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STUDENTS' MATHEMATICAL REPRESENTATION IN SOLVING EXPONENTIAL FUNCTION

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Abstract

One of the important abilities that students need to master when learning mathematics is mathematical representation. This ability will improve students' understanding of concepts, principles and procedures in solving mathematical problems. But in reality, many students have difficulty in conveying their ideas to solve mathematical problems and this has an impact on students' mathematical representation. This research aims to describe the low mathematical representation of students and the factors that caused this. The type of research used is descriptive research with a qualitative approach. Based on this research, it is known that 66.67% of class X MIPA VII students at SMA Negeri 1 Ampek Angkek have low mathematical representation in solving exponential function problems. These results show that students' representation is still low due to difficulty writing down question solving ideas to the use of incorrect settlement intuition.

***Keywords**: Exponential function; mathematical representation; mathematical thinking process.*

Abstrak

Salah satu kemampuan penting yang perlu dikuasai siswa saat pembelajaran matematika adalah representasi matematis. Kemampuan ini akan meningkatkan pemahaman siswa tentang konsep, prinsip dan prosedur dalam menyelesaikan masalah matematis. Namun kenyataannya, banyak siswa mengalami kesulitan dalam menyampaikan ide-idenya untuk menyelesaikan masalah matematika dan hal tersebut berdampak pada representasi matematis siswa. Penelitian ini bertujuan untuk mendeskripsikan representasi matematis siswa yang rendah serta faktor yang menyebabkan hal tersebut terjadi. Jenis penelitian yang digunakan adalah penelitian deskriptif dengan pendekatan kualitatif. Berdasarkan penelitian ini, diketahui bahwa sebanyak 66,67% siswa kelas X MIPA VII di SMA Negeri 1 Ampek Angkek memiliki representasi matematis yang rendah dalam menyelesaikan masalah fungsi eksponensial. Hasil ini menunjukkan bahwa representasi siswa yang masih rendah yang diakibatkan oleh kesulitan menuliskan ide penyelesaian soal hingga penggunaan intuisi penyelesaian yang salah.

Kata kunci: Fungsi eksponensial; representasi matematis; proses berpikir matematis.

INTRODUCTION

Mathematics is one of the compulsory subjects in the field of education. This can be seen from the strategic placement of mathematics learning in the educational curriculum in Indonesia (Utami & Mukhni, 2021). Mathematics is an important subject and must play a role in education. This is because in everyday life, that is passed is inseparable from using mathematical concepts in various activities that have a

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close relationship with each other (Ramanisa et al., 2020). Students who have entered the formal learning level at school need to find special treatment in their development in pursuing mathematics, so mastery of mathematics needs to be done from the beginning of the student's education (Suningsih & Istiani, 2021).

One of the crucial abilities that students must master is mathematical representation. This mathematical representation is one of the foundation for students to understand mathematical ideas and play a role in solving mathematical problems (Wulandari, 2019). If the student's mathematical representation is good enough, it will be easier for students to solve a problem (Deswantari et al., 2020).

To know the level of students' mathematical representation ability, several indicators are needed to assess the extent of students' mathematical representation ability in solving mathematical problems (Herdiana et al., 2019). According to Villegas, indicators of mathematical representation ability are divided into three forms of representation, verbal, visual, and symbolic. This verbal representation is a statement from the given problem described orally or in writing. Next is the visual representation. The visual representation can be in the form of a table, diagram, graph, or in the form of overview. Last is the symbolic representation. This representation is in the form of mathematical symbols or mathematical models (equations) that are formed by these mathematical symbols (Rahayu & Hakim, 2021).

The increase in the mathematical representation ability will impact students' ability to understand mathematical concepts through images, objects, reports, and verbal explanations (Syahdi, 2019). In addition, students' mathematical representation ability is a cognitive ability that affects mathematics learning outcomes and student achievement. (M. Dss. Saputri & Maskudi, 2017). If the student's mathematical representation ability is low, then the student's process of solving mathematical problems will be hampered and vice versa (Mulyati, 2016). The higher the student's representation ability, the better the student's understanding of solving a mathematical problem (Sa'dijah, Rahayuningsih, et al., 2021). Nevertheless, unfortunately, students' mathematical representation ability is currently relatively low (Nurrahmawati et al., 2021). Mathematical representation ability is one of the abilities closely related to students' understanding and ability to solve mathematical problems (Permatasari et al., 2021). This is why it is essential to understand and analyze students' representational abilities to improve student achievement and understanding in mathematics learning.

