Analysis of Students' Errors Based on Kastolan Stages on Sensing and Intuiting Personality

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Abstract

Students' errors in solving math problems, especially on the System of Linear Equations of Two Variables (SPLDV) topic, are an important concern in the learning process. A deep understanding of the types of errors students make, especially in relation to their personality types, can help develop more effective learning strategies. This study aims to analyze students' errors based on Kast Olan stages and Sensing and Intuiting personality types. Using a qualitative case study approach, the research involved 30 high school students who were selected based on the MBTI personality test. The results showed that students with Sensing type had an average error of 83%, with the largest error in the technical aspect (100%), while students with Intuiting type had 100% errors in all categories. Sensing students had difficulty in calculation accuracy while Intuiting students had difficulty understanding concepts and following procedures systematically. These findings suggest that learning strategies need to be tailored to student's personality types, where Sensing students need more practice in technical skills while Intuiting students need a more systematic approach to problem-solving.

Keywords: *Student Errors; SPLDV; Kastolan Theory; Sensing Personality; Intuiting Personality.*

Abstrak

Kesalahan siswa dalam menyelesaikan soal matematika, khususnya pada topik Sistem Persamaan Linear Dua Variabel (SPLDV), menjadi perhatian penting dalam proses pembelajaran. Pemahaman yang mendalam tentang jenis kesalahan yang dilakukan siswa, terutama terkait dengan tipe kepribadian mereka, dapat membantu dalam pengembangan strategi pembelajaran yang lebih efektif. Penelitian ini bertujuan untuk menganalisis kesalahan siswa berdasarkan tahapan Kastolan dan tipe kepribadian Sensing serta Intuiting. Dengan pendekatan studi kasus kualitatif, penelitian melibatkan 30 siswa SMA yang dipilih berdasarkan tes kepribadian MBTI. Hasil penelitian menunjukkan bahwa siswa dengan tipe Sensing memiliki rata-rata kesalahan 83%, dengan kesalahan terbesar pada aspek teknis (100%), sementara siswa dengan tipe Intuiting mengalami kesalahan 100% di semua kategori. Siswa Sensing kesulitan dalam ketelitian perhitungan, sedangkan siswa Intuiting kesulitan dalam memahami konsep dan mengikuti prosedur secara sistematis. Temuan ini menunjukkan bahwa strategi pembelajaran perlu disesuaikan dengan tipe kepribadian siswa, di mana siswa Sensing membutuhkan latihan lebih dalam keterampilan teknis, sementara siswa Intuiting membutuhkan pendekatan yang lebih sistematis dalam pemecahan masalah.

Kata Kunci: Kesalahan Siswa; SPLDV; Teori Kastolan; Kepribadian Sensing; Kepribadian Intuiting.

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INTRODUCTION

Education is a process that aims to develop an individual's ability to think logically and solve various problems in the hope of creating a better future (Dewi et al., 2024). Every individual has the right to obtain education, both in the school environment and outside of school, because education is the foundation for improving the quality of human life. One of the subjects that has an important role in education is mathematics (Vrasetya et al., 2024).

Mathematics is an essential branch of science because it is closely related to everyday life, especially in activities that involve counting (Zalukhu et al., 2023). Therefore, mathematics is taught at various levels of education, from elementary school to college, to train students to think critically, logically, systematically, and creatively (Mahmudah, 2018). The importance of mathematics makes mastering every material taught, including the Two-Variable Linear Equation System (SPLDV), indispensable for students (Siswondo & Agustina, 2021).

SPLDV is one of the topics in the SMP/MTs curriculum which aims to train students to understand concepts and solve problems effectively (Hulu & Siswanti, 2024). Understanding SPLDV is important because this material is the basis for further learning, such as the System of Linear Equations Three Variables (SPLTV) and linear programs, which are often realized in the form of story problems (Shofiawanti, 2022). Mathematical story problems are designed in the form of narratives that relate mathematics to real life, so that they can evaluate students' ability to understand the context of the problem, identify relevant concepts, convert information into mathematical form, and conclude solutions based on data analysis (Nasution et al., 2021). However, many students have difficulty solving story problems due to a lack of concept understanding and analytical skills. This shows the need for a special approach in learning mathematics that emphasizes in-depth understanding and analysis of student errors.

