ISSN Online 2527-5933
MATH-EDU: Jurnal Ilmu Pendidikan Matematika
Volume 11, Nomor 2, Agustus 2026, pp. 135-149

Error Analysis of Junior High School Students in Solving Straight-Line Equation Task

Novia Christyananda[1], Anis Munfarikhatin[2*], Khumaeroh Dwi Nur'aini[3]
[1]Department of Mathematics Education, Universitas Musamus, Papua Selatan, Indonesia
*Correspondence: munfarikhatin_fkip@unmus.ac.id

Informasi Artikel

Received:
1st July 2026

Accepted:
3rd August 2026

Publish:
31st August 2026

Keywords
Students' errors
Straight line equations
Kastolan's error analysis
Conceptual understanding

Abstract

This study aims to analyze the types of student errors in solving linear equation straight-line equation problems based on Kastolan's stages: conceptual errors, procedural errors, and technical errors. This study used a qualitative descriptive approach with subjects consisting of ninth-grade students grouped based on high, medium, and low scores. The research instruments included essay tests and structured interviews. The results showed that students with high scores tended to make technical errors, such as writing the wrong operation sign, as well as procedural errors in the value substitution step. Students with medium scores made technical errors, procedural errors, and conceptual errors, such as the inability to determine the correct formula. Meanwhile, students with low scores made all types of errors, especially conceptual errors, such as confusion in choosing the appropriate formula. These errors were influenced by inaccuracy, lack of conceptual understanding, and irregularity in problem-solving procedures. This study recommends learning strategies that focus on conceptual reinforcement, systematic practice, and increasing student accuracy to minimize errors. This study recommends learning strategies that focus on conceptual reinforcement, systematic practice, and increasing student accuracy to minimize errors.

How to Cite: Christyananda, N., Munfarikhatin, A., & Nur'aini K. D. (2026). Error Analysis of Junior High School Students in Solving Straight Line Equation Task. *Math-Edu: Jurnal Ilmu Pendidikan Matematika*, 11 (2), 135-149.

Introduction

Mathematics is inseparable from everyday human life. Mathematics is also a basic science that plays an important role in students' thinking processes and can help students learn other branches of science. Munfarikhatin (2019) emphasized that students' ability to understand and master mathematical concepts can be key in learning other fields of knowledge. Understanding mathematical concepts plays a crucial role in the learning process because it serves as a foundation before continuing with other learning (Agusta, 2023). According Liu, Miao, & Zheng (2024), understanding mathematical concepts is an important part of the learning process because the ability to understand concepts well enables students to solve mathematical problems and also everyday problems. Whether or not the objectives of mathematics learning are achieved can be assessed by students' success in understanding and applying them to solve mathematical problems in everyday life (Forrester & Covington Clarkson, 2023). Therefore, it is highly expected that students can truly understand and master mathematics lessons, but to date, student understanding of mathematics learning is still relatively low.

In the mathematics learning process, students are accustomed to memorizing formulas and focusing on the procedures taught without attempting to understand the concepts involved in solving math problems (Kit et al. 2023). These errors are commonly when teachers assign assignments and during exams. One way to identify student errors is by analyzing test results, both daily tests and final semester exams. Several studies related to error analysis include those conducted by Oktaviana (2018) revealed the errors found in solving problems included conceptual errors, procedural errors, and technical errors. Furthermore, research conducted by Amelia, Syamsuri, & Novaliyosi (2020) It is said that the errors made by students in solving problems are conceptual errors, procedural errors, and technical errors.

Based on observations and interviews with mathematics teachers at the research location, information was obtained that most students consider mathematics to be a difficult subject to learn. This can be seen from the final semester exam scores of eighth grade students in Mathematics, where 64% of students scored below the Minimum Mastery Criteria determined by the school, which was 68 (scale 0 to 100). Furthermore, student learning achievements were identified and the average student was still unable to understand the concept of algebra in the linear equation material. This low learning achievement in mathematics for students is influenced by the lack of conceptual understanding by students, resulting in errors in solving problems.

According to Kastolan in Esteban et al., (2019) research, errors made by students in solving problems can be caused by several things, including not understanding the learning material, being unable to determine the formula to solve the problem, being unable to solve the problem, and errors in arithmetic operations. Conceptual errors are errors made by students due to misinterpreting concepts, operations, or errors in their application (Mahmudah, 2018). These errors can occur due to a lack of competence in mastering the material, unintentionally, or not answering the question. Munfarikhatin, Natsir, & Palobo (2021) stated that errors in understanding mathematical concepts can be caused by inadequate conceptual knowledge. Furthermore, Susilawati, Farida, & Pranyata, (2020) emphasized that in the process of learning mathematics, errors in understanding a previous concept will affect conceptual understanding in subsequent learning, this is because mathematics is a structured subject.