An important mathematics subject for students to learn is the exponential function (Topa et al., 2018). Many students still have difficulty solving mathematical problems with exponential functions (Gunawan & Fitra, 2021). This is due to students making mistakes when solving the exponential function problems during learning and difficulty writing down the ideas they have in solving the exponential function problems (Junengsih & Sutirna, 2022). Therefore, the students' mathematical representation in solving exponential function problems needs to be analyzed so that it is known that students' mathematical representation abilities are at a high, medium, or low level of

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ability so that the results of this research can be used as a reference. In the end, mathematics learning can be more effective and have a high quality of learning. The aims in this research is to describe the low mathematical representation of students and the factors that caused this. With this research, it is hoped that it can be useful for teachers to know the mathematical representation of students so that it can improve the quality of learning and is also useful for readers in knowing this phenomenon.

RESEARCH METHOD

The type of research that used in this research is descriptive research with a qualitative approach (Sa'dijah, Murtafiah, et al., 2021). The descriptive method is a problem-solving procedure that's investigated by describing the subject or object of the research (a person, institution, society, etc.) in the current moment or situation based on the facts that appear or as it is (Nawawi, 2012). Furthermore, qualitative research is a procedure that produces descriptive data in the form of written or spoken words and observable behaviors of the research subject (Margono, 2014).

The research subjects tested were grade X of SMA Negeri 1 Ampek Angkek 2020/2021. The research class used is X MIPA VII, which is selected based on the low representation ability of students and considers the recommendations of mathematics teachers who teach in class X MIPA. The recapitulation of the notes of the mathematics teacher of class X MIPA related to the average mathematical representation ability of students is listed in Table 1.

Table 1. Recapitulation of mathematics teacher notes in X MIPA that related to the average mathematical representation ability of students

Class	Average
X MIPA I	87,7
X MIPA II	89,0
X MIPA III	83,7
X MIPA IV	80,0
X MIPA V	81,0
X MIPA VI	77,4
X MIPA VII	62,0
X MIPA VIII	76,2
X MIPA IX	74,7

Based on the mathematics teacher's notes regarding the mathematical representation of class X MIPA students, it can be seen that class X MIPA VII is the class that has the lowest average mathematical representation, with an average of 62. According to this fact, observations were made in class X MIPA VII to see the learning situation and student communication skills directly so that later if research is carried out, communication will run smoothly and research can reveal mathematical representation abilities of students.

The results of the observations showed that students at X MIPA VII are an active class and have good two-way communication skills. Most students do not hesitate to ask questions and convey difficulties and strange things, but indeed students' mathematical representation skills are still low. This indicates that if research is carried out in class X MIPA VII, the interview process will run smoothly and help describe students' representation abilities.

After determining class X MIPA VII as the research class, the data collection stage was carried out. The instrument that used in this research is a test instrument that has been validated by experts, where the instrument is an

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exponential function test and also interview guidelines to find out more student explanations about the answers that have been written. The instrument validation carried out is construct validaty where the expert/validator validates whether the designed instrument is capable of measuring students' mathematical representation variables so that later visual representations, verbal representations or symbolic representations of students can be seen in solving problems on the designed instrument (in this case the test exponential function). In addition to the exponential function test, the interview guide was also validated by experts so that the interview process could identify the factors causing students' low mathematical representation. After the instrument is declared valid, then the test is given to students so that student answer sheets are obtained which can then be continued with the process of selecting subjects to be interviewed and ending with analysis of the data that has been obtained.

After this data collection stage is completed, it is continued with the data analysis stage, where all test results and interviews are analyzed as carefully as possible. From this stage, data are obtained so that it can be concluded that students' mathematical representation ability in solving exponential function problems. The stages carried out in this data analysis technique are first after the student answer sheets are obtained, the researcher checks the answers and did the data reduction. Data reduction is done by selecting the low student test results then the answers of the selected students are scanned. After this, interviews were conducted with the selected students in order to find out the factors that influenced students to make these answers. After the interviews were conducted and recorded, the researcher transcribed the interviews to make it easier for researchers to analyze the existing data. After that, the researcher interpreted the students' answers and the results of the interviews so that they could describe the low students' mathematical representation and the factors that influenced it.

RESULT AND DISCUSSION

From the results of data collection and analysis that has been carried out, it is known that as many as 66.67% of students (18 out of 27 students) of class X MIPA 7 received the results of the mathematical representation test of exponential functions under minimum competency assessment (MCA). This result shows that class X MIPA 7, consisting of 27 students, has a low mathematical representation ability and deserves more attention in the following learning. The low ability of students' mathematical representation is a sign that students' understanding of solving exponential function problems is also low (Afriyani et al., 2018). The results of the analysis of the test results from X MIPA 7 on the test of mathematical representation of exponential functions can be seen through Table 2.

