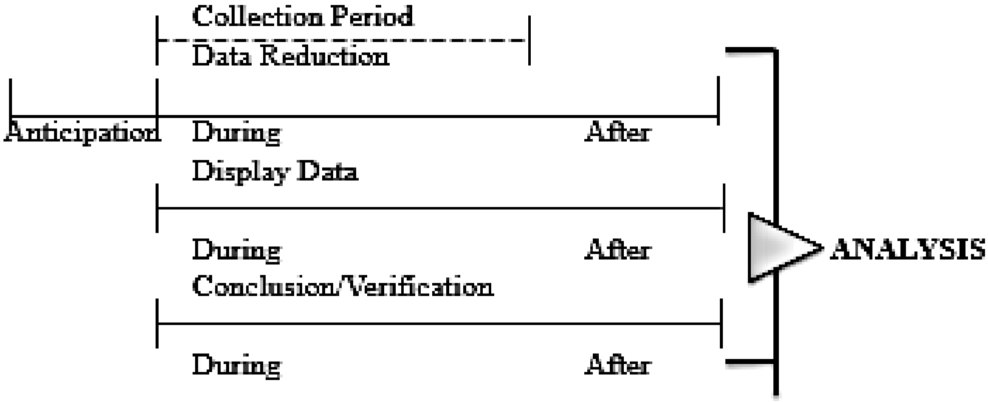

Figure 2. Data Analysis Process

Based on the scheme above, the researcher conducted data collection, anticipatory measures, before conducting data reduction. Each student's test score was determined based on the test results, specifically the conceptual error test in solving mathematics. Answer sheets from the conceptual error test results in solving mathematics were collected for review and scored according to existing scoring guidelines. From this scoring, student interview data were obtained.

C. Result and Discussion

This study analyzed Miles and Huberman data and student and teacher observations during learning. Qualitative data was collected by observation, interviews, documentation, and data combination/triangulation. Data triangulation validated study results, allowing conclusions.

Data Presentation

Data presentation is grouping data reduction results into a story about student answers. Data is reviewed and evaluated to determine next steps, along with interview results in concise, different explanations, illustrations, charts, and category relationships. After the conclusion, the data is rechecked by asking friends as research partners questions, examining field notes, and considering essential areas to be redone. Verification validates the concluding data for truth, robustness, and applicability. According to the problem-based learning methodology, students' replies to mathematical Students made faults in reading, comprehension, transformation, process skills, and coding, according to their replies. Number signals, especially positive and negative, were misread, affecting following processes. Comprehension and transformation errors occurred when students failed to identify key information and translate story issues into equation models. This caused pupils to make mistakes while determining coordinate points and drawing graphs, especially when understanding the x- and y-axes. Students' final conclusions were inappropriate for the problem's context, showing coding problems. Newman (1977) found that mathematical problem-solving errors occur sequentially from reading to writing responses. Polya (1973) stressed that understanding the problem and creating a mathematical model are crucial to problem solving. Student errors indicate the need for conceptual comprehension and systematic procedural skills development.

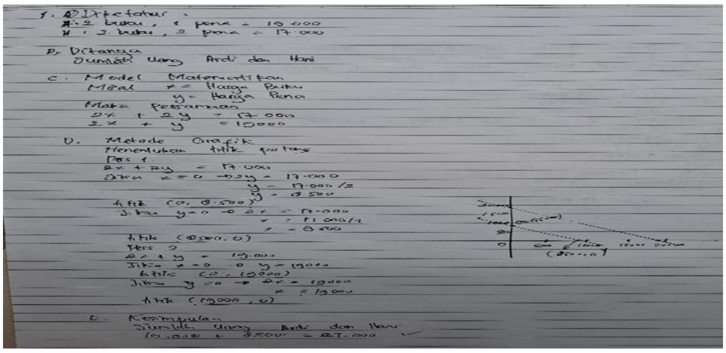

Figure 3. Students' Post-test Answers

The students' replies indicate understanding, transformation, process skills, and coding faults. Students misinterpreted the problem's information and the relationship between coordinates and linear equations, resulting in errors in modelling the variables (x and y as quantities rather than prices). Students made mistakes when calculating coordinate points and generating graphs by combining and transforming equations. Coding errors were also evident in pupils' incapacity to draw problem-appropriate conclusions. Students need to develop conceptual knowledge and structured solution procedures because they haven't mastered the problem-solving phases.

