



## Analysis of Student Errors in Solving Quadratic Equation Problems at SMAN 1 Polombangkeng Selatan Takalar Regency

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### Abstract

*This research is descriptive qualitative research. The subject of the study was students of class X3 SMA Negeri 1 Polombangkeng Selatan, Takalar Regency, which consisted of 30 students. A total of men were 15, and a total of women were 15. The data collection technique used in this study is in the form of an achievement test with the subject matter of quadratic equations and an interview test in connection with the obstacles faced in solving problems. Based on the learning outcomes test, data on mistakes made by students were obtained, namely, the concept level (A1) of 47.66%, which was categorized as moderate; the principle errors (A2) of 49.44%, classified as moderate; algorithm errors (A3) of 68.89 % categorized as high, and the language interpretation error (A4) of 44.44% which can be categorized into the moderate level. Therefore, the mistakes made by students in solving problems are caused by a lack of mastery of the prerequisite materials, a lack of interest in mathematics subjects, and a lack of doing the various exercises.*

**Keywords:** Student error analysis; Quadratic equations.

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## INTRODUCTION

Mathematics, as a fundamental subject at every level of education, plays an important role. Mathematics is always concerned with the appropriate comparison between understanding, knowledge, and abilities that are not always easy to solve. Thus, mathematics must be taught to students when they start to study at school.

As a fundamental subject, mathematics has links with various other sciences. Therefore, it is expected that students, especially at the high school level, can master mathematics subjects following the curriculum. However, it is an undeniable fact that until now, students' mastery of mathematics is still low. This is due to the lack of concept and principle skills in addition to identifying, language interpretation, and procedures or algorithms. This ability is needed in solving quadratic equation problems.

According to Gagne, there are two kinds of objects that students learn in mathematics: *direct* and *indirect*. The direct objects of mathematics learning consist of mathematical facts, mathematical skills or procedures, mathematical concepts, and mathematical principles. Indirect objects of mathematics learning include the ability to think logically, solve problems, think analytically, and have a positive attitude toward mathematics, thoroughness, perseverance, discipline, and other things.

Mathematics is hierarchically arranged with each other so that in solving mathematical problems, an understanding of the previous concept, which is a prerequisite material, is needed. Mastery and understanding of prerequisite material are one of the causes of students often making mistakes in solving math problems. In the topic of quadratic equations, the prerequisites that must be mastered

include linear equations, summation of tribes, knowledge of imaginary numbers, and algebraic operations. Mistakes that students in solving quadratic equation problems often make are:

1. Misconceptions

The error of the concept referred to here is the student's error in determining the factor, writing the formula, determining the values of  $a$ ,  $b$ , and  $c$ , determining the location of points on the graph and the number line, and formulating the problem.

2. Error of Principle

The principle error referred to in this study is the difference in using mathematical properties, namely the multiplication properties of two real numbers with zero results, namely if  $a, b \in R$  and  $ab = 0$  then  $a = 0$  or  $b = 0$ , or errors in the use of quadratic forms, errors in the use of formulas and rules of quadratic equations and errors in the substitution of values into quadratic equations.

3. Procedure or Algorithm Errors

The algorithm error referred to in this study is the disarray of steps in solving the problem of quadratic equations and inequality or the inability to manipulate steps to answer a quadratic equation problem, as well as errors in operating numbers (numbers, differences, divides, times, and roots).

4. Language Interpretation Errors

Mathematical languages generally use symbols that are universal languages; therefore, understanding these symbols is the main prerequisite for being able to understand mathematical language. Mathematical problems are usually presented as questions, application questions, diagrams, tables, etc. To solve the application problem, you must first change the problem into a mathematical language. The language of mathematics is often called the language of logic. In this study, language misinterpretation is students' inability to interpret or misinterpret words or symbols, graphs, number lines, and language used in mathematical models.

The government and competent parties have made various efforts to improve the quality of mathematics education. The efforts include improving the facilities and infrastructure of mathematics education, implementing teacher training, improving mathematics learning methods, and so on. Improving the quality of education can be seen in the achievements achieved by students. Whether students are successful in achieving mathematics learning achievements can be seen from the student's ability to solve math problems correctly. But in solving math problems, students often make mistakes.