Conceptual, procedural, and technical errors in a variety of mathematical disciplines have been widely discovered in earlier research on students' mathematical blunders. However, However, previous studies applying Kastolan's framework, such as Oktaviana (2018) and Amelia, Syamsuri, & Novaliyosi (2020), have primarily examined error types in general problem-solving or literacy contexts, without focusing specifically on straight-line equation tasks or systematically comparing error characteristics across students' achievement levels. This gap indicates the need for a more focused analysis of how conceptual, procedural, and technical errors manifest specifically within straight-line equation problems

To further understand the exact causes of student errors, a more detailed analysis of each error is necessary. This will allow us to identify the types of errors frequently made by students. Given the low student achievement in mathematics, particularly linear equations, it is necessary to analyze the errors frequently made by students in solving mathematical problems, particularly linear equations, based on the Kastolan stages.

Based on the background above, this study addresses the following research questions:

1) What types of errors do students make in solving straight-line equation problems based on Kastolan's framework?
2) What factors contribute to these errors across different levels of mathematical achievement?

Methods

Types of research

This type of research is descriptive research using a qualitative approach. Descriptive research is research that depicts or describes actual symptoms or conditions from the research results obtained, which are then further described or elaborated upon for analysis. Meanwhile, according to Creswell & Clark (2011), qualitative research is research conducted to understand phenomena experienced by subjects, such as behavior, perception, motivation, and other actions, by describing them in naturally arranged words. This aims to find out the types of errors made by students and the causes of students making errors in solving Straight Line Equation problems.

Subject, Population and Sample

Subject selection based on Purposive sampling technique. Wihtin this research, purposive sampling is a sampling technique with the consideration that the research subjects have studied the concept of linear equations. The population consists of 4 classes, namely classes IX A to IX D. Class IX D was chosen as the research subject. The class was selected based on preliminary achievement data provided by the mathematics teacher, indicating that this class had the lowest average performance compared to other classes. This criterion was considered appropriate because students with lower performance tend to demonstrate richer error patterns for analysis. Class IX D consisted of 25 students. However, only 21 students participated in the written test due to attendance during data collection. From the 21 students, 1 student was selected in each category based on the assessment score on the test that will be given. Students in the high category are students who get a score range $\geq$ 75, medium category with a value range of 68 - 74, and low category with a value range < 68. Then the three students were interviewed.

Instrument

The primary instrument in this qualitative research was the researcher, while supporting instruments included a test sheet and interview guide. The test instrument was designed to identify student errors through five descriptive questions on linear equations. These questions were developed by the researcher, approved by the validator, and administered to subjects who had studied the material.

The descriptive questions were chosen to measure students' ability to describe answers using sentences or symbols. Prior to use, the test was validated by an expert. Meanwhile, the interview guide was used to guide the interview process with the aim of obtaining information related to student errors in solving the questions.

The linear equation test questions and interview guide were validated before being used in the study. Question validation was conducted by two Mathematics Education lecturers to ensure the instrument was truly capable of measuring student errors in solving linear equation problems. The validation focused on three aspects: content relevance, clarity of language, and suitability of the items with the indicators of straight-line equation concepts. Based on expert judgment, the instruments were declared valid with minor revisions in wording and task presentation. Similarly, the interview guide was validated by the same two instructors to ensure it could effectively uncover the causes of student errors. This validation aimed to ensure the instrument's reliability and suitability for the research objectives.

Data Collection Techniques or Procedures

This research will go through several stages. The first stage is data collection, which includes administering essay tests to research subjects, correcting and scoring answers, selecting subjects based on score categories (high, medium, low), and conducting interviews and documentation. The second stage is data analysis, which includes data management and analysis, formulating student errors in solving linear equation problems, and compiling a research report.

Data Analysis Techniques

Data analysis in this study followed three stages. First, data reduction was conducted by selecting students’ written responses relevant to the research objectives. Second, data coding and categorization were performed based on Kastolan’s framework, namely conceptual errors, procedural errors, and technical errors. Third, data interpretation was conducted by analyzing the causes of errors through interview transcripts and comparing them with students’ written work. Finally, triangulation between test and interview data was used to strengthen the validity of findings.

Trustworthiness

To ensure the trustworthiness of the data, this study applied triangulation by comparing students’ written responses with interview data. Member checking was also conducted by confirming students’ explanations during the interview process to ensure the accuracy of interpretation. In addition, peer debriefing with fellow researchers was carried out to reduce subjectivity in categorizing students’ errors based on Kastolan’s framework.

