

Analysis of Student Errors in Solving Mathematical Problems in Algebraic Forms Operation Material Based on Newman's Procedure

Lady Fabiola Kaligis^{1*}, Philoteus E. A. Tuerah², Rosiah J. Pulukadang³

^{1,2,3}Program Studi Pendidikan Matematika, FMIPAK, Universitas Negeri Manado, Jl. Kampus Unima, Tonsaru, Kec. Tondano Sel., Kabupaten Minahasa, Sulawesi Utara 95618
lady.kaligis@gmail.com

Abstract

This study aims to discover the mistakes made by students, especially class VII students at Koka Christian Middle School, when solving math problems on algebraic operations using the Newman procedure. This research is a type of descriptive research with a qualitative approach. The technique for collecting data used a written test by providing description questions that totaled 3 items and was supported by interviews with students and documentation. The subjects in this study were 16 students in class VII of Koka Christian Middle School who took the written test, and 3 of them were selected to be interviewed after a deliberation process. The results of the study showed that students made errors in solving math problems in the material for algebraic operations based on the Newman procedure, namely: 1). error in understanding the problem, where students need to write down what is known and asked by the problem or make examples in the form of variables. 2). problem transformation errors, where students cannot determine the mathematical model of the given problem or cannot determine the correct formula. 3). process skill errors, where students need clarification in the problem-solving steps due to errors in understanding the concept of algebraic operations. 4) final answer errors, where these errors result because students are wrong in the problem-solving process.

Keywords: Student Error, Newman's Procedure, Algebraic Forms, Mathematical Problems

Abstrak

Penelitian ini bertujuan untuk mengetahui kesalahan yang dilakukan oleh siswa, khususnya siswa kelas VII SMP Kristen Koka, dalam menyelesaikan soal operasi aljabar dengan menggunakan prosedur Newman. Penelitian ini menggunakan pendekatan kualitatif dengan jenis penelitian deskriptif. Metode pengumpulan data terdiri dari ujian tertulis tiga soal berbasis uraian yang didukung oleh wawancara siswa dan dokumentasi pendukung. Dalam penelitian ini, subjeknya adalah 16 siswa kelas VII SMP Kristen Koka yang mengikuti ujian tulis, dan tiga orang diantaranya dipilih untuk diwawancarai secara musyawarah. Temuan penelitian mengungkapkan bahwa siswa melakukan kesalahan saat menyelesaikan soal matematika yang melibatkan materi operasi aljabar berdasarkan prosedur Newman, yaitu: 1). kesalahan dalam memahami soal, dimana siswa tidak menuliskan apa yang diketahui dan diminta soal atau tidak dapat memberikan contoh berupa variabel. 2) kesalahan transformasi masalah, yaitu siswa tidak mampu menentukan model matematika atau rumus yang tepat untuk suatu masalah yang diberikan. Kesalahan dalam keterampilan proses, dimana siswa melakukan kesalahan dalam langkah-langkah pemecahan masalah karena kesalahpahaman konsep operasi aljabar. 4) Kesalahan jawaban akhir yang diakibatkan oleh kesalahan yang dilakukan siswa pada saat proses pemecahan masalah.

Kata Kunci: Kesalahan Siswa, Prosedur Newman, Bentuk Aljabar, Soal Matematika.

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Corresponding author: Lady Fabiola Kaligis

Email Address: lady.kaligis@gmail.com (Jl. Kampus Unima, Tonsaru, Kec. Tondano Sel., Kabupaten Minahasa, Sulawesi Utara 95618)

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INTRODUCTION

Mathematics and daily activities are very closely related. Mathematics, a scientific discipline, can contribute to solving problems in everyday life and the world of work (Kusumawati & Rizki, 2014; Noor & Husna, 2017; Sartika, 2019). In addition, mathematics is also one of the subjects that must be studied from elementary to senior secondary education (Krisdiana et al., 2014; Utami et al., 2018; Anggraeni et al., 2020; Fauzy & Nurfauziah, 2021). By learning mathematics, students can think

critically, systematically, logically, and creatively and have good teamwork (Marliani, 2015; Siswono, 2016; Badjeber & Purwaningrum, 2018; Agustina, 2020). Therefore, mathematics must be taught correctly in the hope that students can thoroughly master the material in mathematics lessons and solve problems from the context of the studied material.

