



MISTAKE ANALYSIS OF CLASS X STUDENTS IN HANDAYANI SUNGGUMINASA HIGH SCHOOL IN COMPLETING THE PROBLEMS OF EQUATION AND EQUALITY EQUATION SQUARE

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Abstract

This type of research is descriptive qualitative research that presents the percentage of students' errors in solving mathematical problems, especially the questions of quadratic equations and squared inequalities. The research subjects were 22-grade students of SMA Serayani Sungguminasa, as many as 22 people. This study aims to determine the level of error made by class X SMA Handayani Sungguminasa students in solving quadratic equation problems and squared inequalities, especially conceptual errors, principle errors, and algorithmic errors. Data collection is done by providing an instrument in the form of a diagnostic test consisting of 6 items in the class essay with the intention to obtain the score of each type of error level. From the results of the analysis, the percentage of concept error rates was 39.77% (high), the principle error rate was 44.63% (high), and the algorithm error rate was 64.35% (very high). While in general, the level of error of class X students of Handayani Sungguminasa High School in completing the questions of quadratic equations and inequality squares is 54.85% or in the category, the level of error is very high.

Keywords: Error Analysis Solving Problems, Quadratic Equation, and quadratic inequality

A. Introduction

Mathematics is The Queen of Science translation (Mathematics is the queen of science) which is one of the basic lessons at every level of formal education that has relevance to various other sciences or life. Realizing the importance of the role of mathematics, it is desirable that high school students master mathematics subjects in accordance with the demands of the curriculum, but a fact that cannot be denied is that until now students' mastery of mathematics subject matter is still relatively low. This is due to the lack of the ability of the concept and principle of identifying data, interpretation of the language, drawing conclusions, procedures / algorithms and technical, where this capability is very much needed in solving quadratic equation problems and quadratic inequalities.

One of the underlying causes of difficulties in solving quadratic equation problems and quadratic inequalities is the mastery of material that is not optimal. To find out the difficulties of students it is necessary to conduct a search for errors made by students.

On the basis of the above thinking, the author is motivated to conduct a study to see the mistakes made by Class X students of Handayani Sungguminasa High School in solving the problems of quadratic equations and squared inequalities.

Based on the background above, the problem in this study was formulated as follows: How big is the percentage of students who make conceptual errors, principle errors, procedural errors, and causes of errors in Class X students of SMA Serayani Sungguminasa in solving quadratic equations and inequalities.

This study aims as follows: To determine the percentage of students who make conceptual errors, principle errors, procedural errors, and causes of errors in Class X students of Handayani Sungguminasa High School in solving quadratic equations and inequality problems.

B. Literature Review

Mistakes Students Make in the Problem Solving Process

According to Slameto (1995: 2) to obtain an objective understanding of learning, especially learning at school, it is necessary to formulate a clear understanding of learning. Various studies show that there are still many mistakes made by students in solving math problems. In solving mathematical problems especially those related to quadratic equations and quadratic inequalities, students need to understand the settlement process, are skilled in selecting and identifying conditions and relevant concepts, seeking generalizations, formulating completion plans and organizing pre-existing skills.

Before going on to the material, it should master the material prerequisites, namely linear equations, addition of tribes, knowledge of imaginary numbers and basic operations of algebra. In solving quadratic equation problems, students often make mistakes because students lack mastery in the supporting material.

In this study, researchers only examined three common mistakes made by students as indicators in conducting research, namely:

Concept Error

The concept in mathematics is an abstract idea that results in someone being able to classify objects or events and determine whether the object or event is an example or not an example of that idea. Related to that, Hudoyo (Fatmawati, 2006: 16) states that learning concepts is learning to understand the properties of concrete objects or events to be grouped into one type.

Erroneous concepts in mathematics will result in weak mastery of the material as a whole especially the mistakes in the basic concepts will make it difficult to master the next higher concept. This is because the order of mathematics subject matter is arranged hierarchically, one concept being the basis for understanding the other concepts. The conceptual error referred to in this paper is the student's error in writing the model and changes in the form of the attributes of rank, root, and logarithms.

Error Principle

The principle in mathematics which is often also called a principle is an object that expresses the relationship of two objects. The object that is connected is in the form of facts, concepts, and other operations. Principle is a complex mathematical object. The principle can consist of several facts, several concepts that are related by a relationship or operation. In simple terms it can be said that principle is the relationship between various basic objects of mathematics. Principles can be axioms, theorems, traits, and so on.