Result and Discussion

Result

From the results of the essay test on 21 students, three subjects were selected based on high, medium, and low score categories to identify errors in solving linear equation problems. The high-scoring subject (score 80) was chosen by student PT, who made two different types of errors, while subjects AK and AN only made one type of error. The medium-scoring subject (score 70) was chosen by student EY, who made three types of errors, compared to MR who only made one. For low scores (scores below 68), subject MG was chosen because he made three different types of errors, while the other students only made one or two. Subjects were selected based on the number of types of errors made and were ensured to have good communication skills were defined as as those who could clearly articulate their mathematical thinking, and explain step by step the way they wrote their answer sheets, and respond the followed up questions suring classroom interactions To determine the types and causes of errors made by subjects in completing the test questions, interviews were conducted. Prior to the interview process, the interview data were coded for transcription. This coding facilitated analysis of the interview results. The transcript codes used are presented in Table 4.1.

Table 4. 1 Interview Transcript Code

Code	Information
SNT	High Score
SNS	Medium Score
SNR	Low Score
P	Question
J	Answer
00, 01, . . . , 0*i*, …*i* = 1, 2, 3, etc.	Interview conversation code

If the interview was conducted on a subject with a high score, the code in the research interview transcript was written as SNT-P01.This means the first question was asked by a subject with a high score. For answers given by subjects with high scores, the code used is SNT-J01, meaning the first answer was given by a subject with a high score. For subjects with medium scores, the code in the research interview transcript is SNS-P01.This means the first question was given to subjects with a medium score. For answers given by subjects with a medium score, the code used is SNS-J01, meaning the first answer was given to subjects with a medium score. For subjects with a low score, the code in the research interview transcript is SNR-P01.This refers to the first question for subjects with low scores. For answers given by subjects with low scores, the code used is SNR-J01, which refers to the first answer for subjects with low scores. The subsequent number sequences are adjusted according to the interview questions and answers. The coding of the types of errors made by subjects can be seen in Table 4.2 below.

Table 4.2 Error Type Code

Code	Information
KK	Conceptual Error
KP	Procedural Error
KT	Technical Error

Table 4.3 summarizes the distribution of students' errors based on achievement levels

Subject	Score Category	Conceptual Error	Procedural Error	Technical Error
SNT	High	–	✓	✓
SNS	Medium	✓	✓	✓
SNR	Low	✓✓✓	✓	✓

Table 4.3 summarizes the distribution of students' errors based on achievement levels. It shows that students with low achievement demonstrated more conceptual errors, while students with high achievement tended to make technical and procedural errors.

Research Results of Subjects with High Scores (SNT)

These findings indicate that high-achieving students generally possess sufficient conceptual understanding, but their errors are more associated with cognitive carelessness and procedural inconsistency. Subjects with high scores (SNT) made two types of errors, namely procedural errors (KP) and technical errors (KT). KP committed by SNT subjects can be seen in question number 4 and KT committed by SNT subjects can be seen in question number 1. The errors made by SNT subjects can be seen in the following image.

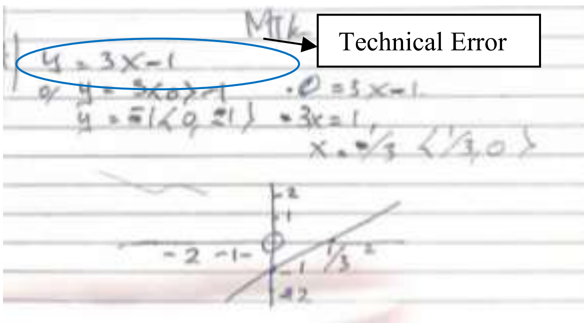

Figure 1. KT by subject SNT on question number 1.

Based on Figure1, it can be observed that SNT made a mistake in writing the operation sign in question number 1. It is known that the subject wrote the question about the equation of a line.$y = 3x - 1$, the equation of the line known in the given problem should be $y = 3x - 1$The subject wrote the operation sign incorrectly in the question, resulting in an incorrect answer. Interview results revealed that SNT made a mistake in writing the operation sign in the question he was working on. This was due to SNT's inattention when writing the question, resulting in an incorrect answer.

The answers and interviews showed that the SNT subject committed a technical error (KT) on question number 1, indicated by a writing error (operation sign). This was due to the SNT subject's lack of thoroughness in writing the question to be worked on, resulting in inaccurate results. Furthermore, the SNT subject committed a technical error (KP) on question number 4.

