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Students' Algebra Errors in the Material of Linear Equations and Inequalities in One Variable

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Abstract

This study aims to determine students' algebraic errors in the material of linear equations and inequalities of one variable. The research method used is qualitative with a hermeneutic phenomenological approach, the study was conducted by giving an algebra test on the topic of linear equations and inequalities of one variable to determine students' algebraic errors and interviews with students to determine the causes of students' algebraic errors. The research subjects in this study were MTs students who had studied the topic of linear equations and inequalities of one variable. The results of the study revealed that 52.85% of students made mistakes in answering the test material of linear equations and inequalities of one variable with the highest percentage of errors in question number 5 at 70% and the lowest error in question number 4 at 26.67%. 4 categories of students' algebraic errors were found in this material with a distribution of 7 of 10 subcategories of algebraic errors. A total of 4 subcategories of students' algebraic errors are related to students' understanding of performing mathematical arithmetic operations and interpretations (mathematization) and 3 other subcategories are related to students' understanding of the definitions in this material.

Keywords Student errors; Algebra; SPLSV

INTRODUCTION

Algebra is a domain of mathematics used to solve problems in other domains, such as geometry, arithmetic, and analysis. Dartmouth (2000) emphasizes that algebra learning should be integrated into elementary education because it is the core of mathematical reasoning and the foundation for all advanced mathematics learning. Furthermore, algebra is also used to solve problems in everyday life. For example, when someone is asked to calculate the price per unit of an item they purchased, but they only remember the total number of items purchased, the total price, and the price comparison between the units, they can use algebra to calculate the price per unit using an equation.

Based on this, algebra plays a role in both mathematics and everyday life, making it essential to master, especially for students beginning to learn algebra at the secondary level. Similarly, Blair (2003) emphasizes that algebra is a core standard for mathematics learning from elementary to secondary levels. Before students perform algebraic operations, they need to transform everyday situations into variable forms that will be solved using equations or inequalities. This allows students to use algebra to solve everyday problems. The process of transforming everyday facts into mathematical forms is called mathematization. According to (Jupri et al., 2014), there are two types of mathematization: horizontal mathematization and vertical mathematization. Horizontal mathematization is the process of translating back and forth between the real world of a problem situation and the world of mathematics. Vertical mathematization is the process of reorganizing a mathematical system or moving within the symbolic world. This transformation process relies heavily on the knowledge and perceptions of students who will use algebra to solve problems. Both types of mathematization are based on students' prior knowledge or experience.

There are facts about student errors in the realm of algebra, student errors on the topic of arithmetic were found (Jupri et al., 2014) in Indonesia, namely students have assumed that -3 + 5 = -8 or more precisely students do not follow the rules when operating integers so that 17 - 3 + 5 = 17 - 8. The results of other studies found in Singapore (Kaur, 1991) understanding that students have is that the coefficients on 2 different variables such as $2x + 3y$ can be operated so that there are 24% of 25 students answering $2x + 3y = 5xy$. In addition (Booth et al., 2014) Identify various conceptual errors that persist in students and show that these misconceptions have an impact on the success of learning mathematics. Based on the previous explanations regarding the urgency of algebra, algebraic errors, and the impact of algebraic errors, this study offers an in-depth analysis of algebraic errors in the topic of linear equations and inequalities in one variable based on two research questions. First, "what types of algebraic errors do students make in the topic of linear equations and inequalities in one variable?" Second, "what are the causes of these types of algebraic errors in the topic of linear equations and inequalities in one variable?"

METHODS

This research uses a qualitative method with a hermeneutic phenomenological approach. Qualitative research according to Creswell in (Stadtländer, 2009) is an approach in which the questioner makes knowledge claims based on a constructivist or participatory perspective. According to Creswell in (Stadtländer, 2009) qualitative research methods use flexible and developing methods, open-ended research questions, use various data sources analyzed descriptively, and interpret the results of data analysis to draw conclusions. According to (Maddox, 1985) the term hermeneutics was originally used to refer to a classical discipline that formulates rules for interpreting texts correctly. The focus of this research is to determine the types of algebraic errors and the causes of students' algebraic errors in the material of linear equations and inequalities in one variable. The stages of data analysis in this study are based on data analysis for hermeneutic phenomenology according to Ricouer in (Tan et al., 2009), namely:

Explanation, (Naïve Understanding, In-depth understanding, Appropriation. The subjects of this study were 120 MTs students who had studied the material on linear equations and inequalities of one variable using 3 research instruments, namely student tests to determine students' algebraic errors and student interviews to determine the causes of students' algebraic errors..

