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Analysis of Student Errors in Solving Mathematics Problems in the Form of Descriptions in Quadratic Equation Material for High School Students Class X

Andhika Valentino Lukas[1], Jorry Ferry Monoarfa[2], Murni Sulistyaningsih[3]
[1,2,3,]Jurusan Matematika, FMIPAK, Universitas Negeri Manado
E-mail: andhikalukas66@gmail.com

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***Abstract**: This article discusses the analysis of students errors in solving mathematical essay questions on quadratic equations for 10th-grade high school students. The subjects of this research were 10 students from class XB at SMA Negeri 2 Tondano. The analysis of students errors based on Newman's procedure. This type of research is a qualitative descriptive study. The instruments used in this research were written tests consisting of 5 questions and interviews with 4 representative students. The results of this study showed that there were errors in understanding the problem by 44%, errors in transformation by 42%, errors in process skil by 48%, and errors in writing finel answers by 14%..*

INTRODUCTION

Mathematics is often considered a difficult subject for some students. One of the reasons is that mathematics is related to numbers, formulas and counting (Annisa & Kartini, 2021; Sundari et al., 2022). In fact, mathematics has many benefits for daily life (Maula et al., 2018; Harefa, 2019). Mathematics is one of the important subjects in the educational curriculum in high school (SMA) (Zagoto & Dakhi, 2018; Rahma & Triana, 2023). One of the subjects taught in high school is Quadratic Equations (Nasution & Pangabean, 2017; Hidayati, 2019). Quadratic equations are quite complex subjects and are often considered difficult for some students (Sulastri & Arhasy, 2017; Ratau, 2021). So, students often make mistakes when solving problems with quadratic equations.

The results of the initial observation of grade X students at SMA Negeri 2 Tondano show that most students are still confused about solving math problems on the subject of quadratic equations. This is because students consider mathematics boring and difficult to learn. Based on the results of interviews with mathematics teachers at SMA Negeri 2 Tondano, when students are given questions that are different from the examples given during learning, students have difficulty solving them. Students are also less optimal in solving quadratic equation problems, so analysis is needed to find the cause of mistakes made by students when solving problems, especially problems in quadratic equation material.

Newman's error analysis is based on errors such as reading, comprehension, transformation, process skill, and encoding (Fatahillah et al., 2017; Darmawan et al., 2018). Students' mistakes in solving problems are a condition used to measure students' ability to master the concepts taught (Suraji et al., 2018; Aqsa et al., 2021; Setiani et al., 2022). This encourages researchers to analyze

students' problem-solving mistakes and look for the causative factors.

The purpose of this study is to find out how much of the percentage of errors students make in solving mathematical problems of quadratic equation material based on Newman's analysis in class XB of SMA Negeri 2 Tondano, which consists of several types of errors, namely (1) errors in reading problems, (2) errors in understanding problems, (3) errors in transformation, (4) errors in process skills, and (5) errors in writing final answers. The results of this research can later be used as a reference for teachers during learning evaluations and improve students' understanding of the material taught.

Based on the discussion above, it can be concluded that there are still many mistakes of students make in solving mathematical description problems, especially in quadratic equation material, which results in poor student learning outcomes due to a lack of student interest in learning. For this reason, the author of this study wants to know what mistakes students make in solving mathematical description problems, especially errors according to the stages of Newman's errors. So, the author of this study took the title: Analysis of Student Errors in Solving Mathematics Problems in the Form of Description in High School Class X Student Material.

METHOD

This type of research is qualitative descriptive research. To examine students' mistakes in solving problems in quadratic equation material. According to Newman, the error analysis used in this study uses the error analysis stages. This research was carried out at SMA Negeri 2 Tondano, located at Tataran Patar, South Tondano District, Minahasa Regency, North Sulawesi. This research was carried out in the even semester of the 2023/2024 school year. Instruments are tools used to collect data. The instrument used in this study is a written test in the form of a description question that will be given to students and an interview with students regarding the quadratic equation problems that have been given.

The subject of this study is a student of class XB of SMA Negeri 2 Tondano. This subject is taught by creating a research class and then giving a written test in the form of a description of 5 quadratic equation questions to all students. Generally, a test is a tool used to measure knowledge or mastery of a measurement object of a certain set of content or material. In this study, the researcher used a written test, a written test that is carried out in writing, either questions or answers. Written tests can be in the form of descriptions.