Error is a natural thing that occurs when students are unable to provide the correct answer as expected (Ratri & Azhar, 2022). Error can be defined as the

difference between the actual answer and the correct answer (Fazzilah et al., 2020). Error analysis is important because through this process, the types of errors and their causal factors can be identified, allowing teachers to develop appropriate strategies to correct them (Septiahani et al., 2020). In the context of mathematics, error analysis is often done using approaches such as Kastolan's theory that classifies errors into three types: conceptual, procedural, and technical (Mauliandri & Kartini, 2020).

In addition to error analysis, it is also important to pay attention to student characteristics, including personality type, as this factor affects the way students understand and solve mathematical problems (Vrasetya & Gunawan, 2024). Student personality, which can be identified through tests such as the Myers-Briggs Type Indicator (MBTI), is one of the relevant variables in learning. The MBTI test categorizes personalities into four dimensions, including Sensing and Intuiting types (Aprillia, 2021). Students with the Sensing type tend to process information based on concrete facts and factual data, while students with the Intuiting type focus more on patterns, relationships, and possibilities (Vrasetya & Nasution, 2024). Understanding these personality types can help teachers develop appropriate learning strategies, so that students can be more effective in solving math story problems, especially on SPLDV material.

This research is different from previous studies because it combines error analysis based on Kastolan's theory with Sensing and Intuiting personality type variables. Other studies such as those conducted by (Mamonto et al., 2022), only use the Newman theory approach to analyze errors in story problems. Meanwhile, (Ndek & Suwanti, 2022) focused on analyzing one-variable linear equation story problems using Kastolan's theory. Research (Ulfa & Kartini, 2021) analyzed story problems on logarithm material without involving personality variables, while (Sholehah, 2023) analyzed student errors based on extroverted and introverted personalities. This research stands out because it focuses on SPLDV material while exploring the influence of Sensing and Intuiting personality types on student errors.

This study aims to analyze student errors based on Kastolan's theory, focusing on Sensing and Intuiting personality types. By understanding the types of errors that often occur in these two personality types, it is hoped that this research can contribute to designing more effective and relevant learning strategies to minimize student errors on SPLDV material.

RESEARCH METHODS

This research used a qualitative approach with a case study method. The research subjects consisted of 30 students of class XA in one of the high schools in Sungai Penuh City. The selection of subjects was carried out using purposive sampling technique, where 4 students were selected as research subjects, namely 2 students with sensing personality type and 2 students with intuiting personality type. Purposive sampling is a subject selection technique that is not done randomly, but based on specific criteria that are relevant to the research objectives, so that it is expected to provide more precise information about the case being studied.

The main instrument in this research is the researcher himself, assisted by supporting instruments that have been validated by experts. The instruments include a closed questionnaire with a Likert scale of 2 for MBTI type sensing and intuiting, a test to identify errors in solving linear equation system problems of two variables, and interview guidelines. The indicators of student errors in this study refer to Kastolan's theory adapted from (Kusuma et al., 2021), can be seen in Table 1.

The research procedure was carried out with the following steps: (1) giving questionnaires to all students, (2) selecting samples based on the highest score on the questionnaire that identifies the Sensing and Intuiting personality types, (3) giving test questions that focus on errors in solving problems of two-variable linear equation systems, (4) analyzing the test results obtained, (5) conducting interviews to find out the reasons students make mistakes, and (6) analyzing the data collected.

Table 1: Indicators of Student Errors Based on Kastolan's Theory

Kastolan Stages	Error Type	Indicator
Conceptual Error	Conceptual errors occur when students have difficulty choosing the right formula or forget the formula that should be used, and cannot apply the formula correctly.	a. Students still have difficulty in choosing the right formula, theorem, or definition to solve a problem. b. Students use formulas, theorems, or definitions that are not in accordance with the terms or conditions required for their application. c. Students do not include formulas, theorems, or definitions when answering a problem.
Procedural Error	Procedural errors occur when the steps taken in solving the problem are not as requested, so students cannot solve the problem until it reaches its simplest form.	a. The steps taken by students in solving problems are often not as expected. b. Difficulty in managing or organizing the right steps to solve a problem. c. Students are unable to complete the task completely or are only able to complete up to the most basic stage. d. Discrepancies in the use of operation signs (such as addition, subtraction, multiplication, and division)
Technique Error	Students make mistakes in calculating the result of a mathematical operation.	a. Students perform calculations in an inappropriate way. b. Students often do not write or are incorrect in moving the coefficients of variables and constants.