Following the Post-Test, Interview Subject Selection

After all students completed the learning process and posttest, the researcher examined their work to identify mistakes in the System of Linear Equations in Two Variables. This investigation used Newman's mistake stages reading, understanding, transformation, process skill, and encoding. After analyzing the post-test response sheets, the researcher selected many students for interviews. Purposefully picked interview subjects represented faults in each student solution method: pictorial, substitution, and elimination. The analysis included interviews with nine students—three from each solution technique. Due to errors in determining coordinates and creating graphs, students with codes 015, 017, and 028 were selected for the graphical approach. Students with codes 021, 022, and 024 were selected for the substitution approach because they had difficulty translating word problems into equations and substituting. For the elimination technique, students with codes 002, 007, and 010 were chosen because they made mistakes in determining and calculating the deleted variable. Interviews were used to learn more about the reasons for post-test errors. Through these interviews, researchers aimed to better understand problem-solving errors.

Subject Selection

The criteria for selecting interview subjects were based on indicators of student ability to analyze errors in mathematical problem solving. The interviewed students were those who experienced significant errors in solving the SPLDV mathematical problem. The criteria measured were reading, comprehension, transformation, process skills, and writing, using three SPLDV solution methods. The methods used in solving SPLDV included elimination, substitution, and graphing. Each of the three SPLDV solution methods was analyzed to determine student response patterns. Based on the dominant response process, students were selected for interview. Through all student responses, the most common errors were analyzed. Error analysis was then conducted using the answer sheets and interviews to identify errors in mathematical problem solving, which were triangulated with the students' response processes in completing the worksheet.

The solution to the constraints identified in Figure 2 focused on the Transformation stage through more systematic modeling techniques. Students needed guidance in accurately translating the verbal statement "more expensive than" into mathematical symbols to avoid errors in variable placement. Teachers are advised to use a "Translation Table" that divides columns between story sentences and algebraic models. With a clear structure, students will more easily determine which variables are most efficient to eliminate first without experiencing procedural confusion that leads to numerous scribbles on the worksheet. Based on the results of the error analysis test in solving mathematics, the subjects who were interviewed were students who made many errors in solving the elimination, substitution, and graphic methods, each of which was taken 3 people for one SPLDV solution method, so that 9 students were interviewed.

Table 2. Selected Subjects for Student Error Analysis Interviews in Mathematics Solutions

No	Student Code	Student Admissions from a Different Aspect
1	015	Graphical Method
2	017	
3	028	
4	021	
5	022	Substitution Method
6	024	
7	002	Elimination Method
8	007	
9	010	

Interview Implementation

Interviews were conducted for each classification of student answer patterns using the elimination, substitution, and graphical methods. Data analysis from the results of the error analysis test in students' mathematical solutions was triangulated by identifying the problems students worked on.

Error Analysis in Mathematics Solutions Using the Graphical Method

In interviews with student 015, it was found that the student had trouble understanding and interpreting the situation. The student admitted to misreading numbers in the problem, particularly in pairings of negative values (x and y). This shows the student didn't understand the math in the problem. The student also said he had trouble determining the numbers and graphing points, so he didn't immediately understand what was known and what was being asked. This suggests reading and comprehension issues, specifically with the stated problem. Student 015 similarly struggled to simplify the problem into two equations for graphing. The student had trouble choosing numbers for the (x) and (y) axes. This made finding axis intersection points and making graph lines challenging. The equations were valid, but the student made errors in computing the numbers and establishing the coordinate axes while making the graph. This suggests problems in the transformation error and process skill error stages, such as converting the problem to math and calculating and graphing.

Interviews with student 017 revealed that the student still struggles to read and comprehend the difficulty. The student said he misinterpreted numbers and symbols in the multiplication and division portions. Before sketching the graph, the student admitted he didn't comprehend what was known and what was asked. This suggests that the learner has trouble reading and understanding the mathematical problem.

The student also struggled to simplify the problem into two equations for graphing. The student admitted to still struggling and not knowing how to find the x- and y-axes' intersection places. The kid said he still didn't comprehend the horizontal x-axis and vertical y-axis. Even with proper equations, the student made graphing errors because to this difficulty. This indicates transformation error and process skill error, specifically errors in converting the problem into a mathematical model and errors in solving it, particularly in drawing the graph and determining the intersection points.

Student 028 struggled to find coordinate axes' intersection locations, especially on the y-axis. This student had trouble identifying these axes' points. Even though the equations were valid, this complexity caused graphing inaccuracies. The student said he didn't use a ruler, therefore the graph lines were imprecise and the points were wrong. This implies a process skill error in the solution approach, particularly in graph drawing and coordinate plane point positioning.

In contrast, the student felt secure in his response after identifying the intersection of the two graphs. The student said he wrote a conclusion from his results. This suggests the learner can explain his solution's findings. However, the student admitted that drawing graph lines and finding the junction points as the solution is the hardest aspect of graphing. According to the interview results, student 028 struggles with procedural skills in drawing graphs, particularly in determining point positions on the coordinate axis and drawing accurate graph lines to find intersection points as solutions to the two-variable linear equation system.