The written test used by the researcher is a description of 5 questions related to quadratic equation material. This written test aims to discover what mistakes students make in solving problems on quadratic equation material.

Interviews are the data collection directly through face-to-face interaction between researchers and respondents, intending to better understand the subject being studied. In this case, the researcher interviewed teachers at school about what mistakes students often make in solving quadratic equation problems. After the test was conducted interviews with teachers, the researcher also interviewed representatives of the students about what caused them to make mistakes in solving quadratic equation problems.

For the researcher to have evidence to the informant or data source that he has conducted an interview, the help of tools such as notebooks, pens, and handphones for documentation is needed. Documentation is something that researchers do to collect data from various print media. Such as books, notes and so on that discuss the subject to be researched.

Researchers will conduct documentation in the form of photos with tools like mobile phones to support research in schools. This document is collected for analysis to ensure the

completeness of the research data. Analyzing the mistakes made by students is done by looking at the completion steps made by students in completing the given test. Therefore, it is necessary to use indicators to make identifying mistakes made by students easier. The error indicators in question are in accordance with Newman's analysis.

RESULT AND DISCUSSION

According to Newman, this study aims to find out students' mistakes in solving problems in quadratic equation material in class XB SMA Negeri 2 Tondano, especially at the error stage. The researcher took data from the results of the student's written test and the results of interviews. Researchers will use the data taken to explore information in class XB students when solving problems on quadratic equation material.

The research was conducted on Tuesday, May 14, 2024, and the researcher took data from students' written tests in solving problems on quadratic equation material. In class XB, with a total of 10 students, this research was carried out offline or face-to-face in class XB by giving each student 5 questions with square equation material for students to work on for 60 minutes.

After conducting a written test for students, data was obtained on the test results of errors in solving quadratic equation material problems. Then, the data of test results on the research subjects was managed. The results of the students' answers were obtained from the data analysis. The test results of class XB students of SMA Negeri 2 Tondano can be seen in the following Table 1.

Table 1. Test Results of the Form of Quadratic Equation Material Description Test

Data Size	Research Subject
Lots of Samples	10
Highest Score	50
Lowest Score	0
Average	29,5

The results of the test answers can be grouped according to Newman's error stage categories, namely reading errors, comprehension errors, transformation errors, process skill errors, and encoding errors in the following table:

Table 2. Classification of Types of Student Error According to the Newman Procedure

Number Questions	Types of errors	Number of Students	Student Percentage
1	*Reading error*	0	0%
	Comprehension error	1	10%
	Transformation error	0	0%
	Process skills error	0	0%
	Endcoding error	0	0%
2	*Reading error*	0	0%
	Comprehension error	1	10 %
	Transformation error	0	0%
	Process skills error)	0	0%
	Endcoding error)	0	0%
3	*Reading error*)	0	0%
	Comprehension error)	6	60 %

	Transformation error)	7	70%
	Process skills error)	8	80%
	Endcoding error)	3	30%
4	*Reading error*)	0	0%
	Comprehension error)	7	70 %
	Transformation error)	7	70%
	Process skills error)	8	80%
	Endcoding error)	2	20%
5	*Reading error*)	0	0%
	Comprehension error)	7	70 %
	Transformation error)	7	70%
	Process skills error)	8	80%
	Endcoding error)	2	20%

Based on the data on the results of the research test conducted on 10 students in class XB of SMA Negeri 2 Tondano which amounted to 10 students, it was found that the mistakes made by the students according to Newman's procedures were; At the stage of understanding the problem, transformation error, process skill error, and encoding error. To find out the percentage of types of student errors, then a calculation is carried out on each question given to students along with an explanation of the results of the percentage calculation based on 5 error analysis methods according to Newman's procedure with the formula:

$$P = \frac{n}{N} \times 100\%$$

Information:
P : Percentage of student error types
n : The number of errors for each type
N : Lots of possible mistakes
Number of possible errors = Many questions Number of students X

$$N = 5 \times 10$$

$$N = 50$$

Table 3. Percentage of Student Error Types

Question	Reading Errors	Misunderstood	Transformation Errors	Process Skills Error	Final Answer Writing Mistakes
1	-	1	-	-	-
2	-	1	-	-	-
3	-	6	7	8	3
4	-	7	7	8	2
5	-	7	7	8	2
Sum	0	22	21	24	7
Percentage	0%	44%	42%	48%	14%

b. Discussion

From the written test conducted by the students, the results of the data analysis obtained by the researcher were the average percentage of reading errors was 0%, comprehension errors 44%, transformation errors 42%, process skills errors 48% and final answer writing errors 14%. To make it easier for researchers to analyze data and maintain the subject's privacy, the researcher uses the initials of each student's name.