RESULTS AND DISCUSSION

The following presents the research results on errors made by students with sensing and intuiting personality types in solving system of linear equations (SPLDV) problems, covering conceptual, procedural, and technical errors. The table below shows the error percentages for each personality type.

Table 2. Sensing Students Make Errors based on Kastolan's Theory

Personality	Problem No.	Conceptual Error	Procedural Error	Technique Error	Total
Sensing 1	1	0	0	1	1
	2	1	1	1	3
Sensing 2	1	1	1	1	3
	2	1	1	1	3
Total		3	3	4	
Percentage		75%	75%	100%	
Average			83,3%		

Based on Table 2, sensing students tend to make errors in three categories, namely conceptual, procedural, and technical. Technical errors have the highest percentage (100%), indicating that this aspect is most often an obstacle. Conceptual and procedural errors each reached 75%, indicating difficulty in understanding the concepts and steps of the solution. The overall average error of 83.3% reinforces that sensing students need special attention in mastering techniques and understanding concepts to improve accuracy in solving problems.

Table 3. Intuiting Students Make Errors based on Kastolan's Theory

Personality	Problem No.	Conceptual Error	Procedural Error	Technique Error	Total
Intuiting 1	1	1	1	1	3
	2	1	1	1	3
Intuiting 2	1	1	1	1	3
	2	1	1	1	3
Total		4	4	4	
Percentage		100%	100%	100%	
Average			100%		

Based on Table 3, intuiting students experienced errors in three categories, namely conceptual, procedural, and technical. The three types of errors have the same percentage, which is 100%, indicating that students experience equal difficulty in understanding the concepts, procedures, and techniques of problem-solving. The overall error average was also 100%, indicating that every student in this category made errors in all aspects measured. This indicates the need for a more systematic learning approach to reduce errors in understanding and solving problems.

Problem 1

1. Conceptual Error

   a. Sensing Personality Type

   Based on S1's answer, no conceptual errors were found. This can be seen when the subject is asked to explain the concepts used in solving the problem. S1 applied the concept of algebraic operations correctly and used the substitution method to determine the y value. In addition, S1 also showed consistency between the concepts explained and those applied in solving the problem. Thus, in problem number 1, S1 did not make conceptual errors.

   In contrast, S2 showed conceptual errors. The subject did not understand the concept used in solving the problem, although he could mention the information given. S2 only tried to find the result without understanding the basis of the concept which showed difficulty in understanding and applying the concept appropriately.

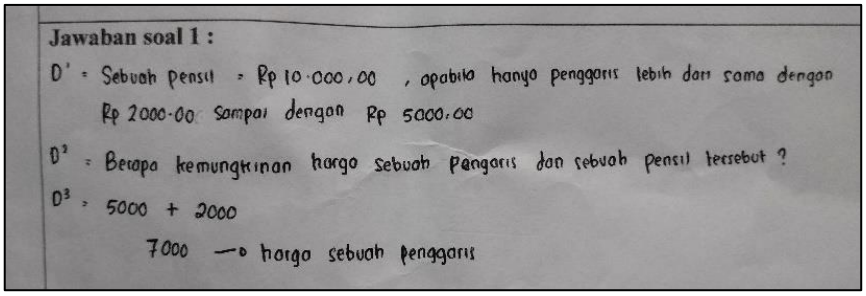
Jawaban soal 1 :
D¹ = Sebuah pensil = Rp 10.000,00 , apabila hanya penggaris lebih dari sama dengan Rp 2000.00 sampai dengan Rp 5000,00
D² = Berapa kemungkinan harga sebuah penggaris dan sebuah pensil tersebut ?
D³ = 5000 + 2000
7000 → harga sebuah penggaris

Image 1. Answer to Question 1 S2

   b. Intuiting Personality Type

   Subject I1's answer showed a conceptual error where the subject forgot and did not know the formula, theorem or definition used. Meanwhile, I2 did not write the System of Linear Equations of Two Variables (SPLDV) model explicitly and did not verify whether the price of the ruler met the requirement of multiples of Rp50 in the range of Rp2,000-Rp5,000. This reflects a lack of understanding of the concepts and limits of the problem.