Table 2. Recapitulation of the analysis of the student's mathematical representation ability to the subject of exponential functions

Number	Assessed Mathematical Representation Ability	Number of Students Who Get The Wrong Answer
1	Verbal Representation	17
2	Visual Representation	10
3	Symbolic Representation	24

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Based on the analysis results, it can be seen that the ability of symbolic representation is the lowest representation ability among the other two mathematical representation abilities. This is related to the research results of (R. Saputri et al., 2021). Based on the recapitulation results, interviews were conducted with students who were constrained in completing the exponential functions that had been given. Based on the consideration and analysis carried out, five students were selected to be interviewed. The student's answer can be seen in Figure 1 until Figure 5.

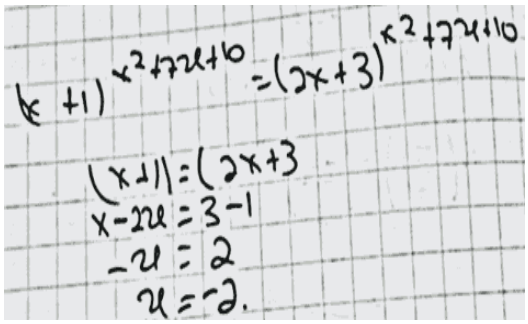

Figure 1. S1's answered

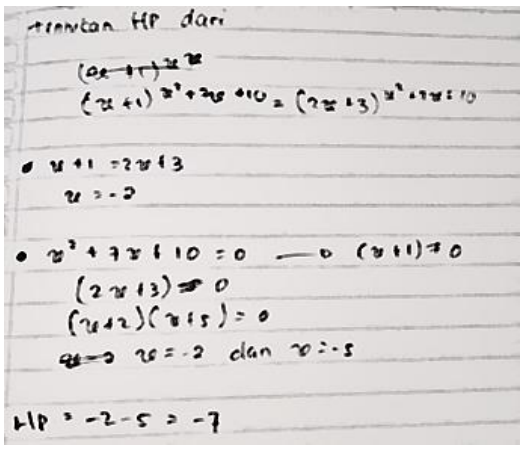

Figure 2. S2's answered

Figure 1 is one of the answers from students initialized with S1, wherein the question is asked about the set of solutions of exponential equations $(x+1)^{x^2+7x+10} = (2x+3)^{x^2+7x+10}$. In figure 1 above, it can be seen that this students only equate the basis of the exponential function equation. The terms of the exponents it is not worked out. When asked, students felt that the exponent needed to be tested first to get the set, but S1 felt that he did not know what to do with the exponent. This finding is related to research (Murniasih et al., 2020) and (Ma'rifah et al., 2020) that students' cognitive barriers to the knowledge of the topic tested in this research (exponential functions) are a factor that causes students to have difficulty expressing problem-solving ideas. Given and causes students to use the wrong mathematical formulas and symbols.

Figure 2 is the answer from students who are initialized with S2. The question asked is the same as the problem in figure 1, where this S2 has solved the exponential function problem by testing the base and exponent. However, when the student writes down the set of completions, the student adds up the scores that have been obtained. When interviewed, it was discovered that S2 represents the solution set of completions or that all the x values obtained must be summed.

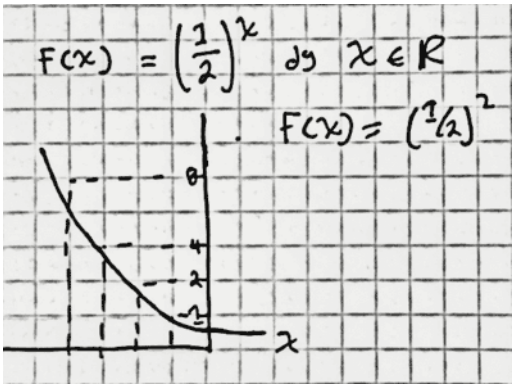

Figure 3. S3's Answered

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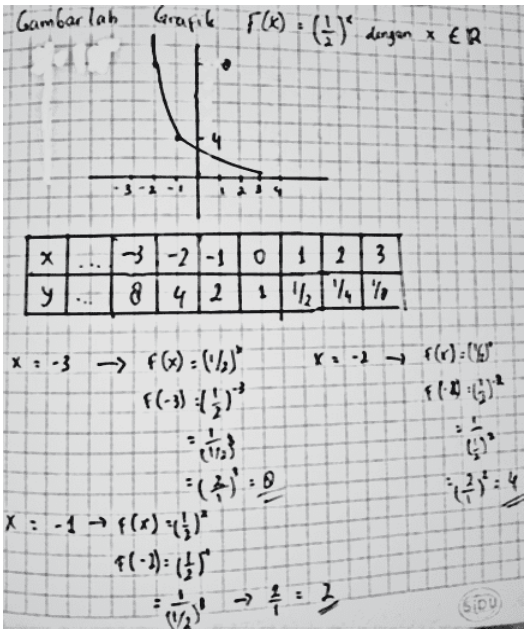

Figure 4. S4's answered

The answer from S3 in figure 3 shows students' visual representation ability. In the given problem, students are asked to draw a graph of the exponential equation $f(x) = \left(\frac{1}{2}\right)^x$, namely $x \in \mathbb{R}$. But at the time of drawing the graph, the student does not write down from which pairs of a point on the graph are created, and the point in question is not written.

