Representation of Trigonometry Graph Funcsion Colage Students Using GeoGebra

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ABSTRACT

This descriptive qualitive research aims to describe the forms of mathematics representation that appear among college students whom try to understand the relation between the change of trigonometry function coefficient and its graph through GeoGebra media. A class consists of 30 college students choosen as research subjects and they are given worksheets. From their work, it can be seen that there are 3 types of tendency of representation forms which is used by college students to solve their worksheet. From each type of tendency, a worksheet of student is choosen randomly for further investigation since it can represent others' work. The research result shows that college students represent GeoGebra view in 3 forms. They are verbal representation, mathematics expression representation, and visual representation.

1.   INTRODUCTION.

Representative ability is an ability that must be owned by everyone when they want to learn mathematics. NCTM (2000) has explained that each student must have at least five basic abilities in learning mathematics, namely; (1) Problem Solving, (2) Reasoning and Prove, (3) Communication, (4) Connection, (5) Representation. But not only for students, this also applies to students studying in college. The lecture process and courses in higher education are more complex, requiring students to have 5 basic abilities that have been formulated by NCTM. According to Hasan (2014), in learning mathematics students are required to have good reasoning and representation skills to construct the right problem solving model. Reasoning ability will support student performance in solving a problem. The ability of representation also plays a very important role in absorbing information on a problem before the right solution is determined.

Garderen (2003) states that representation ability is needed to understand a problem. Representation will determine the understanding students have when given information and problems. If students misinterpret a problem, the solution will also be wrong. This is in line with the research conducted by Maulyda (2017), which states that good representation ability will help a person to understand a problem. One of the basic material of mathematics that requires good representation ability, is material related to graphics (Suweken, 2011).

Based on the results of the Field Practice Lecture (KPL) conducted by researchers at the 2017 Mathematics Education maj-

or, students showed that students still had difficulty understanding graphs of trigonometric functions. In the graph of trigonometric functions there are 3 types of graphs of functions studied, namely, graphs of cosmetics functions, graphs of kocosus functions, and graphs of tangent functions (Royati, et.al, 2010). The three types of graphs of the function have the same general form of equations namely; A Trig (Bx + C) + D. Students must be able to convert trigonometric functions into graphical forms, so that it requires the ability of representation to understand the trigonometric functions provided.

One of the media that can be used to change functions into function charts is to use GeoGebra software. According to Soheila & Rosemaliza (2018), GeoGebra is a computer program (software) that is useful for mathematics learning, especially geometry and algebra. Function graphs are mathematical subjects that require skills in the fields of algebra and geometry. So that the use of GeoGebra software is expected to have a positive influence on the ability of students' mathematical representation. This is because in GeoGebra there is an algebraic, geometric and numerical display (Minarto, 2017). In addition, Qurnia, et.al (2018) also explained that through GeoGebra media mathematics learning would work well because it contained a variety of activities as a demonstration and visualization media and as a construction aid.

In previous studies, GeoGebra software was used to improve student learning achievement at the secondary school level on materials related to function graphics. As in the research conducted

by Minarto (2017) who used GeoGebra media to improve mathematics learning achievement of high school students. While Aksoy (2010) uses GeoGebra media to increase the interest and learning outcomes of junior high school students in Surakarta. But there is no research that looks at how a person's representation process when using GeoGebra learning media. Based on the explanation above, it is important to see how student representation when using learning media GeoGebra in understanding a graph of trigonometric functions.

2. RESEARCH METHOD

This research is a descriptive-qualitative study. This approach was chosen because the purpose of this study was to describe the process of student representation when using GeoGebra learning media on graph material in trigonometric functions. According to Creswell (2012) qualitative research is a research procedure that produces descriptive data in the form of written or oral words of observed behavior.

The location of the study was at the State University of Malang located on Jalan Semarang No.5, Sumbersari, Kec. Lowokwaru, Malang City. The research subjects were 30 students of the 2017 Mathematics Education Department. Of the 30 student work results, 3 student work results were chosen which could represent the results of all research subjects. Two selected subjects will be coded S1 and S2 to facilitate the analysis process. The two results of the student's work will be traced to the representation process that was carried out in solving the problem and strengthened by interviews conducted after students worked on the Student Worksheet (LKM) given. The representation indicators used are as follows:

Table 1. Indicator Representation

Aspect of Representation	Indicator
Understanding graphs of trigonometric functions	Students use verbal representations in understanding graphs of trigonometric functions (Y1). Students use mathematical expression representations to understand graphs of trigonometric functions (Y2). Students use visual representations to understand graphs of trigonometric functions (Y3).