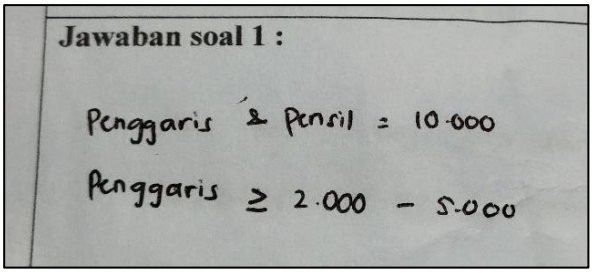

Image 2. Answer to Question 1 I2

2. Procedural Error

a. Sensing Personality Type

Based on the answer sheet of question 1, subject S1 wrote the procedure well and solved the problem correctly. However, the subject still has difficulty in manipulating the steps of solving the problem.

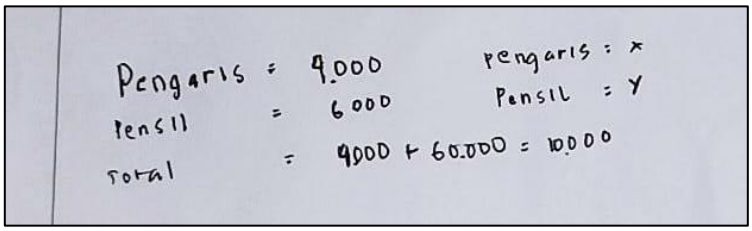

Image 3. Answer to Question 1 S1

Meanwhile, in the answer of subject S2, procedural errors were found due to lack of accuracy in reading the problem. The inappropriateness of the steps used led to errors in problem solving.

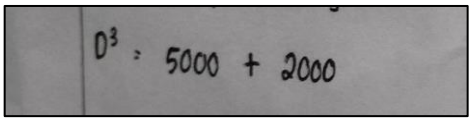

Image 4. Answer to Question 1 S2

b. Intuiting Personality Type

Based on I1's answer, there are several errors, namely the inappropriateness of the steps taken in solving the problem and not being able to work to completion or to a simple stage.

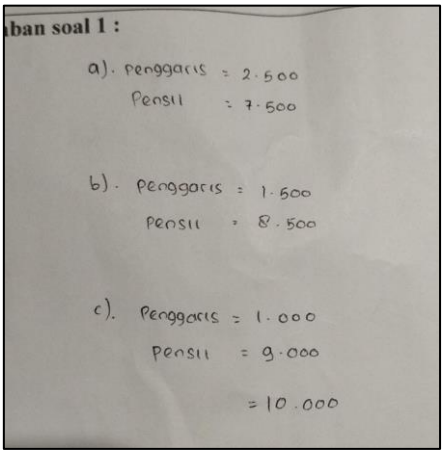

Image 5. Answer to Question 1 S1

If you look at I2's answer sheet which tries the value of the ruler price randomly without a systematic method, there is a risk of missing the correct solution, and does not present the answer in tabular form for verification.

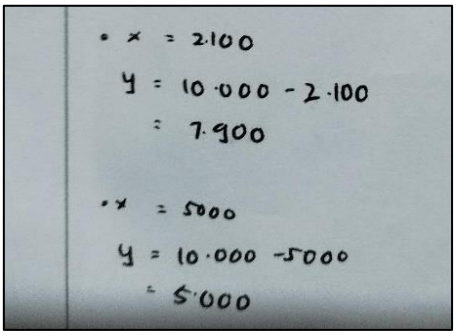

Image 6. Answer to Question 1 S2

3. Technique Errors
   a. Sensing Personality Type

      On S1's answer sheet, technical errors were found in solving problem number 1, namely errors in writing or moving coefficients, variables, and constants. This had an impact on the inaccuracy of the final result.

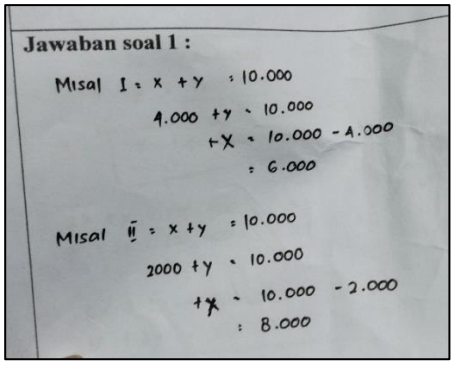

Image 7. Answer to Question 1 S1

Meanwhile, subject S2 also experienced a similar error, namely mistakenly writing or moving the coefficient, which resulted in an inaccurate answer. The subject should have been more careful in understanding and copying the calculation elements to avoid this error.

