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Students Error Analysis In Exponential And Logarithmic Equations

Tri Astuti Arigiyati[1], Welly Yumarsa[2] , Eka Wahyuni Novianti[3], Betty Kusumaningrum[4*]

[1,2,3,4] Universitas Sarjanawiyata Tamansiswa, Indonesia
*Corresponding Author. E-mail: betty.kusumaningrum@ustjogja.ac.id
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Abstract

Mathematics is one of the basic concepts needed by students at every level of education. However, students often have difficulty in understanding mathematics. This can be seen from the mistakes made when working on math problems. Errors made by students must be addressed immediately so that no more errors occur, especially on questions that have the same characteristics. The purpose of this study was to determine the percentage of conceptual errors, arithmetical errors, writing errors and the most common mistakes made by students on the subject of exponential and logarithmic equations. Sampling was done by using purposive random sampling technique. The data in this qualitative descriptive study were collected using test, interview, and documentation techniques. The instrument used to collect data was in the form of test questions and interview guide sheets. The data were analyzed by categorizing the types of errors into conceptual errors, arithmetic errors, and writing errors and then calculating the percentage of errors in each category. The results showed that the errors made by students in each category were conceptual errors of 53%, arithmetical errors of 34.78% and writing errors of 28.99%. The error that many students make is a conceptual error as much as 53% with a moderate error percentage category.

***Keywords**: Error analysis, Mathematics, Exponential and logarithmic equations*

INTRODUCTION

Currently education is the most important thing and is a necessity of life so that humans can adapt to each other, both adapting to the surrounding environment and the wider environment (Adger et al., 2003; Gifford, 2011; Klein, 2015; ZHANG Wen-bin, 2013). According to the Law of the Republic of Indonesia concerning the National Education System no. 20 of 2003 Chapter I Article 1 (1), includes the definition of education;

> "Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential, so that they have religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by themselves, society, nation and state".

In the implementation of education, mathematics is one of the basic knowledge that is needed. Mathematics education has a very important role, because mathematics is a basic science that is widely used in various lives (Arseven, 2015; Ernest et al., 2016; Suherman, 2008). Mathematics is also a branch of exact science that is considered difficult by students, it requires more concentration, tenacity, and perseverance so that students can understand easy mathematics lessons (Bottge et al., 2007; Brunt, 2015; Bryk et al., 2015).

Teachers and students are very important components in determining the success of the learning process in the classroom (Ali et al., 2006; Aliyyah et al., 2020; Decristan et al., 2017; Sammons, 1995). Teachers have a duty to regulate the course of the learning process in the classroom, while students must have the ability, motivation, and self-readiness to take part in the learning process in class (Arigiyati et al., 2021; Katon & Arigiyati, 2018; Kusumaningrum et al., 2021). The obstacles experienced by students when learning can be seen by the mistakes they make (Kusumaningrum et al., 2020). These obstacles may be realized or may not be realized by people who experience obstacles in the process of achieving learning outcomes, as a result the learning achievement achieved is below what it should be (Irfan et al., 2019; Purnomo et al., 2014).

One of the goals of learning mathematics is achieved or not, it can be assessed from the success of students in solving math problems. For this reason, it is necessary to evaluate or test student learning outcomes by giving mathematics questions to students. From the results of this evaluation, it can be seen how far the success of the teaching and learning process and the location of students' mistakes. To improve mathematics learning outcomes, the source of errors made by students must be addressed immediately because students will always have difficulty, if previous mistakes are not corrected, especially questions that have the same characteristics. So that by analyzing student errors, teachers can find out student learning outcomes which can later be used to improve the next teaching and learning process (Chiu, 2004; Driscoll & Burner, 2005; Gareis & Grant, 2014; Van der Kleij et al., 2014).

As stated by Ni'mah (2010), the results of the study show that there are student errors in solving mathematical problems on the subject of exponential and logarithmic

equations which include aspects of (1) catching concepts or language errors, (2) applying formulas, (3) calculating. Based on observations and interviews with teachers of class X TKRO A mathematics at SMK Muhammadiyah 1 Bambanglipuro, the teacher said that students still often made mistakes in solving math problems, as a result, students' mathematics learning achievement was still low. This error can be caused by the process of receiving and processing inaccurate information. Another reason is that students are less precise in performing algebraic arithmetic operations and are less thorough in completing answers.