According to Mappaita (Herman, 2006: 10) that learning principles requires the ability to classify some rules can occur a fairly complex combination. As stated that "the number of two odd numbers is even", this is one example of the principle in arithmetic. The principle error in working on mathematical questions especially on the subject of rank, root, and logarithms is an error in using theorems or properties of rank, root, and logarithms.

Procedure or algorithm error

The algorithm is a series of steps needed to perform a particular task such as solving a problem. In solving the problem of quadratic equations and squared inequalities, algorithms are also things that determine the correct solution to the problem.

The error of the procedure or algorithm referred to in this study is the inability to manipulate steps to answer a problem of equality and inequality of squares and errors in operating numbers (number, difference, divide, times and roots).

As explained earlier that in reality most of the students make mistakes in solving math problems which then have an impact on their learning outcomes. The mistakes made when working on mathematical questions are divided into 3, namely: conceptual errors, principle errors, and algorithmic errors.

With the existence of these conditions, the researcher tried to see the type of errors made by students in solving the quadratic equation and squared inequality problems and calculating the percentage of each of these errors.

C. Methodology

This research is descriptive research which only has one variable aiming to find out the forms of errors made by students who are the subject of research. This study identifies errors made by students in solving quadratic equation problems and quadratic inequalities.

The variables of this study are errors in solving the problems of equations and quadratic inequalities. The error in question consists of three types, namely: (a) conceptual error, (b) principle error, and (c) algorithm error.

The subjects in this study were 22 students of Class X SMA Handayani Sungguminasa, consisting of 11 men and 11 women in the 2016-2017 Academic Year.

The steps taken in compiling the essay test are paying attention to the subject matter of quadratic equations and inequality that have been studied by Class X students of SMA Handayani Sungguminasa.

After paying attention to the subject matter of the quadratic equation and the inequality of squares studied by class X students, the preparation of the steps is as follows: 1). Arrange the grid; 2). Making questions; 3). Assemble the test. 4). Validating tests and, 5). Revise the test.

To obtain data about students' mistakes in solving quadratic equations and squared inequality problems and also to know students' mastery of the material equations and quadratic inequalities, in this study the authors used two instruments namely achievement tests and interview tests. 1). Learning Outcomes Test; Tests of learning outcomes in this research instrument the author uses 6 items in the form of essays about material quadratic equations and squared inequalities. 2). Interview; After seeing the completion of the essay problem done by students, the authors determine 3 students to be interviewed based on the most mistakes.

Data collection techniques used in this study are in the form of tests with subject matter quadratic equations and squared inequalities. This test is a diagnostic test made by the author by taking into account the scope of the subject matter, namely the material of equations and inequality squares. For the interviews, several respondents were taken who made many mistakes.

From the results of the study identified about the form of mistakes made by students in solving the questions that have been given. The method of examination is adjusted to the indicators contained in each item, then calculates the percentage of each form of error (Herman, 2009: 29).

Criteria for categorizing the error rate used in identifying forms of error are:

0% - 10%	: very low category
11% - 20%	: categorized as low
21% - 35%	: medium category
36% - 45%	: high category
46% - 100%	: categorized as very high

The percentage formula of the type of error is as follows:

$$\text{Error Type} = \frac{\text{Total of student errors}}{\text{Maximum possible student total errors}} \times 100\%$$

D. Findings and Discussion

1. Findings

This description will present a descriptive analysis of errors in solving questions consisting of conceptual errors, principle errors, and algorithmic errors. This descriptive analysis includes the percentages of each type of error and error indicators for each item that is done by Class X students of Handayani Sungguminasa High School 2016/2017 Academic Year in solving quadratic equations and squared inequalities.

The following are presented about data on the number and percentage of conceptual errors, principle errors, and algorithm errors.