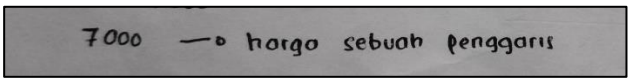

Image 8. Answer to Question 1 S2

b. Intuiting Personality Type

Subject I1's answer answered the question but the student did not perform a calculation process. So the student did not write or move the coefficients, variables, and constants in his answer because the student did not write them down.

Meanwhile, subject I2's answer was not presented systematically, which increased the risk of calculation errors and resulted in the loss of a qualified solution. In addition, the lack of re-verification makes the answer less convincing.

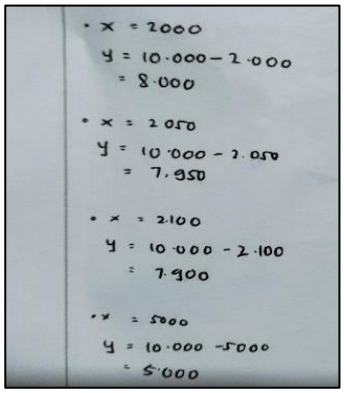

Image 9. Answer to Question I2

Problem 2

1. Conceptual Error

   a. Sensing Personality Type

   In problem number 2, subject S1 made conceptual errors in using formulas, theorems, or definitions that were not in accordance with the prerequisite conditions. This caused errors in the problem solving process.

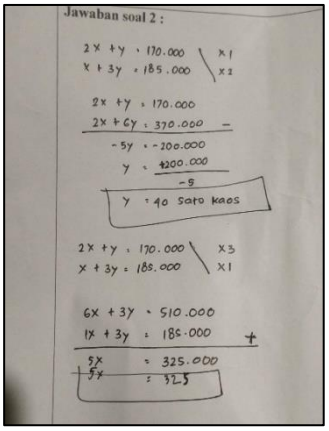

Image 10. Answer to Question 2 S1

Subject S2 also experienced a similar error, namely using formulas, theorems, or definitions without paying attention to the prerequisites that must be met for the concept to apply.

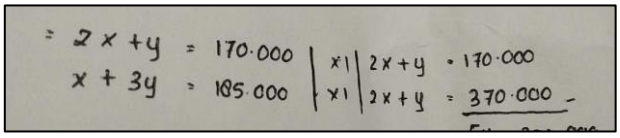

Image 11. Answer to Question 2 S2

   b. Intuiting Personality Type

   Based on the answer of subject I1 (Intuiting 1), there is a conceptual error where students cannot choose the formula correctly and forget the formula to be used. Meanwhile, the answer of subject I2 shows an error in designing a mathematical model that is in accordance with the context of the problem. As a result, the solution approach is not clear. In addition, the understanding of the limits and possible variations of solutions in the inequality system was also not considered.

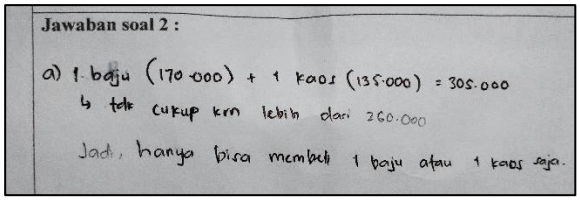

Image 12. Answer to Question 2 I2

2. Procedural Error

a. Sensing Personality Type

Based on S1's answer, no procedural errors were found in understanding the steps of solving the problem. The subject was able to identify the known information, the questions asked, and the steps used in solving the problem. However, due to lack of thoroughness and haste, the subject made a mistake in writing the sign of the operation. It should be an addition operation, but it is written as subtraction. In addition, the subject also did not include the operation sign in the elimination step.

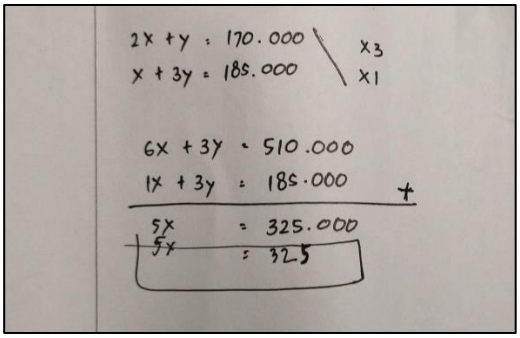

Image 13. Answer to Question 2 S1

Meanwhile, in S2's answer, there were discrepancies in the steps of solving the problem, which indicated an error in following the correct procedure.