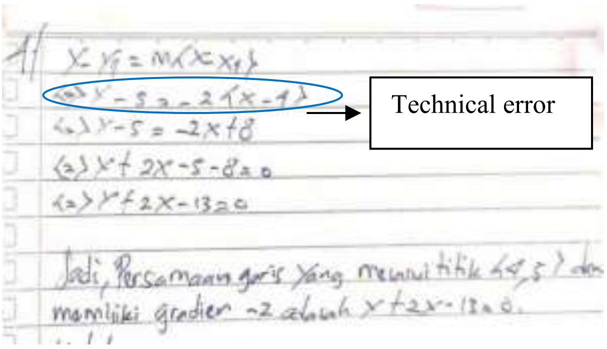

Figure 2. KP by subject SNT on question number 4.

It can be seen that the procedural error made by SNT in question number 4 was that the subject incorrectly substituted the known points in the formula used. The points written by the subject were $y_1 = 5$, should be the point $y_1 = -3$Then the gradient written by SNT is $m = -2$, the known gradient is $m = 5$, and point x written by the SNT subject is $x_1 = -4$, should be $x_1 = -2$. This causes the results obtained by SNT subjects in solving the problem to be inaccurate.

The interview results with SNT showed that the subject made an error in substituting the points in the question into the formula to be used. This was due to the subject's inattention when working on question number 4, resulting in inaccurate results. The test and interview results indicated that the SNT subject committed a procedural error (KP) on question number 4, indicated by the inconsistency of the steps in solving the problem as instructed.

Subjects with Medium Scores (SNS)

This suggests that students at the medium level are in a transitional stage of conceptual mastery, where incomplete understanding leads to mixed forms of errors. Subjects with moderate scores (SNS) made 3 types of errors, namely conceptual errors (KK), procedural errors (KP), and technical errors (KT). KT committed by SNS subjects can be seen in question number 1, then KP committed by SNS subjects can be seen in question number 2, and KK committed by SNS subjects can be seen in question number 4. The errors made by SNS subjects can be seen in the following image.

Based on Figure 3, it can be seen that the SNS subject made a mistake in writing the operation sign in question number 1 that he was going to work on, the subject wrote the question of the equation of a line $y = 3x - 1$, the equation of the line known in the given problem should be $y = 3x - 1$. Subject error in writing The operation sign caused the SNS subject to obtain incorrect results on question number 1.

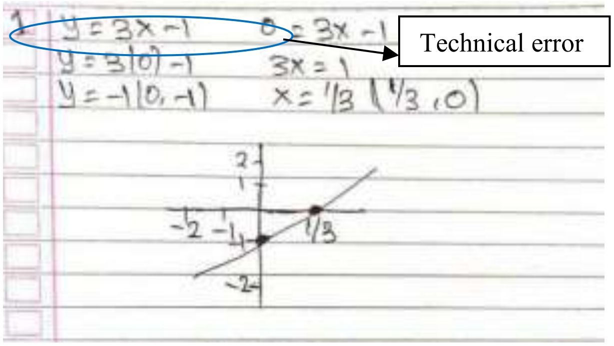

Figure 3. KT by SNS on question number 1

The interview results showed that the subject SNS was less careful when working on question number 1, so the subject wrote the wrong operation sign on the question to be worked on. Therefore, the result obtained by SNS on question number 1 was inaccurate. Based on the results of the answers and interviews, it shows that SNS made a technical error (KT) on question number 1 with the indicator being an error in writing the operation sign. This was caused by SNS's lack of care in writing the question to be worked on, so the result obtained by the subject was inaccurate. Next is the KP carried out by the subject SNS on question number 2.

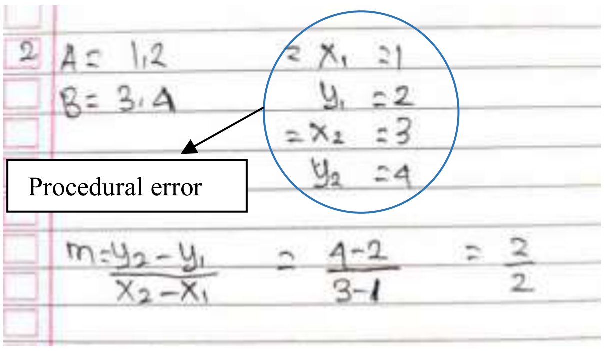

Figure 4. KP by SNS subject on question number 2

Figure 4 shows that the procedural error made by the SNS subject in question number 2 was that the SNS subject was not precise in substituting the known points into the formula to be used. It can be seen that the SNS subject was not precise in substituting the points x_2 and also the point y_2 which causes the gradient obtained by SNS to be inaccurate. Based on the results of interviews with SNS, it can be seen that the SNS subject incorrectly substituted the points in the gradient formula. The SNS subject substituted the points in question number 3 when working on question number 2. Based on the results of the answers and interviews, it shows that SNS committed a procedural error (KP) on question number 2 with indicators that the steps in solving the instructed question are not appropriate. Moreover, SNS did not pay attention to the questions to be worked on properly, causing the SNS subject to make a mistake in substituting the points in the question. Next is the KK carried out by the SNS subject on question number 4.