Concept Error

The misconception made by students in solving quadratic equation problems and quadratic inequality can be seen in the following table:

Table 1. Percentage of Concept Mistakes

Item Number	Number of concept errors	Total concept error	Percentage of misconceptions	Error level category
1	2	44	4,55%	Very low
2	13	22	59,09%	Very high
3	16	66	24,24%	Moderate
4	15	66	22,73%	Moderate
5	55	88	62,50%	Very high
6	40	66	60,61%	Very high
Total	140	352	39,77%	High

From the table above, it can be seen that the conceptual error in number 1 of 4.55% is included in the category of low level of error, then at number 2 of 59.09% which is included in the category of very high error rates, then at number 3 amounting to 24.24% which is also included in the category of moderate error rates. Then, at no.4 of 22.73% which is included in the category of moderate error level, then at no.5 of 62.50% which is included in the category of error rate is very high, and at no.6 of 60.61% is meant in the category the level of error is very high. Furthermore, in general the percentage of total concept errors is 39.77%.

Thus, in general the level of misconception of class X students of SMA Handayani Sungguminasa in solving quadratic equation problems and squared inequality is a high category.

Error Principle

The principle error made by students in solving quadratic equation problems and quadratic inequality can be seen in the following table:

Table 2. Percentage of Error Principles

Item Number	Number of errors Principle	Total errors Principle	Percentage of errors Principle	Level category Principle
1	1	22	4,55%	Very low
2	4	22	18,18%	Low
3	11	44	25,00%	Moderate
4	9	44	20,45%	Very low
5	14	22	63,64%	Very high
6	59	88	67,05%	Very high
Total	108	242	44,63%	High

From the table above it can be seen that the principle error at number 1 of 4.55% which is included in the category of error rate is very low, then at number 2 of 18.18% which is included in the category of low error rate, then at number 3 for 25.00% who are also included in the category of moderate error, then at No. 4 of 20.45% which is included in the category of error rates is very low, then at number 5 of 63.64% which is included in the category of very high

error rates , and at no. 6 of 67.05% referred to in the category of very high error rates. Furthermore, in general the percentage of total principle errors is 44.63%.

Thus, in general the level of error in principle of class X SMA Handayani Sungguminasa in solving quadratic equation problems and squared inequality is a high category.

Algorithm Error

Algorithm errors made by students in solving quadratic equations and quadratic inequalities can be seen in the following table:

Table 3. Percentage of Error Principles

Item Number	Number of Algorithm errors	Total Algorithm Error	Percentage of Algorithm errors	Level category error
1	26	88	29,55%	Moderate
2	178	220	80,91%	Very high
3	81	154	52,60%	Very high
4	15	66	22,73%	Moderate
5	134	176	76,14%	Very high
6	104	132	78,79%	Very high
Total	538	836	64,35%	Very high

From the table above, it can be seen that the algorithm error at number 1 is 29.55% which is included in the category of moderate error level, then at number 2 of 80.91% which is included in the category of very high error rates, then at number 3 for 52.60% which is also included in the category of very high level of error, then at number 4 of 22.73% which is included in the category of moderate level of error, then at number 5 of 76.14% which falls into the category of very high error rates , and at number 6 of 78.79% referred to in the category the level of error is very high. Furthermore, in general the percentage of total algorithm errors is 64.35%.

Thus, in general the level of algorithm error of class X SMA Handayani Sungguminasa students in solving quadratic equation problems and squared inequality is a very high category.

Percentage of Error in All Categories

Errors for all categories of students in solving quadratic equations and quadratic inequalities can be seen in the following table:

Table 4. Percentage of Error in All Categories

Jenis Kesalahan	Jumlah Kesalahan Siswa	Total Kesalahan	Persentase Kesalahan	Kategori Tingkat Kesalahan
K. Konsep	140	352	39,77%	Tinggi
K. Prinsip	108	242	44,63%	Tinggi
K. Algoritma	538	836	64,35%	Sangat tinggi
Jumlah	786	1432	54,85%	Sangat Tinggi

Percentage of errors for all categories:

$$\frac{jNumber\ of\ student\ errors}{Total\ error} \times 100\% = \frac{786}{1432} \times 100\% = 54,85\% \quad (2)$$

From the table above it appears that concept errors amounted to 39.77% which were included in the category of high error rates, then principle errors amounted to 44.63% which were also included in the category of high error rates, and algorithm errors were 64.35% which was a very high error rate. high. Furthermore, in general the percentage of total errors of all categories is 54.85%

Thus, in general the level of error of class X SMA Handayani Sungguminasa in solving quadratic equation problems and squared inequality is a very high category.