The instruments used in this study are Student Worksheets (MFIs) and short interviews in an unstructured manner. The data source is the work of students in working on MFIs and the results of interviews conducted to strengthen the results of the study. The following are the questions contained in the MFI given to students:

Using Geogebra software, draw the following function graph:

a. $y = \cos x$,

b. $y = (\cos x) + 4$, dan

c. $y = (\cos x) - 4$

What is the position of the graph function point a with respect to point b, and point a with respect to point c? Explain!.

Based on the function graph shown in Geogebra, how does the constant D affect the function

$y = A \cos (Bx + C) + D$?

3. RESULTS AND DISCUSSION

The results of the work of 30 students who were given Student Worksheets showed that all students had understood the effect of changing coefficients on the function graph. This result is in line with the results of the research of Kutluca (2013) which states that GeoGebra will simplify the process of students' understanding of geometric graphs. But in representing the results of their work, students use different representations to show the results of their work. Based on the analysis conducted by researchers, the results of student work tend to be divided into 3 forms presented in the following diagram:
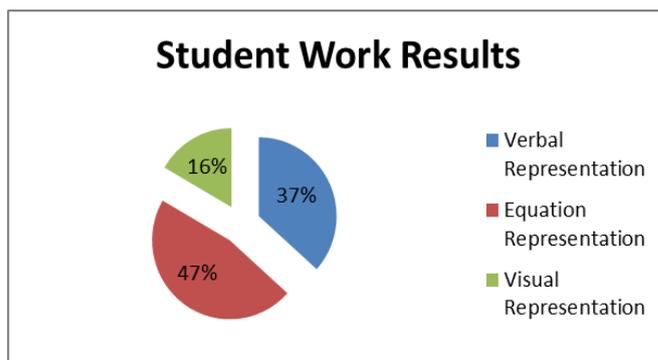

Figure 1. Diagram of Student Work Results

The diagram above shows that 11 students use verbal representations of writing, 14 students use mathematical expressions and only 5 students use visual representation. From these 3 trends, researchers chose 1 of each tendency to be discussed randomly. This is done because the researcher assesses that the work results of students can represent the results of other students' work on each trend. So that the researcher makes the subject code to be discussed, namely S1 for subjects who use verbal representation; S2 for subjects using mathematical expressions; and S3 for subjects using visual representation.

Before discussing the results of student work, the following are the results of displays in the GeoGebra software. The following Figure 2, Figure 3, and Figure 4 are the results for the Student Worksheet command on each of the points (a), (b), and (c);
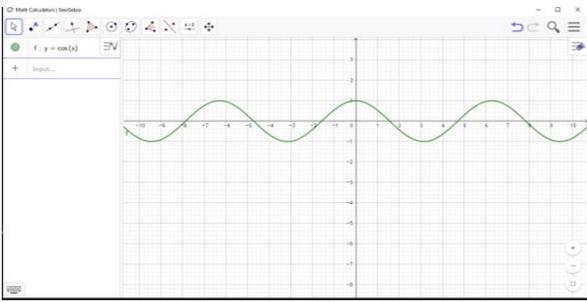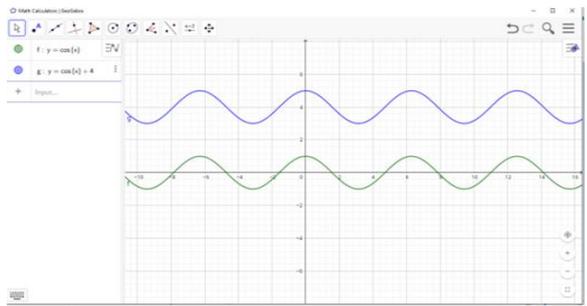
Figure 2. Geogebra display about point a
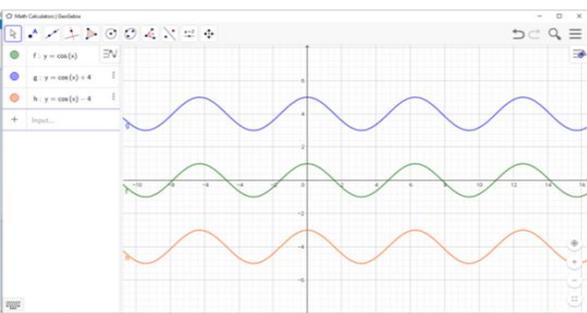