After conducting a written test, the researcher interviewed students in class XB as interview subjects. There were 10 students present at the time of the test, and representatives would be selected based on the error category according to Newman's procedure. The researcher only interviewed representatives, namely 4 students, so that the researcher could find out why they were wrong in solving the problem.

Based on the results of student answers to an interview where one student represents one question number to find out what causes the mistakes made by students on each number. Because only 1 student did not answer questions 1 and 2 correctly, questions 1 and 2 were only represented by 1 person. The following presents the test results of the research subjects' students, along with the mistakes made and the causes. LL students represent questions number 1 and 2.

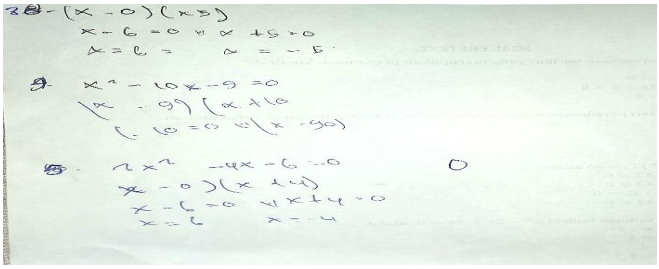


Figure 1. Answer sheet of LL student test results

The researcher then interviewed LL students for questions 1 and 2. The following are the results of the interviews. According to the analysis of LL's work for questions 1 and 2, as shown in Figure 1 and the results of interviews conducted on LL, the mistakes made and their causes can be seen in Table 4.

Table 4. LL Test Results on Questions 1 and 2

Types of Errors	Error Criteria	Place the Fault	Cause
Comprehension	Students don't write answers	Not writing answers 1 and 2	Students do not write answers because of a lack of knowledge about quadratic equation material so that they cannot answer questions number 1 and 2

1. RFM students represent question number 3

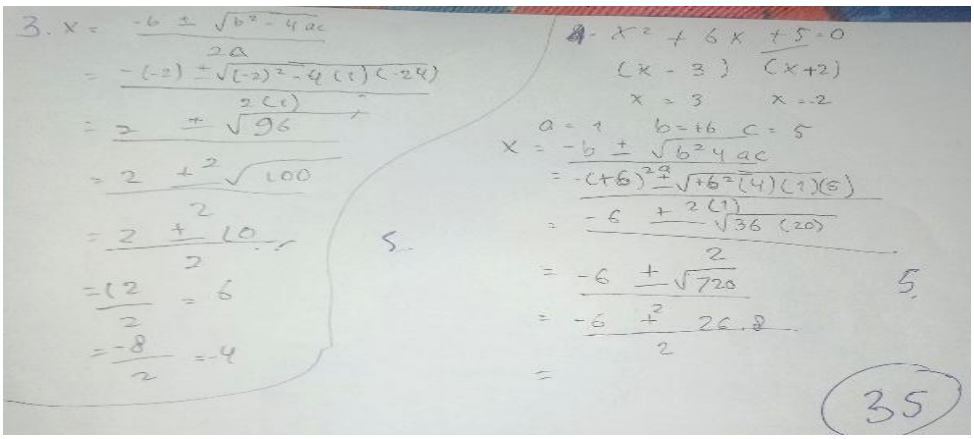


Figure 2. RFM student answer sheet

Then, the researcher interviewed RFM students for question number. The following are the results of the interviews with RFM students. According to the results of the analysis of RFM's work for question number 3, shown in Figure 2, and the results of interviews conducted on RFM, the mistakes and their causes can be seen in Table 5.