Some examples of student mistakes

1. Tentukan akar-akar persamaan kuadrat $x^2 + 2x - 15 = 0$ dengan cara melengkapi kuadrat sempurna!

One of the respondent's answers:

$$x^2 + 2x - 15 = 0$$

$$\begin{aligned}
 (x^2 + 2x - 15) + (-1) - 15 &= 0 \\
 (x + 3)^2 - 16 &= 0 \\
 (x + 3)^2 &= 16 \\
 x + 3 &= \pm\sqrt{16} \\
 x + 3 &= 4 \text{ atau } x + 3 = -4 \\
 x &= 4 - 3 \text{ atau } x = -3 - 3 \\
 x &= 1 \text{ atau } x = -6
 \end{aligned}$$

From the answer it appears that students master concepts and algorithms. This is because students are not careful in carrying out the steps to work on the problem.

The real answer is as follows:

$$\begin{aligned}
 x^2 + 2x - 15 &= 0 \\
 \Leftrightarrow x^2 + 2x - 15 + 15 &= 0 + 15 \\
 \Leftrightarrow x^2 + 2x &= 15 \\
 \Leftrightarrow x^2 + 2x + 1 &= 15 + 1 \\
 \Leftrightarrow (x + 1)^2 &= 16 \\
 \Leftrightarrow x + 1 &= \pm\sqrt{16} \\
 \Leftrightarrow x + 1 &= 4 \text{ atau } x + 1 = -4 \\
 \Leftrightarrow x &= 4 - 1 \text{ atau } x = -4 - 1 \\
 \Leftrightarrow x &= 3 \text{ atau } x = -5 \\
 \text{Jadi, akar-akar dari } x^2 + 2x - 15 &= 0 \text{ adalah } 3 \text{ atau } -5
 \end{aligned}$$

2. Tentukan himpunan penyelesaian pertidaksamaan kuadrat $x^2 - 5x - 6 > 0$ dengan menggunakan garis bilangan!

One of the respondent's answers:

$$\begin{aligned}
 x^2 - 5x - 6 &> 0 \\
 x^2 - 5x - 6 &= 0 \\
 (x + 1)(x - 6) &= 0 \\
 x + 1 &= 0 \text{ atau } x - 6 = 0 \\
 x &= -1 \text{ atau } x = 6
 \end{aligned}$$

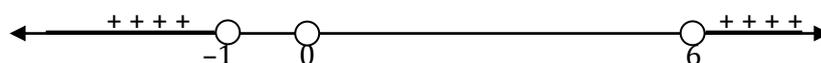
From the answer it can be seen that students lack mastery of concepts and principles. So that students make mistakes in solving problems.

The real answer is as follows:

$$x^2 - 5x - 6 > 0$$

- Tentukan pembuat nol dari pertidaksamaan kuadrat $x^2 - 5x - 6 > 0$

$$\begin{aligned}
 \Leftrightarrow x^2 - 5x - 6 &> 0 \\
 \Leftrightarrow (x + 1)(x - 6) &> 0 \\
 \Leftrightarrow x + 1 &> 0 \text{ atau } x - 6 > 0 \\
 \Leftrightarrow x &> -1 \text{ atau } x > 6
 \end{aligned}$$



- Ambil titik uji $(-2, 0, 7)$
 - Untuk $x = -2$ maka $(-2)^2 - 5(-2) - 6 = +$
 - Untuk $x = 0$ maka $(0)^2 - 5(0) - 6 = -$
 - Untuk $x = 7$ maka $(7)^2 - 5(7) - 6 = +$

Jadi, Himpunan Penyelesaian adalah: $\{x \mid x < -1 \text{ atau } x > 6\}$

Interview result

After checking the results of student work and calculating the number of errors made by each student, 3 students were chosen with the highest total errors. In this case 3 students who make the most mistakes are:

Table 5. List of Students Making the Biggest Error and Amount of Errors

Number	Name	Concept	Principle	Algorithm	Total
1	IF	9	7	33	48
2	MM	9	8	29	48
3	HS	9	8	37	54

The quotations of interviews with the four students are as follows:

Interviewer of Researcher (P) with IF

- P : Apakah Fandi bisa menyelesaikan semua soal yang diteskan?
 IF : Tidak bisa kak
 P : Menurut Anda soal yang menurut Anda paling sulit untuk diselesaikan?
 IF : Soal persamaan kuadrat kak
 P : Misalnya, soalnya seperti apa mungkin bisa dijelaskan
 IF : Soal nomor 2
 P : Coba perhatikan soal tersebut, Anda disuruh menentukan akar-akarnya dengan melengkapkan kuadrat sempurna
 P : Langkah pertama yang anda lakukan adalah menambahkan kedua ruas dengan + 15
 Kemudian tambahkan kedua ruas dengan $(\frac{1}{2}$ kali koefisien x)²
 IF : $x^2 + 2x - 15 = 0$
 $x^2 + 2x - 15 + 15 = 0 + 15$
 $x^2 + 2x = 15$
 $x^2 + 2x + 1 = 15 + 1$
 $(x + 1)^2 = 16$
 $x + 1 = \pm\sqrt{16}$
 $x + 1 = 4$ atau $x + 1 = -4$
 $x = 4 - 1$ atau $x = -4 - 1$
 $x = 3$ atau $x = -5$
 P : Kalau soal nomor 3 Anda bisa selesaikan dengan menggunakan rumus abc kemudian menentukan akar-akarnya.
 IF : Insya Allah kak bisa

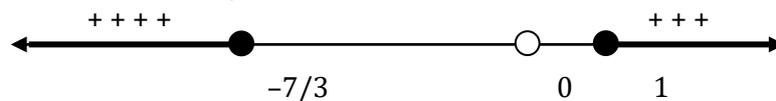
From the interviews with the respondents above, information was obtained that the student had not been able to determine the roots of the quadratic equation by completing the perfect square. It was proven that after being directed only then the respondent was able to answer it.

Interview with Researcher (P) with MM

- P : Menurut Mahmud, apakah dari 6 butir soal yang diteskan sulit ?
 MM : Rata-rata sulit kak
 P : Coba perhatikan soal pertidaksamaan kuadrat khususnya nomor 5
 P : Kesulitan apa yang Anda alami?
 MM : Menentukan pembuat nolnya kak
 P : Coba perhatikan baik-baik soal tersebut, untuk menentukan pembuat nolnya bisa dipakai cara memfaktorkan, melengkapkan kuadrat sempurna dan menggunakan rumus abc.
 P : Mengapa Anda tidak menggunakan cara yang lain?
 MM : Tidak tahu kak
 P : Sekarang coba Anda selesaikan soal tersebut

$$\begin{aligned} \text{MM} & : 3x^2 + 4x \geq 7 \\ & a = 3, b = 4 \text{ dan } c = -7 \\ x_{1,2} & = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \\ & = \frac{-4 \pm \sqrt{4^2 - 4(3)(-7)}}{2 \cdot 3} \\ & = \frac{-4 \pm \sqrt{16 + 84}}{6} \\ & = \frac{-4 \pm \sqrt{100}}{6} \\ x_1 & = \frac{-4 + \sqrt{100}}{6} = 1 \\ x_2 & = \frac{-4 - \sqrt{100}}{6} = -\frac{7}{3} \end{aligned}$$

- Ambil titik uji $-3, 0, 2$



Jadi Himpunan Penyelesaian adalah: $\{x \mid x \leq -7/3 \text{ atau } x \geq 1\}$

From interviews with the respondents above it can be obtained information that the respondent only understands and knows how to factor so that it is difficult to determine the maker of zeros but after being directed only then the respondent is able to determine the maker of zeros by using the abc formula

Interview with Researcher (P) with HS

P : Dari 6 butir soal yang diteskan, manakah yang paling sulit?

HS : Nomor 6 kak

P : Coba perhatikan soal tersebut, Anda disuruh menentukan himpunan penyelesaiannya dengan menggunakan garis bilangan

P : Langkah pertama yang anda lakukan adalah menentukan pembuat nol. Coba Anda tentukan pembuat nolnya

HS : $x^2 - 5x - 6 > 0$
 Tentukan pembuat nol dari $x^2 - 5x - 6 > 0$
 $x^2 - 5x - 6 > 0$
 $(x + 1)(x - 6) > 0$
 $x + 1 > 0$ atau $x - 6 > 0$
 $x > -1$ atau $x > 6$

P : Nah sekarang, tentukan titik ujinya dalam garis bilangan kemudian tentukan intervalnya. Heri bisa tidak diselesaikan sampai selesai.

HS : Insya Allah bisa kak.