Based on the above thoughts, the author tries to analyze the mistakes made by students in solving mathematical problems, especially those related to quadratic equations.

## METHOD

This research can be classified as descriptive qualitative research. Descriptive research is a study that reveals, analyzes, and provides an overview of the phenomenon of subject research that aims to find out what mistakes were made by students who were the subject of the study. Qualitative approaches or methods are used to obtain direct information about the location and causes of student errors in solving questions on the topic of quadratic equations through observation of work results and interviews with research subjects.

In this study, the variables investigated were errors made by students in solving quadratic equation problems. The definition of variable operations will be explained to get a clear picture of the variables in this study. The student's mistake in solving equation questions is the student's incompetence caused by mistakes. Such errors include:

1. The intended conceptual error is the student's error in determining the factor of the equation and quadratic inequality, the error in writing the formula, determining the values of  $a$ ,  $b$ , and  $c$ ,

- determining the intersecting points on the graph, determining the location of the point on the graph, determining the interval in formulating the problem.
2. The principle error referred to in this study is an error in using mathematical properties, namely the multiplication property of two real numbers with the result of 0, namely if  $a, b \in \mathbb{R}$  and apply  $ab = 0$ , then  $a = 0$  or  $b = 0$ , error in the use of quadratic forms, errors in using formulas, and errors in substituting values into equations, graphs, and number lines.
  3. The error of the algorithm/procedure referred to in this study is the non-hierarchy of the steps in solving the problem of quadratic equations or the inability to manipulate these steps, as well as errors in the use of operations (number, difference, time, divide, square, and root).
  4. The misinterpretation of the language intended in this study is an error in translating problems into mathematical models and errors in reading / translating graphs and number lines. It is difficult to write down important symbols or variables and errors in determining the solution.

The error indicators used in solving equation and squares problems are:

1. Misconceptions symbolized A1
2. Principle error symbolized A2
3. Algorithm/procedure error symbolized A3
4. A4 language misinterpretation

The subject of the study was a class X student of SMA Negeri 1 Polong bangkeng Selatan, Takalar Regency. The sampling technique used in this study is a random class technique assuming that the class taken is homogeneous. In this case, students in class X3 were selected as the sample, consisting of 15 men and 15 women. The data collection technique used in this study is in the form of an achievement test with the subject matter of quadratic equations. This test is a diagnostic test made by the author by paying attention to the material scope of quadratic equations. In addition, interviews were also held with students in connection with the obstacles encountered in solving the problems of quadratic equations. In this case, the students interviewed were the 4 students with the lowest scores based on the test results given. To obtain data on students' errors in solving quadratic equation problems, the author applied two instruments: the achievement test and the interview. In this achievement test instrument, the author uses 6 question items as an essay about quadratic equations. After seeing the results of student work, the author determined that 4 students be interviewed based on the most mistakes.

From the research bacillus, it is understood about the form of mistakes made by students in solving the questions that have been given, in the examination adjusted to the indicators contained in each problem motive, then calculating the percentage in each form of error. The criteria for categorizing the level of error experienced by students used a scale of five. The standards used on these five scales, according to Hamzah (2014), are:

- $0\% \leq A \leq 20\%$  categorized as very low
- $20\% < A \leq 40\%$  categorized as low
- $40\% < A \leq 60\%$  categorized as medium
- $60\% < A \leq 80\%$  categorized high
- $80\% < A \leq 100\%$  categorized very high

Percentage formula:

$$\text{Error Type} = \frac{\text{The number of mistake done}}{\text{the maximun number of mistake possibility done}} \times 100\%$$

## RESULT AND DISCUSSION

**Data Analysis Results**

Based on the results of research conducted on class X<sub>3</sub> students of SMA Negeri 1 Polombangkeng Selatan using a learning outcomes test in the form of essay questions with 6 questions on the subject matter of quadratic equations obtained the following data:

**Table 1.** Number and Percentage of Each Type of Error

No	Error Type	Number of Errors	Possible Errors	Error Percentage	Level Categories
1	A <sub>1</sub>	86	180	47,66%	Medium
2	A <sub>2</sub>	89	180	49,44%	Medium
3	A <sub>3</sub>	124	180	68,89%	High
4	A <sub>4</sub>	80	180	44,44%	Medium

Based on table 1, it can be concluded that students committed misconceptions (A<sub>1</sub>) of 47.66% which were categorized as having a moderate level, principle errors (A<sub>2</sub>) of 49.44% were classified as having a moderate level, algorithm errors (A<sub>3</sub>) of 68.89% which were categorized as having a high level, and language interpretation errors (A<sub>4</sub>) of 44.44% which can be categorized into moderate levels.