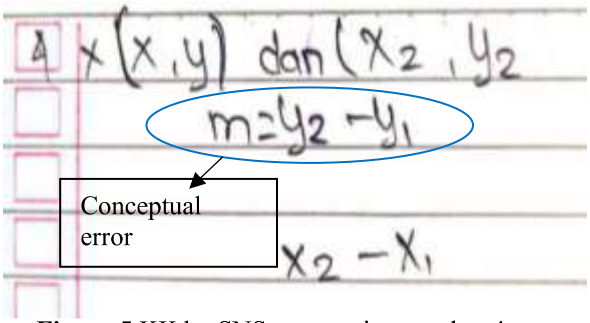

Figure 5.KK by SNS on question number 4.

From figure 5, it can be seen that SNS cannot determine the formula to be used so that SNS cannot solve question number 4. The results of the interview showed that SNS did not know the formula for the equation of a straight line that passes through one point and has one gradient in question number 4. This caused the subject to be unable to solve question number 4. Based on the results of the test and interview answers, it shows that SNS made a conceptual error (KK) with the indicator that the subject could not determine the formula to be used in solving the question. This is caused by the lack of understanding of the SNS subject so that he could not determine the formula to be used correctly. Next are the errors made by subjects with low scores (SNR).

Subjects with Low Score Value (SNR)

Conceptual errors dominated low-achieving students because weak prior knowledge hindered their ability to select and apply appropriate formulas. This confirms that conceptual understanding serves as the foundation for procedural and technical accuracy.

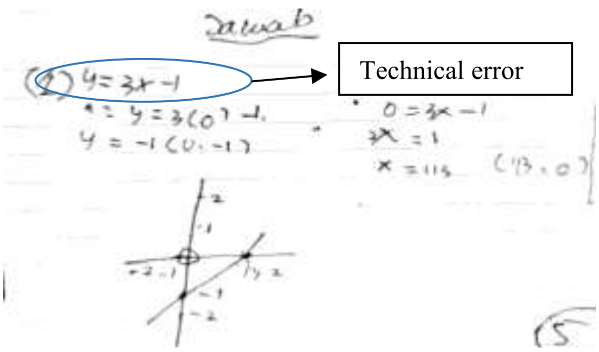

Figure 1. KT by SNR subject on task number 1.

Subjects with low score (SNR) made 3 types of errors, namely conceptual errors (KK), procedural errors (KP) and technical errors (KT). KT committed by SNR subjects can be seen in question number 1, then KP committed by SNR subjects can be seen in question number 2, and KK committed by SNR subjects can be seen in questions number 3, 4, and number 5. The errors committed by SNR subjects can be seen in the following image.

Based on Figure 6, it shows subject SNR made a mistake in writing the sign for question number 1. SNR wrote the equation of the line $y - 3x - 1$, while the equation of the line known in question number 1 is $y = 3x - 1$. The subject's error in writing the operation sign caused SNR to obtain an inaccurate result on question number 1. It can be seen that SNR's error in writing the operation sign in the question caused the subject to obtain an inaccurate intersection point and graph. Based on the review of the interview results, SNR made an error in writing the operation sign because the subject was not careful in reading the question so that the results obtained were inaccurate.

Analysis of the answers and interviews showed that SNR made a technical error (KT), namely a mistake in writing (operation signs) caused by SNR's carelessness in writing the question, resulting in an inaccurate answer. Next is the KP committed by SNR on question number 2.

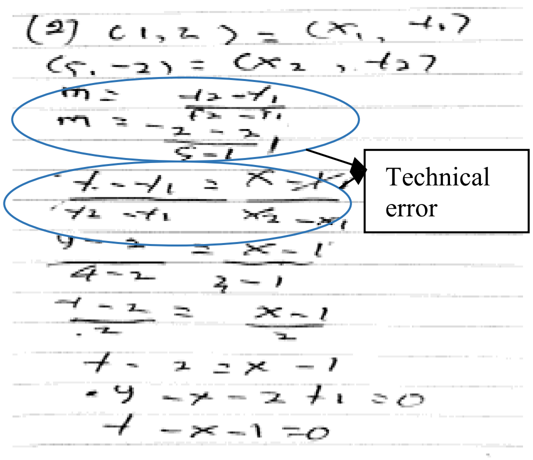

Figure 7. KP by subject SNR on question number 2.

