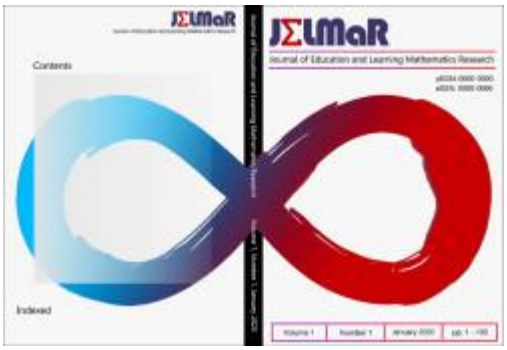

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Identification of High School Students' Success in Representing Logarithm Function Graphs

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***Abstract**: A visual presentation is a form of representation that helps students express the equations of logarithm functions. This is a qualitative descriptive study to identify the success of high school students in representing graphs of logarithm functions. Four students of SMA Hang Tuah 4 Surabaya became the research subjects. Data were collected through the researcher as the main instrument, TMGFL questions, and interview guidelines. The data were analyzed by researchers using the view points of the stages of translation of representation from verbal form to graphs. The subject's success in representing the graph of a logarithm function is based on the accuracy of reading the information, translating the equation into a simple form, determining the coordinates of the points traversed by the graph, connecting the points to form a graph, and verifying it. This study has a weakness, students who succeed in describing graphs of logarithm functions, for that further research is needed to identify the failures of students who do not succeed in representing logarithm functions and find solutions.*

Keyword: success, graph drawing, logarithm

INTRODUCTION

Logarithm is one of the materials studied at the high school level. Logarithms are studied to speeding up calculations, shortening the time in multiplying numbers that involve multiple digits. This material provides benefits in the fields of science and technology, such as in the field of chemistry as a form of expressing the concentration of hydronium ions (pH), determining the order of chemical reactions, measuring earthquake intensity, the magnitude of the brightness of stars, calculating the frequency of music, calculating compound interest, and many others.

Logarithms are useful for determining the power value of a base number or it can be said another way of expressing an exponent. The graph of the logarithm function is a form of presentation of the equation of the logarithm function. Visual understanding in recognizing, imagining, showing, and concluding is a procedure that must be mastered by students when visualizing it (Darmadi, 2015).

Research on drawing function graphs has been a topic of concern for researchers recently. Some of these studies include 2017 (Darmadi, Siregar), 2018 (Kurniawidi, Pratama, Priyati & Mampouw), 2019 (Anggraini & Rosyidi, Maulyda & Khairunnisa), 2020 (Magdalena). Each researcher places a graph of functions based on their point of view, such as student reasoning (Anggraini & Rosyidi, 2019), error identification (Darmadi, 2017; Maulyda & Khairunnisa, 2019), the learning process in the classroom (Magdalena, 2019;

Siregar, 2017), learning media (Kurniawidi, 2018; Pratama, 2018), scaffolding (Priyati & Mampouw, 2018).

From the previous study, it creates a gap to examine the success of students in representing the graph of a function, in this case the graph of a logarithm function. Illustrating a graph of a logarithm function is one of the indicators described in the basic competition in the logarithm subject matter.

Based on the observations at Hang Tuah 4 High School Surabaya, information was found that students often have difficulty in logarithm material. Students tend to memorize the properties of logarithms compared to understanding the basic concepts. As a result, when faced with different problem situations, students often experience confusion in solving them. For example, you are asked to describe the equation of the logarithm function $y = {}^{a}\log x$. Before solving it, students must identify the domain of the base and its numerus. The students' ability to identify these equations supports the success of graphing logarithm functions.

In addition, student success is also determined by determining the supporting points. The selection of points is an important concern considering that the selection of an inaccurate point will make it difficult for students to determine the point on the Cartesian coordinate plane. The more points that students can draw on the Cartesian plane, of course, the smoother the graph represented. The students' accuracy in identifying these stages are factors that support success in representing graphs of logarithm functions.

Students who succeed in representing graphs of logarithm functions can be said to be able to communicate functions in the form of graphic images (Rahmawati & Siswono, 2014; Roth & McGin, 1997). Furthermore, Leindhart (1990) explains that functions and graphs are two different representation systems. In fact, they are two systems that can be connected using a bridge, the translation of two different forms of representation (Boose, et al., 2014; Swastika, et al., 2018; 2020). So that the indicators of student success in representing the graph of the logarithm function are as follows.