RESULTS AND DISCUSSION

Based on the research results, the following presents the students' errors when answering the test questions that occurred for each subcategory, along with examples of the errors presented in the following tables. Table 2 presents the distribution of the subcategories of students' algebra errors across the four categories of students' algebra errors, together with examples.

Table 2. Subcategories of Students' Algebra Errors Across the Four Categories of Algebra Errors

No.	Error Category	Error Subcategory	Occurred (Yes/No)
1.	Arithmetic	Related Operations	Yes
		Related Rules	Yes
		Related Properties	No
2.	Algebra	Expected Answer Obstacle	Yes
		Lack of Closure Obstacle	No
3.	Variables	Misunderstanding the Problem	Yes
		Explaining Variables	Yes
4.	Mathematization	Horizontal Mathematization	Yes
		Vertical Mathematization	Yes

Source: Processed Research Data (2026)

Table 3. Examples of Students' Algebra Errors in Each Error Subcategory

No.	Error Subcategory	Examples of Errors
1	Related Operations	b = 15 ÷ 5 = -3
2	Related Rules	-2a ≥ -800 ↔ a ≥ 400 -5b = -3 ↔ b = -5 + 3 4t + 2t ≥ 3 + 5 ↔ 6t ≤ 8 The student did not change the inequality sign when the coefficient/constant was divided by (-1).
3	Expected Answer Obstacle	The student guessed the answers (without providing reasons/solution procedures) for questions number 3, 4, 5, 6, and 7. The student selected option B for question number 7 by rounding the numbers. The student determined (without calculation) the ages of the

		younger sibling and the older sibling in question number 6.
4	Misunderstanding the Problem	The student determined the solution for questions number 1 and 2. In question number 4, the student did not determine the value of "3b" after the value of "b" was known. The student used the sign (>) in question number 4.
5	Explaining Variables	A variable in a linear equation is a second-degree variable. A one-variable linear equation is an equation that has one variable. A variable is a letter. One-variable linear equations and inequalities are equations and inequalities that have one variable. One-variable linear equations and inequalities are inequalities that have two types of variables.
6	Horizontal Mathematization	The student used the sign (=) to represent the sign (≥) in question number 5. The student used the sign (>) to represent the sign (≥) in question number 4. The student used the sign (<) to represent the sign (≤) in question number 5.
7	Vertical Mathematization	The student used "90 - 15 - 20 = 55" for question number 7. The student used the ratio "3 : 1" for question number 6. The student used the equation for the older sibling's current age and the older sibling's age five years later, "x + 5 = 3x" ↔ "x + 15 = 3(15 + y)," for question number 6.

Source: Processed Research Data (2026)

Based on Table 3, the algebra error with the lowest variation in examples occurred in the **Related Operations** subcategory. This was caused by the test questions directing students with incomplete understanding to provide such answers. Meanwhile, algebra errors in the **Explaining Variables** subcategory had the greatest variation in examples because students had diverse interpretations of variables. The following presents the interview results conducted to identify the causes of students' algebra errors in each category of algebra errors on the topic of one-variable linear equations and inequalities.

Table 4. Causes of Students' Algebra Errors in Each Subcategory

No.	Error Subcategory	Cause of Error

1	Related Operations	The student performed number operations incorrectly.
2	Related Rules	The student believed that a number divided by 1 would produce the same result as a number divided by -1.
3	Expected Answer Obstacle	Students who do not have complete understanding tend to guess the "answer" to a question.
4	Misunderstanding the Problem	Students who misunderstand the problem tend to guess or are unable to answer the problem completely.
5	Explaining Variables	The student has an incorrect or incomplete understanding or interpretation of the definition of a variable.
6	Horizontal Mathematization	The student has an incorrect understanding of the relationship between equality and inequality symbols.
7	Vertical Mathematization	The student incorrectly managed the information presented in the problem, resulting in an incorrect (inaccurate) solution.

Source: Processed Research Data (2026)

Based on Table 4, it was found that the seven error subcategories were caused by students' incomplete understanding of the topic of one-variable linear equations and inequalities. Three of these were related to students' understanding of the definitions in the topic of one-variable linear equations and inequalities, while the other four were related to their understanding of performing arithmetic operations and mathematical interpretation (mathematization).

CONCLUSION

Based on the research results, it was found that around 50% of students still made mistakes in answering the test material on linear equations and inequalities of one variable with the highest percentage of errors in question number 5 at 70% and the lowest error in question number 4 at 26.67%. 4 categories of students' algebraic errors were found in this material with a distribution of 7 out of 10 subcategories of algebraic errors. A total of 4 subcategories of students' algebraic errors are related to students' understanding in performing mathematical arithmetic operations and interpretations (mathematization) and 3 other subcategories are related to students' understanding of the definitions in this material.

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