From figure 7 which shows question number 2, it shows that the SNR subject wrote 2 formulas, namely $m = \frac{y_2 - y_1}{x_2 - x_1}$ and also the formula $\frac{y - y_1}{y_2 - y_1} = \frac{x - y_1}{x_2 - y_1}$. The SNR subject did not write down the results of the first formula used, then used another formula so that the results obtained by the SNR subject were inaccurate. Based on the interview results, it was known that the SNR subject was confused about the gradient formula that should be used in solving problem number 2. Therefore, the results obtained by the subject on problem number 2 were inaccurate.

The results of the answers and interviews indicate that the SNR subject made a procedural error (KP) on question number 2, with the indicator being that the subject was unable to solve the problem to its simplest form. This is indicated by the subject not completing the calculation with the first formula, but the subject wrote another formula so that the results obtained were inaccurate. This is caused by the subject's lack of understanding in determining the gradient of the line. Next is the KK carried out by SNR on questions number 3, 4, and 5.

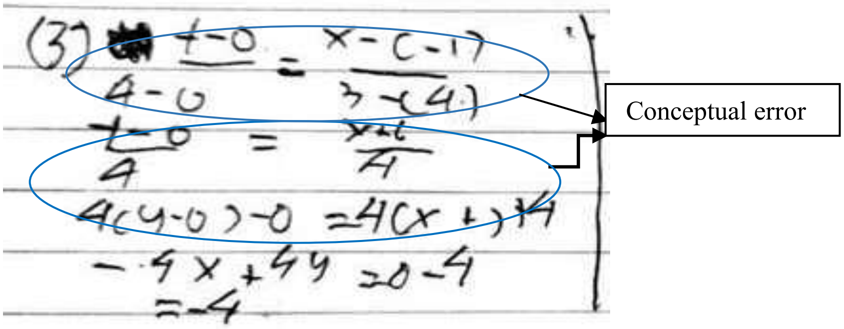

Figure 8. KK by subject SNR on question number 3.

It can be seen in Figure 8, that SNR did not write the formula used in solving problem number 3, but SNR directly substituted the known points into a formula that should not be applied. The formula that should be used in solving problem number 3 in finding the equation of a line that passes through two points is $\frac{y-y_1}{y_2-y_1} = \frac{x-y_1}{x_2-y_1}$. Based on the interview results, it was said that the SNR subject was confused about the correct formula that should be used to solve question number 3. The SNR subject substituted the dots in the question unclearly in the results of his work. Based on the analysis of the results of the answers and interviews, it showed that the SNR subject made a conceptual error (KK) in question number 3 with an indicator of not being able to determine the formula to be used in solving the question correctly. This was caused by a lack of understanding of the SNR so that it could not determine the right formula to solve it.

Figure 8. shows that SNR used an incorrect formula. It can be seen from the answer to number 4 that the SNR subject did not write the formula that should be used to determine the equation of the line, namely $y - y_1 = m(x - x_1)$, so the results of the SNR subject's work were inaccurate. Based on the interview results, it was discovered that the SNR subject was still confused about the formula that should be used to determine the equation of a line. It can be seen that the SNR subject wrote an incorrect formula when solving problem number 4.

Based on the results of the answers and interviews, it shows that the SNR subject does not know what formula to use to solve the problem so that the SNR subject makes a mistake in solving problem number 4. The SNR subject makes a conceptual error (KK) with the indicator that the subject cannot determine the formula to be used in solving the problem, this is caused by the subject's lack of understanding so that he cannot determine the formula to be used correctly in solving the problem of the equation of a straight line that passes through one point.

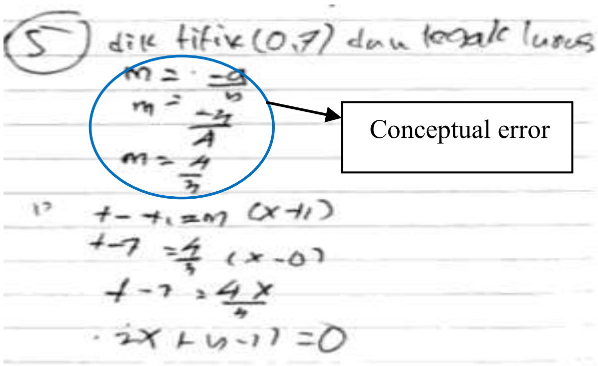

Figure 9.KK by subject SNR on question number 5.