Table 5. RFM Test Results in Question Number 3

Types of Errors	Error Criteria	Place the Fault	Cause
Comprehension	Students do not write what is known in the question	Not writing what is known in the ABC formula	Students are incomplete in writing answers because they only see what they know without rewriting
Process skills)	Students cannot continue the calculation	Errors in calculations	Students are still confused about determining the result *x*
Endcoding)	Students do not write down the final answer	Final answer error	The student has done the calculation correctly but did not write the final answer

2. ATW students represent question number 4

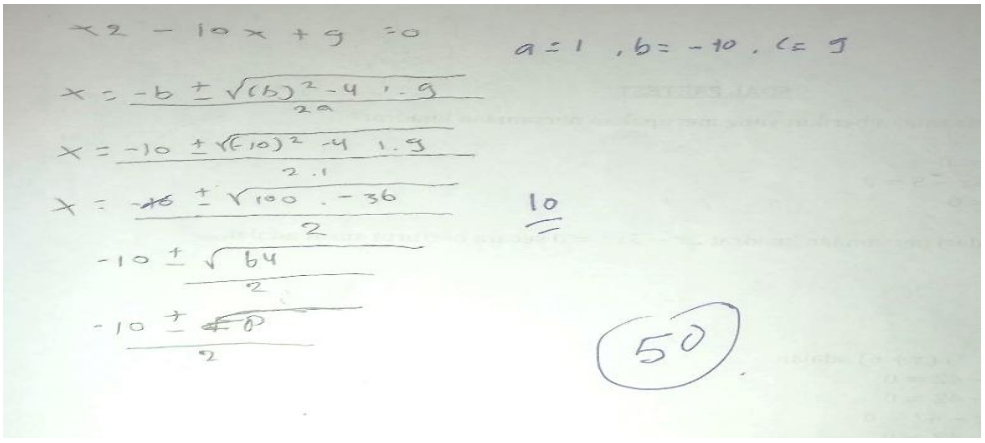


Figure 3. ATW student answer sheet

The researcher then interviewed ATW students for question number 4. The following are the results of the interviews.

Researchers	: Good morning
ATW Students	: Good morning sir
Researchers	: Do you understand the number 4 question?
ATW Students	: I don't understand you
Researchers	: You wrote down the ABC formula correctly but unfortunately didn't operate it correctly!
ATW Students	: Yes sir, I am not thorough
Researchers	: Why are you wrong in operating $\sqrt{b^2 - 4ac}$?
ATW Students	: It was in a hurry, so I was careless in operating it.

According to the results of the analysis of ATW's work for question number 4 as shown in Figure 3 and the results of interviews that have been conducted on ATW, the mistakes made and their causes can be seen in the following Table 6.

Table 6. ATW Test Results in Question Number 4

Types of Errors	Error Criteria	Place the Fault	Cause
Comprehension	Students do not write what is known in the question	Not writing what is known in the ABC formula	Students are incomplete in writing answers because they only see what they know without rewriting
Process skills	Students cannot continue the calculation	Errors in calculations	Students are still confused about determining the result x
Endcoding	Students do not write down the final answer	The mistake is in the final answer	The student has done the calculation correctly but did not write the final answer so

	that the answer made is incomplete

3. Question number 5 is represented by LLT students

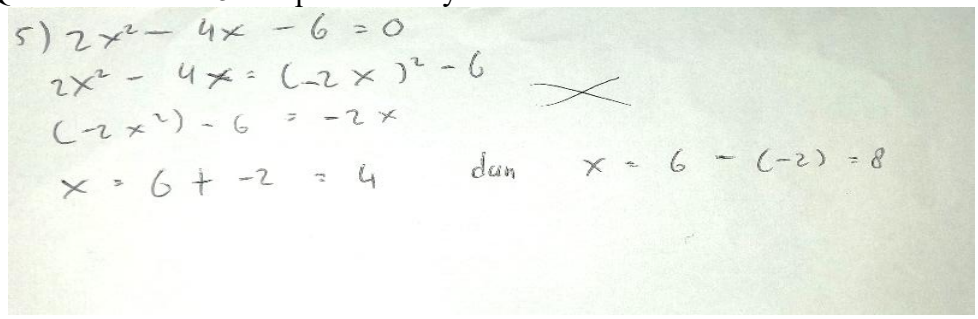


Figure 4. LLT student answer sheet

The researcher then interviewed LLT students about question number 4. The following are the results of the interviews. According to the results of the analysis of the LLT work for question number 5, as shown in Figure 4, and the results of interviews conducted on the LLT, the mistakes made and their causes can be seen in Table 7.