However, in learning activities, many students still need help in mastery of the material, one of which is material for algebraic operations. Students who master the operations of algebraic forms are low, only 3.7% of students (Hasibuan, 2015). As a result, students will make mistakes in working on problems, and if students cannot solve algebraic operation questions, students are also likely to have difficulties in solving other math problems (Yuliana, 2015; Susilawati & Febrian, 2016; Oktaufika, 2023).

Operations on algebraic forms are one of the mathematics materials taught and studied at the junior high school level. Operations on algebraic forms are also material that underlies some subsequent material, such as systems of two-variable equations, equations of straight lines, and so on (Review. C, 2020). In addition, in daily activities, algebraic operations can be applied in various fields, such as finance, technology, and others (Wati, 2021; Riana, 2022; Uno & Umar, 2023).

Based on interviews with the mathematics teacher at Koka Christian Middle School, information was obtained that as many as 14 out of 16 students in class VII made mistakes in the steps of solving questions on material for algebraic operations, such as errors in adding, subtracting, dividing, and multiplying in algebraic form so that the final answer given be wrong. Therefore, the mistakes made by students need to be analyzed to solve problems that occur so that they can help students solve math problems. In analyzing student errors in solving problems, a method is needed, and one of them is the Newman error analysis method (Safitri, 2017; Rismawati & Asnayani, 2019; Rosmiati & Maya, 2021). Newman suggests five stages in analyzing errors in problem-solving, namely: reading errors (reading errors), comprehension errors (comprehension errors), transformation errors (transformation errors), process skills errors (process skills errors), and errors. They write the final answer (end coding errors) (Sri, 2018; Putri & Nur, 2022).

Based on this background, the writer is interested in analyzing students' mistakes in solving math problems on material for algebraic operations based on Newman's procedure in class VII of Koka Christian Middle School.

METHOD

The type of research used in this research is descriptive research with a qualitative approach. This research was conducted at Koka Christian Middle School. The time of research was carried out on December 16, 2021, the odd semester of 2021. The main instrument in this study was the researcher, using supporting instruments in the form of tests designed to know the mistakes made by students and through interviews with students about the questions given. The technique used in analyzing the data in this study is a descriptive analysis using a qualitative approach. Analyzing

descriptive data begins with examining all the data obtained from the written test and interview results.

Data collection techniques used in this study were tests, interviews, and documentation. The test was given to students in grade 7 at Koka Christian Middle School, which contained essay questions on algebraic operations material and aimed to find out where the mistakes students made while working on the questions were. The interview technique used in this study was unstructured, meaning that the interview was conducted freely, and the researcher needed to use interview guidelines arranged systematically and thoroughly when collecting data (Sugiyono, 2016). In this study, the documentation that will be taken is photos of the results of the written test of the students who will be interviewed, photo documentation of the interview, and the implementation of the research. Qualitative data analysis techniques have 3 stages: data reduction, data presentation, and conclusion.

The implementation procedures in this study were (1) Administering a written test, (2) Recapitulating the results of the student's written tests, (3) Identifying student errors from the results of the written tests, (4) Determining the students as research subjects to be interviewed, (5) Conducting interviews, and (6) Making conclusions from the results of the interviews that have been carried out.

RESULT AND DISSCUSION

Analysis of Student Errors in Solving Mathematical Problems in Algebraic Operation Material Based on Newman's Procedure

This research was conducted at Koka Christian Middle School in class VII, which 16 students attended by giving test questions. Furthermore, the results of student answers were analyzed for mistakes made by students using a classification based on the Newman procedure, namely reading, comprehension, transformation, and process skill errors, and errors in writing the final answer (end coding error). Classification of the types of errors made by students can be seen in the following table:

Table 1. Types of errors made by students

No. Problem	Type of Error	Number of Student
1.	Reading error	-
	Comprehension error	4
	Transformation error	5
	Proces skill error	5
	Endcoding error	5
2.	Reading error	-
	Comprehension error	5
	Transformation error	7
	Proces skill error	13
	Endcoding error	15
2.	Reading error	-
	Comprehension error	8
	Transformation error	11
	Proces skill error	15

No. Problem	Type of Error	Number of Student
	Endcoding error	15

From Table 1. the mistakes made by students were comprehension errors, transformation errors, process skill errors, and coding errors.

Analysis of Interview Result Data

Based on Table 1 and through several considerations such as variations in the form of errors in the written test, students who are easy to find, have openness and fluency in verbal communication, and live around the school, 3 students were selected to represent each item as research subjects to be interviewed.