The mistakes made by students need to be analyzed. Error analysis is the investigation of a deviant event to find out the actual situation. Error analysis in solving math problems is a determination of the type of problem or weakness in solving math problems (Irfan, 2017; Jasak, 1996; Kingsdorf & Krawec, 2014; O'Brien et al., 2017). Several types of conceptual errors related to understanding the problem, counting errors related to the ability to count towards problem solving, writing errors related to students' indiscipline in writing the form of rank in order of problem solving steps, and operating errors related to numeracy skills (Copur-Gencturk, 2021; Gopnik & Meltzoff, 2021; Niemi, 1996).

Conceptual errors are errors made by students in interpreting terms, concepts, and principles or incorrectly using terms, concepts and principles. The indicators of conceptual error are (1) incorrectly determining the formula or theorem or definition to answer a problem, (2) the use of formulas, theorems, or definitions that are not in accordance with the prerequisite conditions for the validity of the formula, theorem, or definition, and (3) does not write down formulas, theorems or definitions to answer a problem (Sáenz, 2009). For counting errors, it is an operating error. According to Widodo (2014) operation is a rule to obtain a single element from one or more known elements. Examples of what is meant by calculation errors are errors in adding, errors in subtracting, errors in dividing and errors in multiplying. While writing errors are errors related to the use of notation or symbols, if there is an error in the use of notation or symbols it will cause a different meaning so that the results of the questions will be wrong.

Based on this background, the researcher wanted to find out the mistakes made by students in solving mathematical problems on the subject of exponential and logarithmic equations. Therefore, researchers are interested in researching "Error Analysis in Solving

Main Mathematical Problems on Exponential and Logarithmic Equations in Class X TKRO A Students at SMK Muhammadiyah 1 Bambanglipuro Academic Year 2019/2020". The objectives of this study are to find out: 1) Percentage of conceptual errors, calculation errors, writing errors and 2) The most common mistakes made by class X TKRO A students at SMK Muhammadiyah Bambanglipuro for the 2019/2020 academic year on the subject of exponential and logarithmic equations

METHOD

This research was conducted at SMK Muhammadiyah 1 Bambanglipuro Bantul in the 2019/2020 school year. For this type of research is descriptive qualitative research. The research design uses a *one shot case study*, in this design only one class is involved. This study uses a qualitative approach and the type of research conducted is descriptive. In this study, researchers used written data in the form of diagnostic test data, namely in the form of description tests. Diagnostic tests are tests that are used to find out the weaknesses of students, so that with the weaknesses of these students, appropriate steps can be taken to try to overcome existing weaknesses. While qualitative research is research that intends to understand the phenomena of what is experienced by research subjects such as behavior, perceptions, motivations, actions, etc., holistically, and by means of descriptions in the form of words and language, in a special natural context. and by utilizing various natural methods (Moleong, 2004).

Descriptive analysis aims to describe the form of errors from students solving problems related to exponential and logarithmic equations. While qualitative analysis is a description of the errors made by students in solving exponential and logarithmic equations. For the data collection technique, the researcher uses a non-probability technique, this technique means that the sample is determined by the researcher himself.

The research subjects were taken from class X TKRO A students at SMK Muhammadiyah 1 Bambanglipuro for the 2019/2020 academic year as many as 23 students. The object of this research is the analysis of student errors in solving essay questions or descriptions on the subject of exponential and logarithmic equations. Data was collected by means of tests and interviews. The purpose of using the test method to obtain material for observations related to student errors in solving problems describing the material on exponential and logarithmic equations. On the other hand, the interview aims to find out the students' difficulties in solving exponential and logarithmic

equations. In this study, the researcher only used the validity and reliability test of the test instrument in the form of description questions.

The instrument testing was carried out using validity and reliability tests, this was intended to obtain information about the quality of the instruments used. An instrument or item can be said to be valid if it is able to measure something desired and can state data from the variables studied appropriately. Data analysis technique with three-way method, namely data reduction, data presentation and data verification. Reduction is a method of collecting data on student work, which of course will be used to determine students who will be research subjects, the results of students' work who are research subjects. The data presentation stage is to present the results of solving math problems by students which are used as material for interviews, and present the results of interviews that have been obtained. The next step is data verification. Data verification is comparing the results of student work and the results of interviews so that conclusions can be drawn about the location and causes of errors.