Table 1. Indicators of successfull in drawing graphs of logarithm functions

Indicators	Description
Unpacking the source	Identify the given logarithm function information
Coordination preliminary	Determine the coordinates of the points forming the graph
Building the target	Gives a point on the Cartesian coordinate plane Connect the dots to form a graphic image
Determination of the equivalance	Verifying the graph

METHOD

This is a descriptive study with a qualitative approach to describe a natural phenomenon, the success of students in describing graphs of logarithm functions. This research was carried out in the even semester of the 2021/2022 academic year at Hang Tuah 4 High School Surabaya. The subjects in this study were four students who managed to describe the graph of the logarithm function correctly. In this case, the subject did not make errors such as procedural errors, operations, working steps, describing the Cartesian coordinate plane, and the resulting graphic image. The question used is a test question for representing a graph of a logarithm function (TMGFL).

The main instrument is the researcher herself, while the supporting instruments are TMGFL and interview guidelines. Data were collected through giving TMGFL questions and interviews to the subjects. Interviews were conducted to confirm the answers that the subject had written and explore findings that were not obtained from the answers to the TMGFL questions. The TMGFL questions given to the subject are as follows.

Given a logarithm function as follows $f(x) = \frac{1}{2}logx$!
Draw a graph of the function along with the steps you use!

The data analysis technique used consisted of reduction, data presentation, and conclusion drawing. Analysis of the data used using a representational translational point of view by Boose, et al. (2014).

RESULT AND DISCUSSION

36 students of SMA Hang Tuah 4 Surabaya were given TMGFL questions, then the results were analyzed. The results of this analysis and input from mathematics teachers related to communication skills were obtained by four subjects, i.e DAA, LI, MHPA, and GNM. The identification of the success of the subject in representing the graph of the logarithm function of each subject is described as follows.

1. DAA subject

When given a logarithm function TMGFL, DAA identifies the form of a given equation with respect to the given basis. Then change it to a power form, $x = 2^{-y}$ as an equation form known as DAA and is considered easy in doing calculations (unpacking the source). Next, DAA performs calculations by assuming the value of y and continues to get the value of x so that the points that are passed through the equation of the logarithm function are obtained. From the results of the interview, information was obtained that the subject had an understanding by doing so, it was possible to determine several point coordinates that helped him in forming a graph of the logarithm function (coordination preliminary). The results of DAA's work at this stage are presented in Figure 1 below.

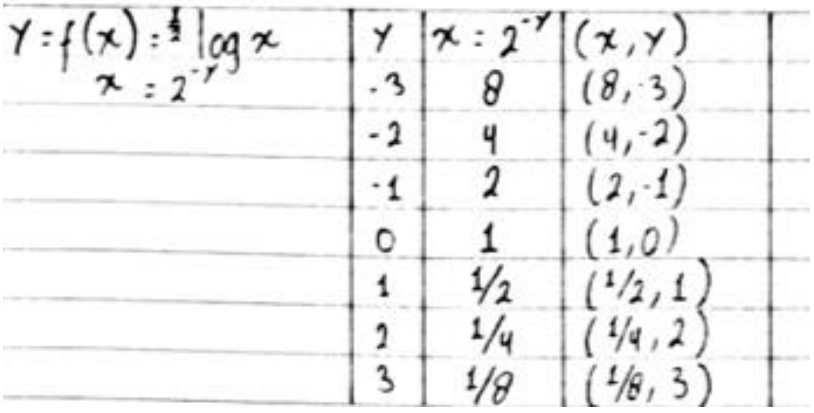

Figure 1 DAA results for unpacking the source and coordination preliminary

Determining the coordinates of a point, the subject immediately describes the point on the Cartesian coordinate plane. This activity is carried out by DAA alternately between determining the point and describing it on the Cartesian coordinate plane. After it is deemed sufficient, DAA connects the dots so that a graphic image is formed that corresponds to the initial image of the subject (building the target). To ensure that there are no errors in the process carried out, DAA checks the process of calculating and placing points on the Cartesian coordinate plane (determination of the equivalance). At the time of the interview, DAA revealed that the graph of the function was in accordance with the given problem situation. The results of DAA's work at this stage are presented in Figure 2 below.