Table 7. LLT Test Results in question number 5

Types of Errors	Error Criteria	Place the Fault	Cause
Comprehension	Students are still confused about working on problems using factoring methods	Do not understand how to factor a quadratic equation with a value of a=2	Students do not understand because they are still confused about factoring $2x^2 - 4x - 6 = 0$
Transformation	Students only rely on the way of factoring	Students only use the factoring process even though there are three ways to find quadratic equations	Students are lacking in applying the perfect square solution and the abc formula because they are in a hurry
Process skills	Students cannot continue the calculation	Errors in calculations	Students are still confused about determining the result *of x* because they are in a hurry and are careless in determining it
Endcoding	Students write the final answer is not right	Final answer error	The student has made a mistake in the previous stage so that the student wrote the final answer that was not right

Based on the data of test results that have been carried out on 10 students in class XB of SMA Negeri 2 Tondano, it is found that the mistakes made by students in solving the descriptive form of the quadratic equation material according to Newman's procedure, namely at the stage of

comprehension of 44%, transformation of 42%, process skills of 48% and writing of final answers (encoding) of 14%.

This study shows where the mistakes made by students are located and the causes when students solve problems in the form of mathematical descriptions of quadratic equation material. The student's mistake occurs when understanding the problem or the problem given, where the student does not understand how to answer the question and does not know the important points in the problem, for example, what is known when using the ABC formula. Some students do not write what is known because it is considered unimportant, so they are ignored, because they are too lazy to write it and also because they are in a hurry because there is not enough time, so they do not have time to write it even though the process of answering the questions must be ordered.

Then, in the problem transformation part, students make mistakes, students cannot transform the problem, students only stick to 1 way that is understood even though in solving quadratic equation problems, there are 3 ways, namely factoring, completing perfect squares and the ABC formula so that students have difficulty solving the problem.

Furthermore, errors in the process skills section occur because students do not understand the problems, so the process of doing the problems is not done correctly. Some students are not thorough in operating addition, subtraction, multiplication, division and root, so students solve problems incorrectly. At the skill stage of the process of mistakes made by students cannot be separated from the negligence of the students themselves, namely not paying attention to certain things and the lack of students' numeracy skills.

Furthermore, errors in the final answer happen because the student made a mistake in the previous stage, so the process of writing the final answer became wrong. Students who do not write the final answer because they are in a hurry also make mistakes.

This study has a flaw where the researcher only describes the mistakes made by students in class XB of SMA Negeri 2 Tondano based on Newman's procedure. To find out the cause of the mistakes made by students using the interview method, the researcher only took student representatives to be interviewed, namely 4 out of 10 students who attended the description test. In this study, the interviewees were limited to 1 student who only represented one description test question that experienced an incomplete error. Each subject in this study, namely those who made mistakes, should be interviewed to represent all questions that experienced errors. This is because the research time is quite short, which coincides with the final exam week of the semester. In this study, the researcher did not provide a solution or follow-up on the students' mistakes in solving the descriptive form problems on the quadratic equation material.

CONCLUSIONS AND SUGGESTIONS

Based on the results of research conducted at SMA Negeri 2 Tondano in class XB, it show that:

The mistake students make when solving the descriptive form problem in the quadratic equation material is a comprehension error, where students do not write what is known, especially in the way of the formula ABC of quadratic equations. Transformation error: students do not transform the problem and only rely on one way of solving the quadratic equation problem. Process skills error, where students are still not thorough in operation. Encoding error is when students make mistakes in concluding or writing the final answer and do not write the final answer.

The types of errors seen from the error analysis method according to Newman's procedure have the following percentages: reading errors as much as 0%, understanding errors as much as

44%, transformation errors as much as 42%, process skills errors as much as 48% and final answer writing errors as much as 14%.

The reason why students make mistakes in solving descriptive form problems in quadratic equation material is that in the stage of understanding the problem (comprehension), students do not write down what they know about the problem, especially in the ABC formula, because they are in a hurry to feel that it is not important to write, students also feel lazy, so students do not write what is known from the ABC formula. In the transformation stage, students are only based on one way of completion, whereas in solving quadratic equations, there are three ways of solving, so they cannot solve it well. At the stage of process skills, students are still not thorough in operating numbers in the form of multiplication, division, addition, subtraction, and roots, so students experience difficulties in the process of solving problems. Students' numeracy skills are still lacking because they are negligent in solving problems and do not pay attention properly. At the stage of writing the final answer (encoding), students experienced errors because of the mistakes in the previous stage, so the final answer was not accurate. Some do not write the final answer because they are in a hurry to solve the problem and feel that it is not important so they are ignored.

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