In detail, the mistakes made by students can be seen in the description of each type of error below:

1. Misconceptions

Concept errors made by students in solving quadratic equation problems can be seen in the following table:

**Table 2.** Number and Percentage of Concept Errors

Question no.	Number of Errors	Possible Errors	Error Percentage	Error Categories
1.	12	30	40%	Low
2.	25	30	83,33%	Very High
3.	11	30	36,67%	Low
4.	16	30	53,33%	Medium
5.	14	30	46,67%	Medium
6.	8	30	26,67%	Low
<b>Total</b>	<b>86</b>	<b>180</b>	<b>47,66%</b>	<b>Keep</b>

Table 2 shows that the total concept errors committed by students amounted to 47.66%, which was categorized as moderate level. Here it is shown that students experienced a considerable misconception in question number 2 about completing the perfect t quadratic.

2. Error of Principle

The principle errors made by students in solving the problems of the quadratic equation could not be corrected in the following table:

**Table 3.** Number and Percentage of Principle Errors

Question no.	Number of Errors	Possible Errors	Error Percentage	Error Categories
1.	12	30	40%	Low
2.	25	30	83,33%	Very High
3.	8	30	26,67%	Low
4.	18	30	60%	Medium
5.	16	30	53,33%	Medium
6.	10	30	33,33%	Low
<b>Total</b>	<b>89</b>	<b>180</b>	<b>49,44%</b>	<b>Medium</b>

Table 3 shows that the principle error made by students in solving the problems of the quadratic equation was 49.44% which belonged to the category of moderate level. Principle errors are often made in question number 2, which is a matter of finding the set of solving quadratic equations by completing the perfect square.

3. Algorithm Error

Algorithmic errors made by students in solving quadratic equation problems can be seen in the following table:

**Table 4.** Number and Percentage of Algorithm Errors

Question no.	Number of Errors	Possible Errors	Error Percentage	Error Categories
1	14	30	46,67	Medium
2	28	30	93,33%	Very High
3	14	30	46,67%	Medium
4	19	30	63,33%	High
5	25	30	83,33%	Very High
6	24	30	80%	High
<b>Total</b>	<b>124</b>	<b>180</b>	<b>68,89%</b>	<b>Tall</b>

Table 4 shows that the algorithmic error made by students in solving the problems of the quadratic equation was 68.89% which was categorized as a high level.

4. Language Interpretation Errors

Language interpretation errors made by students in solving quadratic equation problems can be seen in the following table:

**Table 5.** Number and Percentage of Language Interpretation Errors

Question no.	Number of Errors	Possible Errors	Error Percentage	Error Categories
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1	18	30	60%	Medium
2	24	30	80%	High
3	5	30	16,67%	Very Low
4	9	30	30%	Low
5	13	30	43,33%	Medium
6	11	30	36,67%	Low
<b>Total</b>	<b>80</b>	<b>180</b>	<b>44,44%</b>	<b>Medium</b>

Table 5 shows that the misinterpretation of language made by students in solving quadratic equation problems is 44.44%, categorized as a moderate level.

### Interview Results

After checking the results of student work and counting the mistakes made by each student, the 4 students with the most errors were selected. In this case, the 4 students who made the most mistakes were:

**Table 6. List of Names of Students Who Made the Most Mistakes and The Number of Errors**

No.	Name	A1	A2	A3	A4	Sum	Likelihood
1	Ra	5	5	6	5	21	24
2	Ma	5	6	6	3	20	24
3	Sya	6	5	5	4	20	24
4	Mu	4	5	5	5	19	24

### DISCUSSION

Based on the learning outcomes test given to students, data were obtained about the mistakes made by students, namely the concept level (A1) of 47.66%, which was categorized into the moderate level, principle errors (A2) of 49.44% were classified into the moderate level, algorithm errors (A3) of 68.89% categorized into high level, and language misinterpretation (A4) of 44.44% which can be categorized into moderate levels. Almost on every number, most students make algorithm/procedure mistakes in operating numbers and the disarray of the steps to solve them.