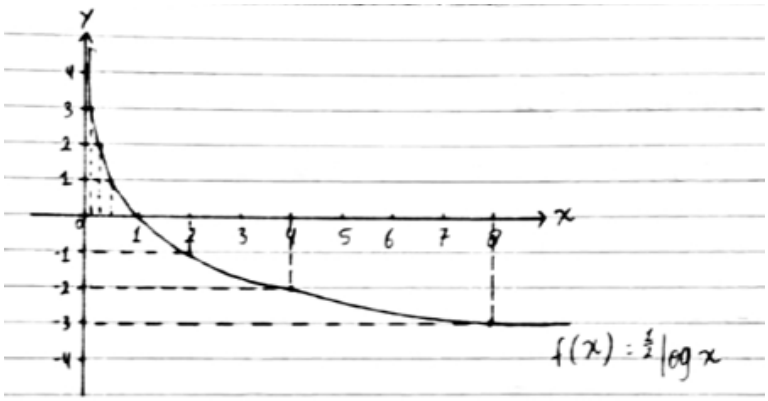

Figure 2 DAA results for bulding the target and determination of the equivalance

During the interview, DAA explained that the selection of points affects the smoothness of the graph depicted. DAA admits that there are no difficulties if the steps for describing the graph of the logarithm function are met.

2. LI Subject

The LI subject identified the logarithm function given to the TMGFL question concerning a given base. LI translated the form of a given logarithm function into a exponent form $x = 2^{-y}$ (unpacking the source). LI performs a calculation process to determine the points through which the logarithm function passes. LI begins by determining the value of y that is around the zero point and obtains the value of x so that the pairs become the points connecting the graph of the function. From the interview results, LI has an understanding that the coordinates of the points that help him in forming the graph image of the logarithm function (coordination preliminary). The results of LI's work at this stage are presented in figure 3 below.

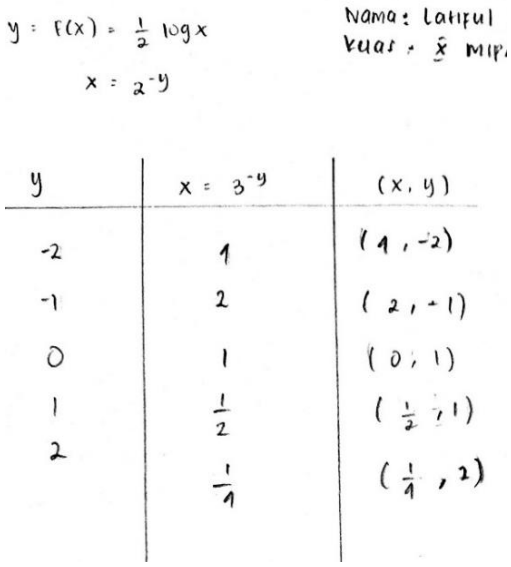

Figure 3 LI results for unpacking the source and coordination preliminary

The points obtained by LI are then represented on a Cartesian coordinate plane. From the results of the interview, LI believes that the points on the cartesius plane represented are the points that form the graph image of the logarithm function of the equation of a given function. Then, LI connects the points so that it forms a graph image according to the equation of a given logarithm function (building the target). After finishing connecting the specified points so as to form a graph, LI re-examines the process of

calculating and placing the points (determination of the equivalance). LI uses only five points so the graph represented is felt to be less smooth. However, LI believes the graph represented corresponds to the graph of the logarithm function given to the problem. The results of LI'S work at this stage are presented in Figure 4 as follows.

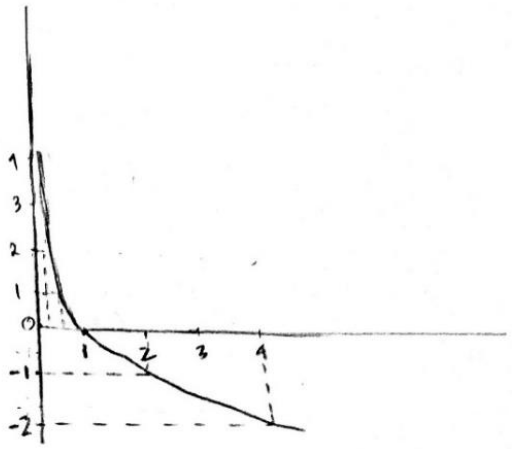

Figure 4 LI results for bulding the target and determination of the equivalence

3. MHPA Subject

MHPA is given the TMGFL problem of the logarithm function, after reading it then proceeds to identify the form of the given equation. MHPA focuses on the given base on the equation of the logarithm function and proceeds with the translational process of the equation. The first step taken by MHPA by changing to a form of rank is $\left(\frac{1}{2}\right)^{y}$ and translating into 2^{-y} (unpacking the source). From the results of the interview, MHPA assumes that if the calculation process using fractional form will definitely take a longer time. MHPA continues its work by performing calculations to determine the points contained in the logarithm function. The subject explains the points helping him in describing the graph (coordination preliminary). The results of the work of the MHPA at this stage are presented in the following Figure 5.