1. Problem Number 1 Represented by KK Students.

Based on the work done by the KK on question number 1, the KK needed to write down what was known and asked. Based on Newman's procedure, KK made mistakes at the stage of understanding the problem but was able to solve the questions until they got the correct final answer. The following is a picture of the results of the KK's answers to question number 1.

1. puzzle : x
 lego : y

$$7x + 5y + 3x - 2y$$

$$= 7x + 3x + 5y - 2y$$

$$= 10x + 3y$$

Figure 1. Results of KK students' work on Question No.1

The following is the result of an interview with KK on question number 1.

Q : Pay attention to question number 1. Please read the question.

KK : (read the question)

Q : What do you know about the problem?

KK : Jeni has 7 puzzle boxes and 5 Lego boxes, and his father gave him 3 more puzzle boxes. Then Jeni gave 2 Lego boxes to Nana.

Q : Then, what is asked in the question?

KK : How many puzzle boxes and Lego boxes does Nana have now?

Q : Then, why didn't you write it down?

KK : It is not necessary, ma'am, because I already know it, and the important thing is that I have written down the examples for puzzles and lego with x and y so they can be solved in algebraic form, ma'am.

Q : Are you sure about the answer?

KK : Yes, ma'am, I am very sure about the answer.

Based on the results of the written test on the pictures, KK students made mistakes when understanding the problem because they needed to write down what they knew and were asked about the questions. However, when interviewed, KK students could explain what was known and what was asked in the questions. This error occurs because students think what is known and asked can be written without being written again. After all, the KK already understands what is known and asked.

2. Problem Number 2 Represented by CA Students.

Based on the work on question number 2 by CA students, CA completed the questions based on Newman's procedure. CA writes down what is asked and what is known, writes formulas, and completes the steps for solving clearly. Nevertheless, the CA needed to correct a mistake at the process skill stage and had the wrong final answer. The following is a picture of CA's answer to question number 2.

Handwritten student work for problem number 2. The work is written on a dark background and shows the following steps:

$$\begin{aligned} 2. \text{dik.} &= \text{panjang Persegi} = 5 \text{ cm} + \text{lebar} \\ &\text{lebar} = x \\ \text{dit.} &= \text{luas} = ? \\ \text{Peny} &= \text{luas} = \text{panjang} \times \text{lebar} \\ &= 5 \text{ cm} + x \times x \\ &= 5 \text{ cm} + x^2 \\ &= x^2 + 5 \\ \text{Jadi, luas keramik} &= x^2 + 5 \end{aligned}$$

Figure 2. CA students' work results in Problem No.2

The following is the result of the interview with CA on question number 2.

Q : Look at question number 2. Can you read the questions?

CA : (read the questions)

- Q : What do you know about the problem?
- CA : Ceramic rectangle with a length of 5 cm more than the width, and the width is x
- Q : Then, what is asked in the question?
- CA : How wide is the tile?
- Q : Then, can you explain the steps for the solution?
- CA : Yes, Ma'am. First, I wrote down the formula for the area of a rectangle that I remember: length times width. Then I wrote down the value under the formula and then calculated it.
- Q : Very good. Furthermore, are you sure about the calculation process?
- CA : Yes, ma'am, I am sure because I followed the steps well.
- Q : Your completion steps were correct with the right formula. Then in the section on multiplying, why do you only multiply x by x?
- CA : Because x and x have the same variable, ma'am.

Based on the results of the written test in the picture, CA students made several mistakes, namely process skills errors and final answer errors. Processing skill errors occur because CA only multiplies x with x and not with 5, resulting in the wrong final answer. When interviewed, CA students said that CA multiplied the same variables even though all variables can be multiplied in the multiplication operation.

3. Problem Number 3 Represented by GS Students.

Based on the work on question number 3 by GS students, GS completed the questions based on Newman's procedure. The GS made an error at the problem transformation stage because it could not proceed to the following process, so it made an error at the processing skills and writing final answers stages, processing skills, and writing final answers. The following is a picture of the results of GS's answers to question number 3.