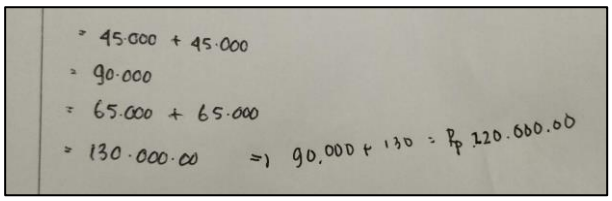

Image 14. Answer to Question 2 S2

b. Intuiting Personality Type

In answer I1, there were several errors, such as discrepancies in the steps of solving the problem and the inability to solve the problem until the final stage or simpler form.

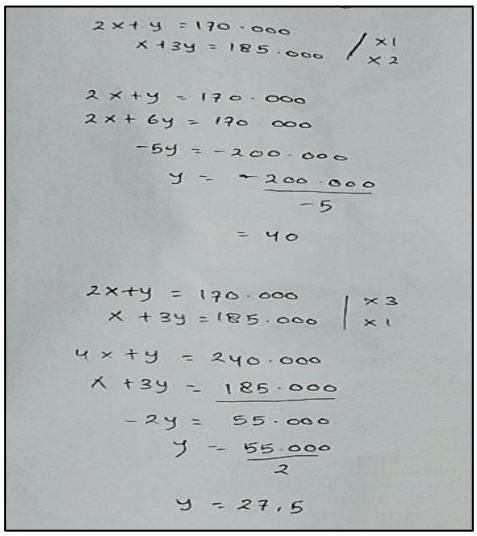

Image 15. Answer to Question 2 I1

Whereas in answer I2, students did not use systematic steps in finding solutions. The solution was done directly without considering other alternatives that might be more appropriate. In addition, students also do not evaluate other possibilities that meet the requirements of the problem.

3. Technique Error

a. Sensing Personality Type

Subject S1 did not make mistakes in calculations, but was less careful when writing the nominal. This error has the potential to change the final result even though the previous step was correct.

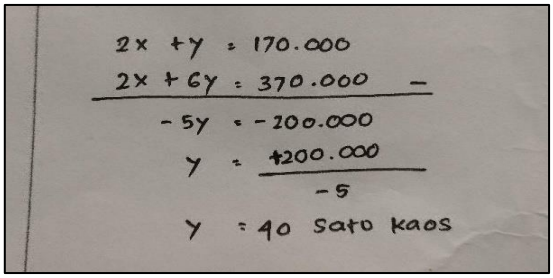

Image 16. Answer to Question 2 S1

Subject S2 made mistakes in moving coefficients, variables, and constants. This error can cause changes in the equation, so that the answer obtained is not appropriate.

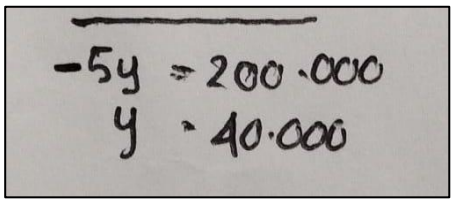

Image 17. Answer to Question 2 S2

b. Intuiting Personality Type

On the answer sheet of subject I1 there is an error where the student is wrong in writing and moving the coefficient on the answer sheet and also the student makes a mistake in calculating the value of an equation.

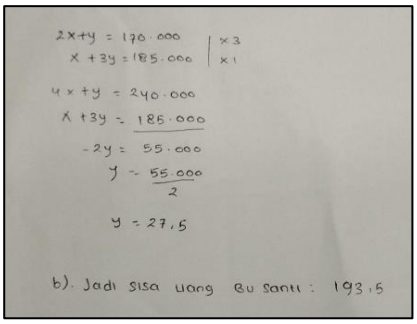

Image 18. Answer to Question 2 I1

Subject I2 did not organize the answer clearly and systematically, so the correct solution could be missed. In addition, the subject did not double-check the results obtained, which increased the possibility of errors in interpretation or final conclusions.

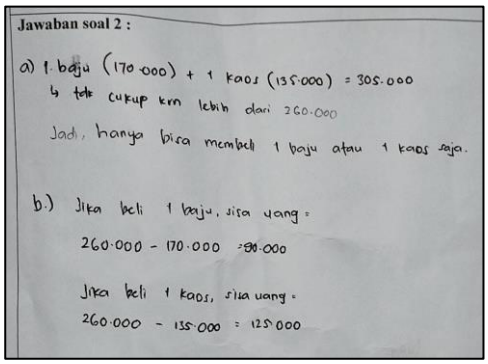

Image 19. Answer to Question 2 I2

Based on the results of research on each research subject with Sensing and Intuiting personality types, various types of errors made in solving the story problems of the System of Linear Equations of Two Variables (SPLDV) can be identified. The errors were analyzed based on Kastolan's stages and categorized into three main types, namely conceptual errors, procedural errors, and technical errors.