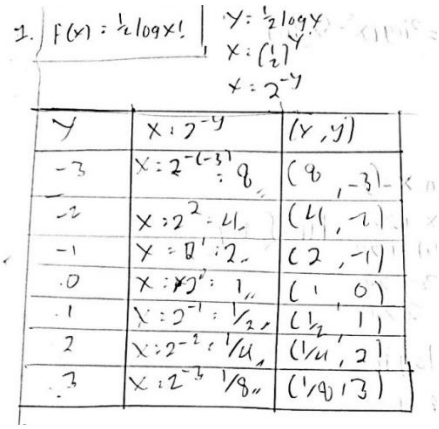

Figure 5 MHPA results for unpacking the source and coordination preliminary

Further activities are carried out by MHPA by describing points on the plane of cartesius coordinates. After all the points are sufficient, the MHPA connects each of these points so as to form a graph image of the logarithm function (building the target). To believe there were no errors in the process carried out, the MHPA examined the process of calculating and placing points on the plane of cartesius coordinates (determination of the equivalance). At the time of the interview, the MHPA revealed

that the graph image of the function was in accordance with the situation of the given question. The results of the work of the MHPA at this stage are presented in the following Figure 6.

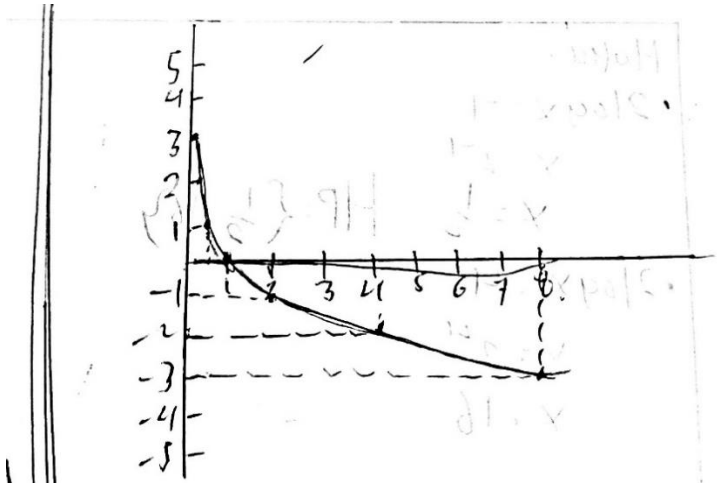

Figure 6 MHPA results for bulding the target and determination of the equivalence

4. GNM Subject

The GNM subject began to read and identify the logarithm function given to the TMGFL question. In this case, the GNM focuses on the basis of a given logarithm function. GNM translating the given form of the logarithm function into another form of logarithm $f(x) = 2^{-1}{}_{\log x}$ and translated again to $x = 2^{-y}$ (unpacking the source). The GNM performs a calculation process to determine the points through which the logarithm function passes. GNM begins by determining the value of y that is around the zero point and obtains the value of x so that the pairs become the points connecting the graph of the function. From the results of the interview, GNM has an understanding that the coordinates of the points that help it in forming a graph image of the logarithm function (coordination preliminary). The results of the LI's work at this stage are presented in the following Figure 7.

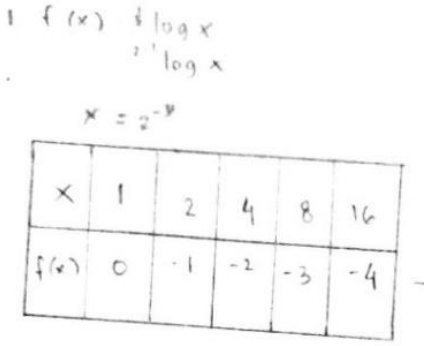

Figure 7 GNM results for unpacking the source and coordination preliminary

The points obtained by the GNM are then depicted on the plane of cartesius coordinates. GNM believes the points on the cartesius plane depicted are the points that form the graph image of the logarithm function of a given function equation. Then, the GNM proceeds to connect the points so that they form a graph image according to the equation of the given logarithm function (building the target). After finishing connecting the specified points so as to form a graph, GNM re-examines the process of calculating and placing the points (determination of the equivalance). GNM only uses

five points so the graph depicted is considered less smooth. However, GNM believes the graph depicted corresponds to the graph of the logarithm function given to the problem. The results of GNM's work at this stage are presented in Figure 8 as follows.