After being interviewed, it was discovered that S3 felt that this was the graph; this student made the graph based on his intuition alone. When asked if the student could solve this problem in another way, S3 stated that that was all he thought of when answering the question. This is related to the research (Sholihah et al., 2019), which says that the visual ability of the student depends on the student's understanding of the concept of graphs studied. In this study is the concept of graphs of exponential functions.

The following answer is from S4, as shown in figure 4 above. The question asked is the same as in the previous S3. On the given questions, students are asked to describe the graph of the exponential equation $f(x) = \left(\frac{1}{2}\right)^x$, which $x \in \mathbb{R}$.

The answer written by S4 is appropriate and correct, but when interpreting the graph, S4 describes a graph that does not match the pair of dots that have been obtained. After being interviewed, it was discovered that S4 was not good at describing graphs. Therefore, S4 draws an arbitrary graph with the thought that the calculation answer to looking for pairs of dots on the graph is correct, so S4 feels that he will still get points for the question. This kind of thinking of students is in line with the research results.

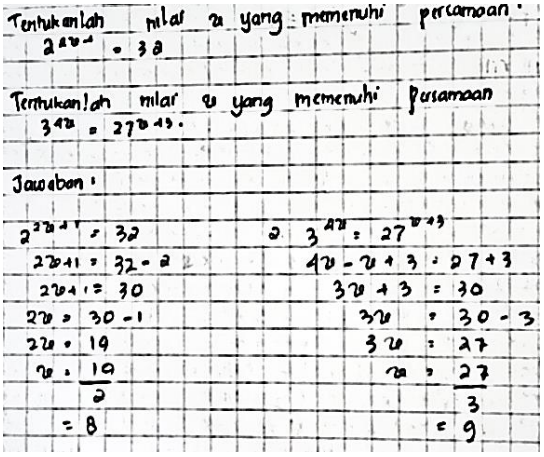

Figure 5. S5's answered

The answer of S5, which can be seen in figure 5, the student is asked to determine the value that meets the equation $2^{2x-1} = 32$ and $3^{4x} = 27^{x+3}$. In the answers that have been given, it can be seen that S5 misinterpreted the mathematical formulas and symbols used in solving the problem of the given exponential function.

When interviewed, students think that the existing base can be moved, and when it has been moved, the base will

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be lost, and only the exponents are left. When asked if it is true that such a solution is taught, S5 is silent and says that is all S5 can think about and write down when the test giving takes place.

This results are related with research of (Nurjanah & Sa'dijah, 2021), which states that students with low *self-efficacy* tend to expand the schematic representations they make to be used in determining the final outcome. In addition, in the study (Afriyani et al., 2019), it is said that the understanding and application of incorrect settlement procedures in symbolic representation is also one of the factors that cause the low representation power of students. Here, the representation used by S5 is incorrect, causing a settlement result that does not match mathematical rules.

From the results of the data analysis that has been carried out, it is known that 66.67% of students have a low mathematical representation, where this low mathematical representation is due to misrepresentation in solving a given problem. In addition, the intuitive errors used by students in solving problems are also the main trigger for students' low mathematical representation. Then the students' low understanding of the exponential function causes errors in students' mathematical representations.

The results of this study have been used by math teachers for class X MIPA 7 SMA Negeri 1 Ampek Angkek as a reference for further understanding the mathematical representation of class X MIPA 7 students. The results of this study are not general in nature and cannot be used for all middle schools, therefore it is necessary to conform the characteristics of schools, students and the environment for readers who will use the results of this study.

CONCLUSION AND SUGGESTION

Based on the results of the research, it is known that as many as 18 out of 27 students of X MIPA 7 have a low mathematical representation ability in solving the problem of a given exponential function. As for the interviews' result, it is known that students find it challenging to write down the idea of solving the problem that has been given and feel doubtful about the formula used so that in the process of solving the exponential function problem given, there are errors and even among them do not write down the answer because of the difficulty in writing down the solution idea they have. Students feel afraid to write down the wrong solution step because the solution idea in mind is different from how they are learned. Another known factor is that students feel that their thoughts and intuitions are the correct answer to the exponential function problem given, even though the answer is different from the solution taught by the teacher.

From these conclusions, the researcher suggests that in the learning process the teacher can provide various questions so that students are able to solve the questions easily. Then for students it is suggested to increase the number of varied problem practice so that they are more proficient in conveying the idea of the solution.

This research only focuses on describing students' low mathematical representation. Therefore, for researchers who want to carry out relevant research, it is advisable to examine the representation of students with high and medium abilities in order to complete this research.

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