1. Conceptual Error

Conceptual errors occur due to students' lack of understanding of the concept of the system of linear equations of two variables. Students need to practice more in solving story problems to get used to doing math problems quickly and accurately. Conceptual errors include inaccuracies in choosing or applying formulas, understanding concepts, and using rules that apply in the material.

According to Kastolan in (Mauliandri & Kartini, 2020), conceptual errors occur when students misinterpret or use taught terms, concepts, or principles. One common form of conceptual error is inaccuracy in choosing or applying formulas, so that the answers obtained are not appropriate.

This study found that conceptual errors occurred because students could not choose the right formula, forgot the formula that should be used, or were unable to apply it correctly. These results are in line with research (Sari & Pujiastuti, 2022) which concluded that one form of conceptual error is the use of inappropriate formulas. Similarly, research (Kurnia et al., 2024) shows that students often experience errors because they forget to use or are unable to apply formulas correctly in solving problems.

The lack of conceptual understanding in solving SPLDV problems shows the need for special guidance and increased learning motivation. This is following (Vrasetya et al., 2024) which states that increasing learning motivation consistently and continuously is an important step so that students are more active in learning and following lessons. Motivating additional tutoring can also help students who have learning difficulties to be more motivated to understand the material well, both at school and at home.

2. Procedural Error

Procedural errors occur when students do not follow the steps of solving problems systematically and coherently. Students should understand the problem, form a mathematical model, perform calculations, and draw conclusions correctly (Hijriani et al., 2023). However, many students make procedural errors, such as not continuing the solution procedure, using unclear steps, or not solving the problem to the simplest form.

In this study, procedural errors were found to be the type of error that most students made compared to other types of errors. These errors occurred because students did not follow the appropriate steps, skipped some important stages in solving the problem, or were unable to manipulate the calculation steps properly so that the answer became incoherent. In addition, some students also did not write down the known and asked information in the problem, did not make the appropriate mathematical model, and made mistakes in the final stage of solving (Syahril et al., 2021).

According to (Hoar et al., 2021) students should be able to write and explain the process of solving problems coherently and systematically. Students who have good procedural knowledge will be better able to follow the solution steps correctly (Hijriani et al., 2023). In addition, (Krisnadi, 2022) emphasized that understanding the prerequisite material is very important to help students build bridges between the knowledge they have learned and the new concepts being introduced.

3. Technical Error

Technical errors refer to errors in calculations and writing symbols and signs in problem solving. Kastolan in (Bauk et al., 2022) states that technical errors are often caused by inaccuracy in calculations. (Zakiyah, 2023) also found that common technical errors are errors in calculating numbers and mathematical operations.

The results of this study indicate that technical errors are often caused by students' lack of accuracy when working on problems. Students often read the problem incorrectly, write numbers or coefficients incorrectly,

and make mistakes in writing symbols, operations, and variables (Lelboy et al., 2021). In addition, students are often in a hurry to work on problems so they do not recheck their answers, which leads to calculation errors.

The main factor causing technical errors is the lack of skills in performing mathematical calculations and lack of accuracy in the process of work (Susilawati et al., 2024). In line with research (Istiqomah & Sulistyowati, 2023) technical errors can also occur due to carelessness and rushing in solving problems without rechecking answers.

CONCLUSION

The results showed that students with sensing and intuiting personality types made errors in three main categories: conceptual, procedural, and technical. Sensing students had the highest rate of technical errors (100%), indicating that they had difficulty in calculation accuracy and symbol manipulation. Conceptual and procedural errors each reached 75%, indicating that there were still difficulties in understanding concepts and applying solution steps. Overall, the average error of sensing students was 83.3%.

On the other hand, intuiting students had evenly distributed errors in all categories (100%), indicating that they faced more extensive difficulties in understanding concepts, applying procedures, as well as solving problems technically. This finding indicates the need for learning strategies tailored to each personality type. Sensing students need more practice in accuracy and symbol manipulation, while intuiting students need reinforcement in concept understanding and systematic problem solving.

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