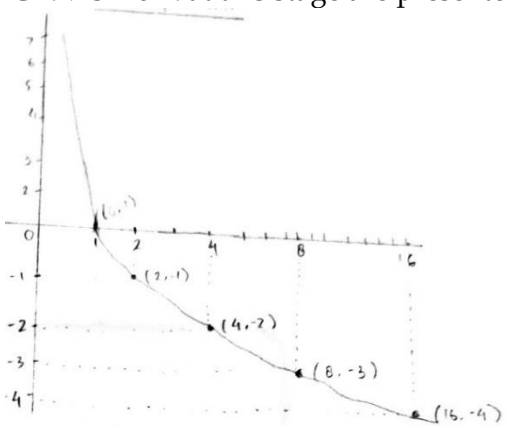

Figure 8 MHPA results for bulding the target and determination of the equivalence

Discussion

From the four subjects, it can be seen that subjects who manage to describe the function graph well certainly begin with good reading skills. Through reading, the subject is able to understand the situation of the problem, identifying information where all of them are cognitively influenced (Hart, et al., 2009; Mullis, et al., 2011). The subject of being able to understand the problem situation correctly is the key to success in solving the problem (Maharani & Kurniasari, 2016; Prayitno, et al., 2020). As a result, the subjects were able to identify the situation of the given problem, starting from determining the equation of the known logarithm function, determining the desired purpose of the problem properly. The activity of unpacking the source is the initial process of the subject in translating from symbols to graphs (Boose, et al., 2014; Swastika, et al., 2020).

After being able to determine the purpose of the problem, each subject translated the form of the logarithm function equation into a simple, easy-to-understand form. Subjects who have a good understanding of the concept of logarithms must immediately change into the form of rank so that they directly write $x = 2^{-y}$. However, the subjects of MHPA and GNM changed it first into another form of logarithm, then continued as a simple form of rank. This translation process is a process of translating symbols to symbols that support the problem-solving process (Ahmad, et al., 2020; Rahmawati, 2017; Swastika, et al., 2020). Each of the subjects argues that converting into the form of rank will help them in determining the points of the graph of the logarithm function.

The determination of the points through which the graph passes, begins each subject by setting the value of the ordinate y in advance. After the ordinat y is selected, then calculate the value of x so that dots are formed as shapers of the graph. The subject determines this way according to his own ideas, as Broodie (2010) conveys that subjects with categories like this are categorized as having mathematical reasoning. The selection of coordinate points that are getting tighter will certainly form a graph of logarithm functions that are smoother when compared to only a few coordinate points (Istiqomah, 2014). It's different if you use a special program to draw graphics, such as geogebra. Each subject determines the number of points according to his or her liking because each subject believes that the coordinate points he chooses are appropriate. The activity of the subject determining the coordinate point is an indicator of coordination preliminary that helps him draw graph of the logarithm function (Boose, et al., 2014; Swastika, et al., 2020).

From these points, the subject describes the coordinates of each point on the Cartesian coordinate plane. The subject believes that the points he makes are points that lie on the

graph of the logarithm function. Then the subject continues by connecting the points so that a smooth graph curve of the logarithm function is formed. Subjects who have many points certainly provide a more detailed visual experience than students who only take a few points (Nur, 2017; Rahmawati, 2017; Rahmawati & Siswono, 2014; Roth & McGin, 1997). At the representation translation stage, this activity is in building the target, which is a follow-up activity after making preparations in describing the graph of the logarithm function.

The last stage, the subject re-examined the graph of the logarithm function generated by re-examining the points that had been described (determination of the equivalance). Subjects have confidence that they did not make errors in manipulating the calculation process that was carried out after examining the process carried out. In addition, the subject also believes that the point is in accordance with the coordinates described. This checking process aims to verify the process that has been carried out so that it raises confidence from the answers given (Prayitno, et al., 2020).

CONCLUSION

The conclusion that can be drawn is that success in describing graphs of logarithm functions begins with (1) reading carefully the information on the given problem, (2) translating the equations of logarithm functions into exponents. It aims to make it easier for the subject to perform calculation operations in the form of an exponent compared to a logarithm form. (3) determine the coordinate points that represent the graph of the logarithm curve, (4) connect the points on the coordinate plane so that a graph of the logarithm function is formed according to the desired function equation, (5) verify the calculation process, the suitability of the point, and the graph of the logarithm function resulting from. From the results of this study, researchers suggest to teachers in the process of teaching to draw function graphs that involve students' mental processes about function graphs. In addition, it is necessary to further identify students who are not successful in describing graphs of logarithm functions as well as find solutions.

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