The analysis used in this study is to use the formula, $P_i = \frac{E_i}{N \times M_i} \times 100\%$ Information for the above formula according to (Hamzah & Muhlisrarini, 2014) is " pi = Percentage of errors in the i-th item, i = 1,2,3,4,5; Ei = Total score error in the item about all I; = Total number of students; Mi = Score maximum error in the item about all I. "

RESULTS AND DISCUSSION

Based on the error analysis conducted by the researcher on 10 questions of exponential and logarithmic equations, to find out the cause of the error, the researcher chose several students to analyze the answers. Students are selected based on the total score of students who are below the KKM and are considered to represent students who make a lot of mistakes. Based on the test data, 5 students were taken who made a lot of mistakes to be studied. These students are the subjects of 1,2,3,4 and 5. Research data collection using the interview method. By doing the research, it is expected to be able to find out the difficulties experienced by students in solving exponential and logarithmic equations. So conduct interviews with selected students. This interview was conducted to students with the results of the test answers that have been analyzed. From the results of the analysis of errors made by students, the following is an explanation of conceptual errors, calculation errors and writing errors:

Concept error

Conceptual errors that occur are students do not know the first step in working on problems, students do not understand the properties of logarithms so that many students write down the wrong properties so that the results obtained are wrong. Conceptual errors made by students can be seen from Table 1.

Table 1. Percentage of Conceptual Errors

Question number	1	7	8	9	10
Total error score	15	4	3	16	23
Maximum error score	2	2	2	2	2
Percentage of concept errors	65.22%	17.39%	13.034%	69.57%	100%
Error percentage category	high	Very low	Very low	High	Very high
Average concept error	53%				
Error presentation category	Medium				

From Table 1, it can be seen that 53% of students' conceptual errors were included in the medium category. The highest concept error in question no. 10. While the lowest concept error is at no. 8. To find out the conceptual errors made by students, it can be seen from Figure 1.

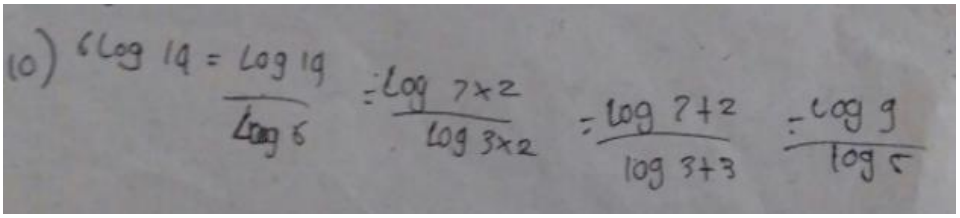

Figure 1. Error Concept number 10

In Figure 1, it shows that students do not understand the concept of solving logarithms with a form like the one above, it can be seen that the initial step was wrong. Students describe ${}^{6}\log 14 = \frac{\log 14}{\log 6}$, should remember the nature of the logarithm ${}^{a}\log b = {}^{c}\log a / {}^{c}\log b$, the translation is not like that. If question no.10 is done with the correct concept it is

$$6_{\log 14} = \frac{2_{log14}}{2_{log6}} = \frac{2_{\log 2\times 7}}{2_{\log 2\times 3}} = \frac{2_{\log 2} + 2_{\log 7}}{2_{\log 2} + 2_{log3}} = \frac{1+a}{1+b}$$

The choice of ${}^{2}\log\ldots$ is a skill that must be possessed by students because it is very important when the form of the question from number 10 is known to be ${}^{2}\log 7 =$

a and $^{2}\log 4$ = b, therefore students need the logarithmic properties of $^{a}\log b\ ^{c}\log a/\ ^{c}\log b$ to be used in the form of the question like this. So that after understanding the properties above we can change $^{6}\log 14$ into the form of $^{2}\log 14/\ ^{2}\log 6$ with the next step it will make it easier for students to answer questions because what is known from the questions is already visible so students just replace them with a and b.

Researchers have conducted interviews with students of X TKRO A SMK Muhammadiyah 1 Bambanglipuro regarding the concept error in question no.10. After conducting interviews with these students, information was obtained that students did not know the initial steps of working on questions, students also did not understand the concept of the nature of logarithms so that students could not work on the questions correctly, because these students could not solve the questions so students only saw the students' answers. other.

Miscalculation

The calculation error that occurs in the problem is the inability of students to do addition and multiplication of root numbers. The following calculation errors made by students can be seen from Table 2.

From Table 2, it is known that the calculation errors made by students are counting errors with a low level of 34.78% with the same percentage of 34.78% included in the low category. To find out the calculation errors made by students, it can be seen from Figure 2.