Figure 9 shows that the SNR subject cannot determine the gradient of the equation that was known beforehand in question number 5. The gradient of the subject's work result is $\frac{4}{3}$, while the correct gradient is $m_1 = \frac{1}{2}$, thus causing the SNR subject to obtain an inaccurate final result. Based on the interview results, it is known that the SNR subject does not know how to apply the gradient formula correctly. The subject still does not understand the line gradient material, as evidenced by the same statement found in question number 2. From the analysis of the answers and interview results, it shows that the SNR subject made a conceptual error (KK) in question number 5 with the indicator that the subject cannot apply the formula correctly in solving the problem. It appears that the SNR subject does not understand which values of a and b will be substituted in the gradient formula of the equation of a straight line from a known point and perpendicular to another line.

Discussion

The results of this study indicate that student errors in solving linear equation problems can be categorized into three main types: conceptual, procedural, and technical errors (Gais & Afriansyah, 2017). Beyond simply confirming this taxonomy, the pattern found here is that error type is not randomly distributed across ability levels but shifts systematically as achievement increases — from predominantly conceptual (low-scoring students) toward predominantly technical (high-scoring students). This gradient suggests that the three error types are not independent categories but stages along a single developmental trajectory: as conceptual understanding solidifies, the locus of failure moves downstream to execution.

High-scoring students were more likely to make technical and procedural errors rather than conceptual ones (Fazzilah, Effendi, & Marlina, 2020). A plausible explanation is that once conceptual knowledge becomes sufficiently automatized, students pay less attention in monitoring each solution step and result, which can cause an error, misreading an operation sign, or skipping a substitution check, even though the underlying schema is intact. This interpretation is consistent with Amalia (2017), who linked procedural error to unsystematic working steps rather than to a lack of conceptual knowledge.

This finding also in line with Fazzilah et al. (2020): if both technical or procedural errors exsist among conceptually competent students, then instructional interventions for high-achievers should prioritize self-monitoring and verification habits rather than repeat the teaching concepts.

Average-scoring students exhibited all three error types, with conceptual errors emerging alongside technical and procedural ones. This co-occurrence is notable, thus, it suggests these students occupy a transitional zone where conceptual understanding is only partially consolidated, so that gaps in the underlying schema (e.g., confusion between the point-slope and two-point formulas) surface *together* with downstream execution errors rather than being masked by them, as appears to happen for high-scoring students. This is broadly consistent with Amelia et al. (2020), who attributed similar formula-selection difficulties to gaps in understanding the underlying theory, though their study did not examine how conceptual gaps co-occur with procedural and technical errors within the same ability band, as a co-occurrence pattern this study makes visible. We conclude the practical implication is that remediation for this group cannot follow a single-error-type of protocol; conceptual reinforcement and procedural drilling likely need to happen concurrently rather than sequentially.

In low-scoring students, all three error types were prevalent, with conceptual errors — particularly the inability to select an appropriate formula, appearing most frequently and, based on the interview data, appearing to co-occur with, and often precede, procedural and technical errors in the same students' work. This pattern lends empirical support to Susilawati et al. (2020), who revealed that unresolved errors in one mathematical concept propagate into subsequent learning because mathematics is a cumulative and structured subject. It also extends Mahmudah (Mahmudah, 2018) and (Munfarikhatin, 2019) accounts of conceptual error as arising from inadequate conceptual knowledge: the present data suggest this inadequacy is not merely a static knowledge gap but may be linked to downstream procedural disorganization, thus, students who cannot identify the correct formula have no stable framework against which to check their subsequent steps, so procedural and technical slips go undetected rather than corrected mid-process.

Togetherly, these findings suggest that the three error types described by Kastolan's framework may not be entirely independent: conceptual errors appeared to be associated with, and in several cases seemed to precede, procedural and technical errors within the same student's work. However, as this study relies on descriptive qualitative data from a small number of subjects, this pattern should be read as an observed association rather than an established causal sequence. This has a theoretical implication beyond the pedagogical recommendations typically drawn from error-analysis studies: it suggests teacher should employ diagnostic assessment by prioritizing conceptual gaps first, since remediating procedural or technical errors in isolation is unlikely to be effective if the underlying conceptual foundation remains unstable. Practically, this supports a staged instructional approach — diagnostic screening for conceptual understanding, by following procedural practice, and only then targeted accuracy training — rather than treating the three error types as parallel targets for intervention.

Conclusion

This study revealed that students frequently make errors in solving linear equation problems, which can be classified into conceptual errors, procedural errors, and technical errors based on the Kastolan stages. Conceptual errors occur because students do not understand or cannot determine the correct formula, and do not know how to apply it. Procedural errors involve unsystematic work steps, such as incorrect value substitution or the use of incorrect formulas. Technical errors are more related to student inaccuracy, such as writing incorrect operation signs. These findings indicate that these three types of errors are found in students of various ability levels, including high, medium, and low, with variations in the type and frequency of errors. Among the three error types, conceptual errors were found to be the most critical because they often triggered subsequent procedural and technical errors. Therefore, strengthening conceptual understanding should become the primary focus in mathematics instruction.