Based on interviews conducted with 4 students who made many mistakes in solving problems, it can be concluded that students needed to understand the concepts and principles that apply to mathematics. Students were also weak in basic algebraic operations or operating numbers.

From the learning outcomes test and interviews, it was obtained that students made many mistakes in solving quadratic equation questions due to a lack of mastery of prerequisite material and lack of practice in doing questions so that when given questions that were somewhat different from the examples they had given, they could not do it. Based on information obtained from teachers of mathematics subjects at the school, students are less active (even if they experience difficulties and when the teacher allows asking questions about material that is not yet understood). Consequently, this overwhelms teachers in facing and finding solutions to the difficulties experienced by students.

To reduce the mistakes made by students, several alternative solutions can be done including:

- a. Remedial Teaching

In planning and creating a remedial program, the teacher must be willing to take the time to look at all the factors that may affect the student's achievement in learning mathematics, including the child's attitudes and interests, in which case it takes the teacher's readiness to help with these weaknesses.

In remedial teaching programs, the thing to note is individualized teaching and group teaching. For individualized learning, the teacher must first provide diagnostic tests to students to find out their shortcomings; then, an interview is held to determine the weaknesses of such students in depth. After remedial teaching can be carried out, in this case, a selector of errors found prepared one collective of an individual nature. To find out the student's abilities should be given at the end of each lesson test which is 5-10 minutes. Group teaching is carried out when in a small or large group; there are almost the same errors in one group.

#### b. Out-of-Class Guidance

Tutoring is the provision of assistance to students or groups of students aimed at directing and increasing potential in the learning process to obtain optimal learning achievement. Guidance can be done by providing the student with the opportunity to consult in relation to the difficulties they face in the study of mathematics in the classroom. Students are allowed to ask questions that are considered difficult in mathematics prerequisite materials that are not yet understood.

Furthermore, student teaching guidance outside the classroom can not only be done by the teacher but also by other parties or students; guidance outside the school is expected to support the smooth teaching and learning process in the classroom and minimize student mistakes in solving problems related to mathematics.

#### c. Tasking methods

This method is usually simply called the melding task. The task often given in teaching mathematics is in the form of homework which is interpreted as an exercise in solving problems. In addition to the practice of solving the questions. It can also tell students to learn the topic to be discussed in advance. Told to look for other evidence of a theorem, told to read the history of the development of geometry in ancient Egypt and others.

The purpose of giving homework questions is so that students are skilled in solving questions, better understanding, and exploring the lessons given at school. In addition, so that students are accustomed to learning on their own, fostering a sense of responsibility and a positive attitude towards mathematics, therefore do not give tasks that are too difficult so that students do not have time for other activities outside of school, also do not give questions too much even though it is easy. Frequent members of many difficult questions can discourage students from solving them. The composition of the question should consist of easy, medium, and difficult.

### CONCLUSION

Based on the learning outcomes test that was carried out on 30 students of SMA Negeri 1 Polombangkeng Selatan in solving quadratic equation questions, the following data were obtained:

1. Concept level of 47,66%, which belongs to the moderate category
2. The principle level of 49,44%, which belongs to the moderate category
3. The level of algorithms or procedures is 68,89% which belongs to the high category.
4. The language misinterpretation rate was 44,44% which belonged to the moderate category.

Based on interview tests conducted with 4 students making many errors in solving problems of equations and quadratic inequality, it can be concluded that students do not understand the concepts and principles that apply in mathematics, and they also have difficulties in basic algebraic operations (operating numbers). The two tests that have been given show that students make many mistakes in solving questions, especially in squared calculation questions, almost as much as students cannot complete them. This is most likely due to the lack of mastery of prerequisite materials, lack of interest in mathematics subjects, and lack of practice in doing various questions so that if they face questions



that are somewhat different from the examples they have given, they are unable to do them.

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