Table 2. Percentage of Error Counting

Question number	1	7	8	9	10
Total error score	0	8	8	0	0
Maximum error score	2	2	2	2	2
Percentage of calculation errors	0	34.78%	34.78%	0	0
Error percentage category	Very low	low	Low	Very low	Very low
Average calculation error	34.78%				
Error presentation category	Low				

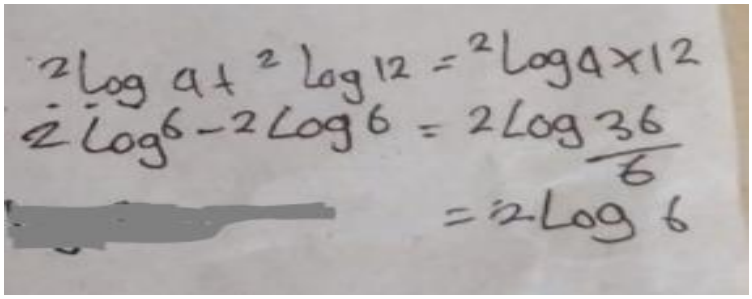

Figure 2. Error Counting Question Number 8

The calculation error in Figure 2 is that the student did not correctly multiply 4 and 12 so that the result obtained was 36 and the answer was wrong, the calculation error as above is very fatal because the student understands the work steps correctly, namely being able to apply the logarithmic property where $^a\log b + {}^a\log c = {}^a\log b \times c$. However, due to the inaccuracy of the students the answer was wrong. The correct answer is

$$2_{\log 48} + 2_{\log 12} - 2_{\log 6} = 2_{\log \frac{48x12}{6}}$$

$$= 2_{\log 8x12}$$

$$= 2_{\log 16}$$

$$= 2_{\log 2^4}$$

$$= 4\ 2_{log 2}$$

$$= 4$$

Researchers have conducted interviews with students of X TKRO A SMK Muhammadiyah 1 Bambanglipuro regarding the calculation error in question No.8. After conducting interviews with these students, information was obtained that students knew the initial steps of working on the questions, but students were not careful with the calculations they did so that the answers were wrong, it is very unfortunate because carelessness about questions with difficulty levels can easily be wrong. Miscalculations like this can be overcome if students are more careful before leaving work or students need to re-correct their answers.

Writing mistake

The writing error that occurs is that students are not careful in writing the power of the number so that it can change the meaning of the number itself. The following percentage of writing errors made by students can be seen from Table 3.

Table 3. Percentage of Writing Errors

Question number	1	7	8	9	10
Total error score	8	0	10	2	0
Maximum error score	2	2	2	2	2
Percentage of calculation errors	34.78%	0	43.48%	8.7%	0
Error percentage category	Low	Very low	Medium	Very low	Very low
Average calculation error			28.99%		
Error presentation category			Low		

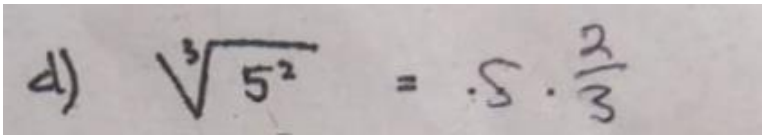

Figure 3. Error in Writing Question number 1

From Table 3 it is known that writing errors made by students are writing errors with a low level of 28.99% Writing errors in the moderate category occur at No. 8 with a percentage of 43.48%. To find out the writing errors made by students, it can be seen from Figure 3.

In the concept of exponential and logarithmic equations, the subject of discussion is how students can write numbers to the right, because it will affect the steps of working on the problem, when the rank is not written above but in addition to the base number, the calculation becomes different, as well as student answers in Figure 3, the correct writing should be $5^{\frac{2}{3}}$, if it is written like the picture above it will mean $5 \times \frac{2}{3} = \frac{10}{3}$, so it is clear that the answer will be wrong, just because students do not pay attention to writing to the power of numbers.

Based on the results of interviews conducted with students of X TKRO A SMK Muhammadiyah 1 Bambanglipuro, it was obtained information that students understand the concept of the nature of the root number well, but because of lack of discipline in writing ranks so that the answer becomes wrong. Discipline is very important in learning mathematics because if the writing is different, the meaning will also be different.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that (1) the percentage of conceptual errors made by students of class X TKRO A SMK Muhammadiyah 1 Bambanglipuro for the Academic Year 2019/2020 in solving the description questions on the subject of exponential and logarithmic equations is 53% in the medium category. (2) The percentage of calculation errors made by class X TKRO A SMK Muhammadiyah 1 Bambanglipuro Academic Year 2019/2020 in solving description problems on the subject of exponential and logarithmic equations is 34.78% in the low category. (3) the percentage of writing errors made by class X TKRO A SMK Muhammadiyah 1 Bambanglipuro Academic Year 2019/2020 in solving description problems on the subject of exponential and logarithmic equations is 28.99% in the low category. (4) The most common mistakes made by class X TKRO A SMK Muhammadiyah 1 Bambanglipuro Academic Year 2019/2020 in solving description problems on the subject of exponential and logarithmic equations

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