Analysis of Errors in Solving Mathematics Problems Using the Substitution Method

Based on interviews with three students (numbers 021, 022, and 024) who solved SPLDV problems using the substitution method, it can be concluded that students still encountered several errors at certain stages of the solution process. The most common errors occurred in reading and understanding the information in the equation. Some students admitted to misreading or rewriting coefficients or signs in the given equation. These errors resulted in inaccurate initial information used in the solution, potentially leading to errors in subsequent steps.

Furthermore, some students also experienced difficulty understanding the meaning of the variables (x) and (y) in word problems and in determining which equations should be changed first for the substitution process. This indicates that students' understanding of the basic concepts of the substitution method is still not fully optimal. When students lack an understanding of the role of variables and the strategic steps for solving equations, they tend to feel confused when starting the solution process.

Other errors frequently experienced by students occur at the solution stage, particularly when moving sides in equations and performing algebraic operations such as addition and subtraction. Some students still made errors in changing signs when moving terms to the other side and in the calculation process after performing substitution. However, some students were able to write a complete final answer after obtaining the values of (x) and (y). This indicates that student errors were more prevalent during the solution process stage than during the final answer-writing stage. Thus, it can be concluded that student errors in the substitution method are primarily related to the accuracy of reading equations, understanding the concept of variables, and skills in performing algebraic procedures.

Analysis of Errors in Mathematical Solutions Using the Elimination Method

From interviews with three students using the elimination method to solve a System of Linear Equations in Two Variables (SLSV), students 002, 007, and 010, Newman's error analysis shows that the students made errors at several stages of the solution procedure. In general, the three pupils had little trouble reading the symbols, signs, and coefficients in the equations. Some students still had trouble comprehending the objective of utilizing the elimination procedure to determine the SLSV solution set.

In addition, numerous students struggled to identify variables to delete and equate the coefficients of the two equations during transformation. Students had trouble grasping the beginning steps in the elimination process, especially with larger coefficients or more complex equations. This suggests kids don't understand the elimination method's solution strategy. At the process skills stage, numerous pupils still made mistakes in multiplication, division, and negative numbers. The elimination procedure failed due to these issues, influencing the result. At the answer-writing (encoding) stage, some students did not write down the conclusion or solution set completely, and some did not continue solving until they had both variables. When solving SPLDV using the elimination approach, the most common errors were in transformation, process skills, and answer-writing.

Based on graphical, substitution, and elimination analysis, the following table lists all Newman errors from nine interview participants. This table might reveal patterns of student errors at the end of Chapter IV subsections.

Table 3. Recapitulation of Newman's Errors in Solving

No.	Student Code	Method	Reading Error	Misunderstanding	Transformation Error	Process Skills Errors	Encoding Error
1	015	Graph	Yes	Yes	Yes	Yes	Yes
2	017	Graph	No	Yes	Yes	Yes	Yes
3	028	Graph	No	Yes	Yes	Yes	Yes
4	021	Substitution	No	Yes	Yes	Yes	Yes
5	022	Substitution	Yes	Yes	Yes	Yes	Yes
6	024	Substitution	No	Yes	Yes	Yes	Yes
7	002	Elimination	No	Yes	Yes	Yes	Yes
8	007	Elimination	Yes	Yes	No	Yes	Yes
9	010	Elimination	Yes	Yes	Yes	Yes	Yes

The summary table of Newman's SPLDV mistakes illustrates students' errors in reading, comprehension, transformation, process skills, and coding, as well as their solution approaches (elimination, substitution, and graphing). The understanding and coding stages were where most pupils struggled, not the reading stage. while pupils don't understand the problem, they make transformation errors while turning it into a mathematical model. Process skills errors arise when pupils calculate incorrectly, and coding faults appear in improper writing or no conclusion. Since faults tend to occur progressively, the chart also indicates that early errors can affect later stages.

According to Newman's indicators, 69% of 29 students solving SPLDV solved the problem without errors, while 31% made errors in reading, comprehension, transformation, process skills, and coding. Errors were mostly connected to reading numbers, comprehending equation variables, turning word problems into mathematical models, and eliminating and substituting. According to Newman's hypothesis (1977), student mathematical problem-solving failures fall into five categories: reading, comprehension, transformation, process abilities, and coding. This analysis shows that most students have mastered SPLDV's basic concepts, but more attention should be given to problem reading and comprehension, as well as procedural skills to reduce transformation and coding errors, to improve solution accuracy and completeness.

Based on Table Recapitulation of Newman's Errors in Completing SPLDV involving 9 student interview subjects, the number of errors at each Newman stage can be calculated from the ✓ sign as an error that occurred, while the - sign indicates no error.