Recommendation

Further researchers are advised to develop innovative learning approaches that focus on strengthening students' conceptual understanding and accuracy, such as the use of interactive visual or digital media, as well as conducting similar research on other mathematical materials to broaden insights into students' error patterns and improvement strategies.

References

Agusta, E. S. (2023). Peningkatan Kemampuan Pemahaman Konsep Bangun Ruang Sisi Datar Melalui PMRI dengan Aplikasi Learning Management System (Lms). *Jurnal Lingkar Mutu Pendidikan*, *20*(1), 43–52. https://doi.org/10.54124/jlmp.v20i1.106

Amalia, S. R. (2017). Analisis Kesalahan Berdasarkan Prosedur Newman Dalam Menyelesaikan Soal Cerita Ditinjau Dari Gaya Kognitif Mahasiswa. *Aksioma*, *8*(1), 17. https://doi.org/10.26877/aks.v8i1.1505

Amelia, I., Syamsuri, S., & Novaliyosi, N. (2020). Identifikasi Proses Penyelesaian Soal Literasi Matematika Siswa Kelas IX Pada Konten Peluang dan Data. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *4*(1), 331–345. https://doi.org/10.31004/cendekia.v4i2.212

Creswell, J. W., & Clark, V. L. P. (2011). Choosing a mixed methods design. In *Designing and Conducting Mixed Methods Research* (pp. 53–106). California: Sage Publications, Inc.

Esteban, C., Franco, J., Fasulo, A., Garcia-Rodriguez, L., G6mez-Camacho, C., Renovables, E., … Никитин, Ю. П. (2019). Analisis Kesalahan Siswa SMK Dalam. *IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP) 2017*, *41*(2), 84–93. Retrieved from www.elsevier.com/locate/desal

Fazzilah, E., Effendi, K. N. S., & Marlina, R. (2020). Analisis Kesalahan Siswa Dalam Menyelesaikan Soal Pisa Konten Uncertainty dan Data. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *4*(2), 1034–1043. https://doi.org/10.31004/cendekia.v4i2.306

Forrester, J. V., & Covington Clarkson, L. M. (2023). Cultivating Mathematical Proficiencies and Identities Through Culturally and Community Inspired Activities. *Prometeica*, (27), 761–771.

https://doi.org/10.34024/prometeica.2023.27.15375

Gais, Z., & Afriansyah, E. A. (2017). Analisis K Esulitan S Iswa Dalam P Roses P Emecahan M Asalah. *Jurnal "Mosharafa," 6*(2), 287–298.

Kit, Y., Yeong, O., Yeter, I. H., & Ali, F. (2023). Learning data science in elementary school mathematics : a comparative curriculum analysis. *International Journal of STEM Education*. https://doi.org/10.1186/s40594-023-00397-9

Liu, H., Miao, Z.-Q., & Zheng, G.-H. (2024). A Mathematical Theory of Microscale Hydrodynamic Cloaking and Shielding by Electro-Osmosis. *SIAM Journal on Applied Mathematics*, *84*(1), 262–284. https://doi.org/10.1137/23M1554837

Mahmudah, W. (2018). *Analysis of Student Errors in Solving Hots Type Math Problems Based on Newman's Theory*. *4*, 49–56.

Munfarikhatin, A. (2019). *Musamus Jurnal of Mathematics Education*. *2*.

Munfarikhatin, A., Natsir, I., & Palobo, M. (2021). *Student ' s Obstacle in Solving PISA Like Task : An Error Analysis*. *603*(Icss), 431–437.

Oktaviana, D. (2018). Analisis Tipe Kesalahan Berdasarkan Teori Newman Dalam Menyelesaikan Soal Cerita Pada Mata Kuliah Matematika Diskrit. *Edu Sains: Jurnal Pendidikan Sains & Matematika*, *5*(2), 22. https://doi.org/10.23971/eds.v5i2.719

Susilawati, L., Farida, N., & Pranyata, Y. I. P. (2020). Analisis Kesalahan Peserta Didik Dalam Menyelesaikan Soal Aljabar Model Pisa Pada Konten Change and Relationship Berdasarkan Nea (Newman'S Error Analysis). *Jurnal SILOGISME : Kajian Ilmu Matematika Dan Pembelajarannya*, *5*(1), 8. https://doi.org/10.24269/silogisme.v5i1.2577