From the interviews with the respondents above, information was obtained that the student had not been able to determine the set of resolutions of the quadratic inequality questions, this proved that after being directed.

2. Discussion

Based on the results of the descriptive analysis it was found that the level of errors made by class X students of SMA Serayani Sungguminasa in solving quadratic equations and inequality problems was very high, which meant that students' mastery of the material was still lacking.

For the percentage of each type of error made by students, namely:

Obtained the level of conceptual error made by students classified as high with a percentage of 39.77%, which means mastery of students' concepts of matter about quadratic equations and inequality squares is still lacking. 2) obtained by the principle level of error made by students classified as high with a percentage of 44.63%, which means mastery of the principle of students towards the material about quadratic equations and inequality of squares is less. 3) From the data in Table, the category of algorithm error rate that is done by students is very high with 64.35%, which means that mastery of students' algorithms on the subject matter of the

system is two variables that lack two variables. 4) From the data on the Table, the most common types of errors were made by students were algorithm errors of 54.85% with a very high error rate category.

Solution Alternative

To further minimize the mistakes made by students in the future some solutions are proposed as follows:

Remedial Teaching

In planning and preparing a remedial program, the teacher must be willing to take the time to look at all the factors that might influence student achievement in learning mathematics, including attitudes and interests. In this case the readiness of teachers is needed in monitoring the weaknesses of these students.

There are two things that need to be considered in the implementation of remedial teaching, namely: 1) Individual teaching; 2) Group Teaching. For individual teaching, the teacher must first provide diagnostic tests to students to find out the weaknesses/weaknesses that are individual and fields that receive special treatment. Interviews were then held to find out the weaknesses of these students. After that, remedial teaching can be done, in this case for any errors found, a collective work is prepared for each individual, to determine the ability of students, should always be given a test at the end of each meeting with only ten to fifteen minutes, while for teaching groups are carried out if small groups or large groups have almost the same weaknesses in a particular group.

Remedial teaching is directed at achieving learning outcomes optimally according to the abilities of each student through overall improvements in teaching and learning.

Guidance outside the classroom

Tutoring is a process of providing assistance to students or groups of students whose aim is to direct and increase potential in the learning process in order to obtain optimal learning achievement.

Guidance can be done by giving students the opportunity to consult with regard to the difficulties faced in teaching mathematics in the classroom. Students are given the opportunity to ask things that are considered difficult in mathematical prerequisite materials that have not been understood.

Furthermore, the teaching guidance of students outside the class can not only be done by the teacher but also with other parties or other students. Guidance outside the classroom is expected to support the smoothness of the teaching and learning process in the classroom and minimize student errors in solving problems related to mathematics.

Study Group

In the Dictionary of Sociology M. Jafar Masuha (Mulyono, 2012: 27), expresses the understanding of groups as follows: "groups are a set of two or more people who are intertwined in an interaction"

Based on the above limits, it gives an understanding that group learning is the collective effectiveness of a number of students to study mathematics, certain lessons or trying together to solve certain problems in achieving a goal.

Group learning has social benefits. Group learning can emphasize an interaction in terms of helping, communicating, discussing, dividing tasks, accepting responsibility in developing mutual respect for friends and their jobs. Group learning is also determined by the number of group members as M. Jafar Masuha (Mulyono, 2012: 28) provides a clue that the most effective and ideal groups are groups of two to six people, more than that will lead to unfair competition.

E. Conclusion

The results of this study can be seen that the three types of categories include the difficulty of the concept, difficulty of principle, and algorithm, in the subject of quadratic equations and squared inequality class X of Handayani Sungguminasa High School, 2016/2017 school year, with 22 respondents, conclusions can be drawn as follows: 1). The misconception of class X students of Handayani Sungguminasa High School in solving quadratic equation problems and squared inequality of 39.77% is categorized as high error rate. 2). The mistake of the class X students of Handayani Sungguminasa High School in solving quadratic equation problems and squared inequality of 44.63% is categorized as a high error rate. 3). The algorithm error of class

X SMA Handayani Sungguminasa in solving quadratic equation problems and squared inequality of 64.35% is categorized as a very high error rate. 4). In general, the level of difficulty of students completes the problems of quadratic equations and inequality of squares in class X of Handayani Sungguminasa High School at 54.85% or included in the very high category.

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