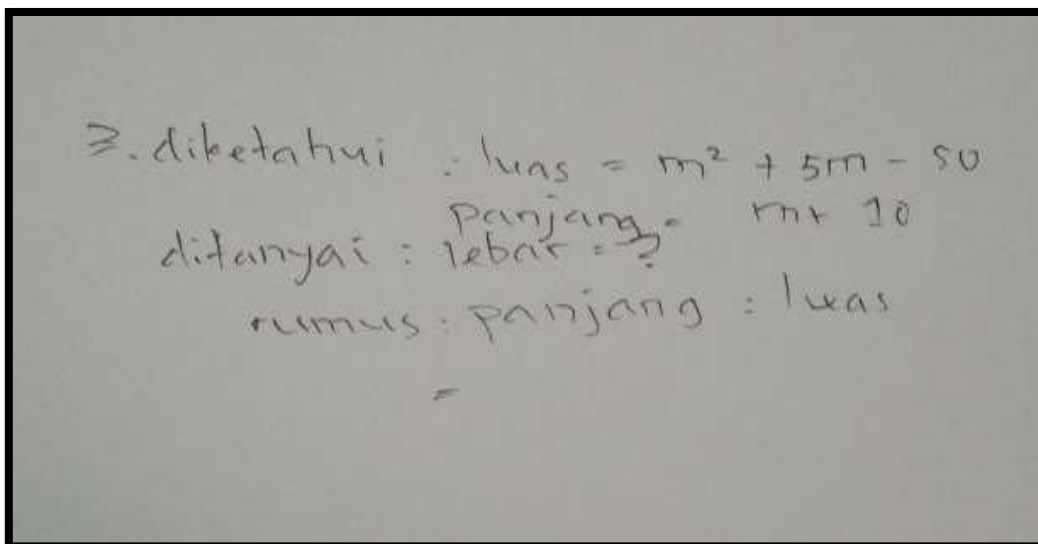


Figure 3. GS students' work results on Problem No.3

The following is the result of the interview with GS on question number 3.

Q : Look at question number 3. Can you read the questions?

GS : (read the questions)

Q : What do you know about the problem?

GS : Land area $m^2 + 5m + 50$ and length $m + 10$

Q : Then, what is asked in the question?

GS : How wide?

Q : Can you explain the steps you used to solve the problem and what arithmetic operations you used?

GS : I do not know, Ma'am. I do not understand.

Q : But you wrote down the formula on your answer sheet, then why not replace the formula with what you know?

GS : I do not know how to make it; I memorize the formula, and I have spent much time thinking about how to solve it, and suddenly, time is running out.

Q : Then, where did you get the solution formula?

GS : I only remember it, ma'am.

Based on the results of the written test on the pictures, GS students made several mistakes, namely transformation errors, process skills errors, and final answer errors. The transformation error occurs because the GS cannot substitute what is known about the problem with the formula it remembers and determines the wrong solution formula. As a result, GS also made mistakes at the process skill stage, so it could not determine the final answer.

Based on the data from the results of the error analysis on the written test and the results of the analysis on the interviews, the students' mistakes during the problem-solving process in the algebraic operations material and the mistakes made by students were analyzed based on the classification of Newman's procedure, namely:

1. Misunderstanding the problem, at this stage, students make mistakes because they are unable to determine what is known and asked and cannot exemplify it in the form of variables, or students do not write down what is known and asked by questions because they feel this is unnecessary because they already know it.
2. Transformation error. This error occurs because students need help to make a mathematical model of the given problem. After all, they cannot determine what is asked and known, and students cannot determine the formula to solve the given problem.
3. Process skill errors, at this stage, occur because students cannot transform the questions that were done before, which results in students not being able to continue solving steps in the subsequent algebraic form operations; students are not careful in the solving process, such as forgetting to add symbols or variables that should be there because of rush.

4. Errors in writing the final answer, errors at this stage occur because students have made mistakes during the completion process, such as forgetting to add symbols due to a rush or erroneous understanding of the concept of operating algebraic forms so that students find the wrong final answer and cannot even find the final answer.

CONCLUSION

Based on the results of the analysis on the written test and the results of the analysis on the interviews carried out with class VII students at Koka Christian Middle School, it is concluded that:

1. Error in understanding the problem, where students need to write down what is known and asked by the problem or make examples in the form of variables.
2. Problem transformation errors, where students cannot determine the mathematical model of the given problem or cannot determine the correct formula.
3. Process skill errors, where students cannot continue the steps of problem-solving because they need to understand the concept of operating algebraic forms.
4. Error in the final answer, where this error results because the student is wrong in the process of solving the problem.

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