Table 4. Summary of the Number of Errors Based on the Newman Stage

Newman Stages	Number of Errors	Percentage
Reading	4	3,45%
Understanding	9	7,76%
Transformation	8	6,90%
Process Skills	27	23,28%
Coding (Writing)	36	31,03%
Total	84	72,41%*

According to data recapitulation, students' errors in solving Systems of Linear Equations in Two Variables (SPLDV) were highest at the coding stage (31.03%) and process skills (23.28%), while reading (3.45%), comprehension (7.76%), and transformation (6.90%) were lower. Students understood the questions but struggled to calculate and write the answers. Students failing to write final conclusions or deliver data in a problem-appropriate way caused most coding errors. Anne Newman's mistake analysis approach culminates in coding, which requires students to present their findings clearly. Students with poor mathematical communication abilities fail at this stage, even though the previous steps were correct. George Polya agrees, saying that the final phase in problem-solving is re-examining and concluding the results, which students typically neglect.

The process skills stage errors show that pupils are still struggling with calculation operations, especially elimination, substitution, and combination. These errors include algebraic, sign, and solution step combining errors. Due to the disparity between instrumental and relational knowledge, children tend to memorize processes without understanding their purpose, making them prone to errors when solving problems, according to Richard Skemp.

The low number of understanding and transformation errors suggests that most students can identify and translate known information into a mathematical model. This is linked to Problem-Based Learning (PBL), which helps students grasp challenges contextually. Howard Barrows says PBL helps students assess real-world challenges and gain conceptual understanding. The high number of students who made no initial mistakes shows this. PBL improves conceptual knowledge, this study found that it has not totally decreased procedural and answer-writing errors. Hiebert and Lefevre agree that conceptual comprehension and procedural abilities work together to help students learn math.

The average student score was 68.41, with 20 students scoring a perfect, demonstrating that PBL improves problem-solving ability. Low scores (≤55) indicate that some students struggle to master all stages of problem-solving. This shows the necessity of final learning reinforcement, especially in computational precision and conclusion-drawing.

Discussion

Mathematical concepts such as the System of Linear Equations in Two Variables (SLSV) require reading, understanding, translating problems, procedural skills, and expressing answers. Student errors are categorized as reading, comprehension, transformation, process skill, and encoding errors by (Newman, 2021). These stages give a systematic framework for analyzing student math errors, including SLSV. Students 015 and 017 struggled to read the problem (Rahayu, 2025). Student 015 frequently misread negative numbers (x, y), while student 017 misunderstood multiplication or division signs. Reading errors involve misreading numerical information or mathematical symbols (Rasyid, 2023).

Both children had comprehension errors, which are problems processing material and identifying what is known and what is asked. Student 015 struggled to locate points on the x- and y-axes, while student 017 could not distinguish between the horizontal and vertical axes. Students who are unfamiliar with mapping mathematical texts to visual representations or mathematical models commonly make reading and understanding errors, according to (Riadi, 2021).

A contextual problem-based approach in PBL can reduce these errors by offering real-world scenarios that require data and variable relationships before calculations. Students can discuss, question, and highlight key data in group activities. This method enhances problem-solving and comprehension and lowers initial errors (Ratnaningsih, 2023). Students 015 and 017 struggled to translate the problem into a graphable equation (Safari, Y., & Putri, 2022). Student 015 had trouble establishing the coordinate axes, resulting in an improper intersection point, whereas student 017 had trouble choosing an equation. Transformation mistakes occur when the information cannot be organized into a correct mathematical model (Hartati, 2021).

Students also made procedural errors, including drawing the graph line and finding the intersection location. Even if the calculations were correct, faulty approaches produced inaccurate lines and intersection points. Visual simulations or manipulatives, such as interactive graphing software or board sketching, can support problem-based learning (PBL). These activities teach students to follow procedures and double-check before writing the final response (Samosir, C. M., & Dasari, 2022).

D. Conclusion

The research objectives can be concluded as follows. The research objective was to identify students' errors when solving mathematical problems using problem-based learning models. Students made errors in solving Systems of Linear Equations in Two Variables problems at all stages of Newman's procedure: reading, understanding, transformation, process skills, and coding. Thus, problem-based learning approaches improve conceptual comprehension but do not eliminate process skills and coding errors. Thus, procedural correctness and mathematical communication must be emphasized to reduce student errors.

Problem-based learning methods that emphasize conceptual comprehension, problem analysis, and student involvement in solving problems can resolve student errors. Students can reduce transformation and process errors through planned procedural exercises and media such as translation tables that link problem statements to algebraic models. Problem-based learning methods can improve students' conceptual comprehension and reduce mathematical errors. Based on 29 students' learning activities, the average student activity score was 6.55 out of 8.00 (81.9%), which is high. This shows that students were engaged during the learning process. The Newman approach can reveal student faults when handling SPLDV problems, according to the research. A problem-based learning strategy can also enhance conceptual understanding and student learning, thereby reducing mathematical errors.

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