**Figure 3**. Geogebra's display of points b

Figure 4. Geogebra's display of points c

S1 Work Results

S1 subjects represented from 11 other subjects who used verbal writing representation to represent their understanding of changes in constant D on graphs of functions displayed in GeoGebra software. This data is contrary to the results of research by Paridjo & Waluya (2017) which states that students will use images or mathematical expressions to solve problems related to graphics, but S1 subjects use sentence descriptions to get the results of their representation. This can be seen in Figure 4 below:

Figure 5. S1 work results
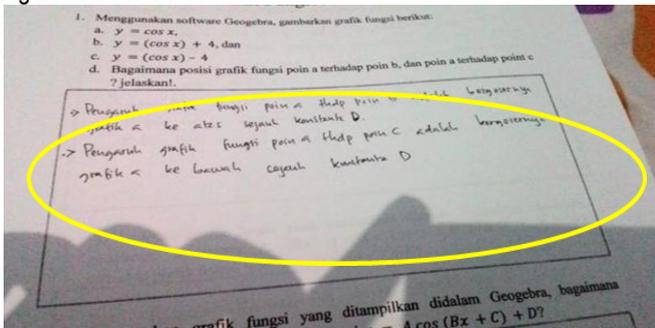
In Figure 5, it can be seen that S1 subjects describe verbally that the changes that occur in the trigonometric function graph are in the graph shift up or down as far as constant D. This shows that S1

subjects have understood the effect of changing constant D to the graph of its function. In addition, by answering points (d), S1 subjects have also demonstrated their understanding of graph changes from the function cos x to the functions cos x + 4 and cos x -4. In point (e) S1 subject also succeeds in making the conclusion that if constant D is positive (+) then the graph will shift upwards, otherwise if the D value is negative (-) then the graph will shift downward.

S2 Work Results

The S2 subject was representative of 14 other subjects who used representations of mathematical expressions to represent their understanding of changes in constant D on the graph of functions displayed in GeoGebra software. This data is in line with the results of research by Paridjo & Waluya (2017) which states that most students will use images or mathematical expressions to solve problems related to graphics. This can be seen in the following picture 6:
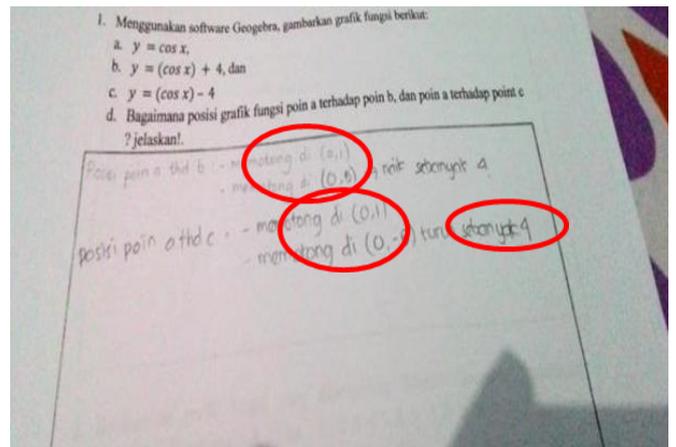

Figure 6. S2 work results

In Figure 6 it can be seen that the subject S2 expresses the results of his work using mathematical symbols to show that the changes that occur in the trigonometric function graph are in the graph shift up or down as far as constant D. According to the study conducted by Dindyal (2007) this mathematical expression will help the subject in expressing mathematical sentences that are read from the GeoGebra software, because the subject does not need to translate mathematical sentences verbally to express the results of his work. This shows that S1 subjects have understood the effect of changing constant D to the graph of its function. In addition, by answering points (d), S1 subjects have also demonstrated their understanding of graph changes from the function cos x to the functions cos x + 4 and cos x -4. In point (e) S1 subject also succeeds in concluding that if constant D is positive (+) then the graph will shift upwards, otherwise if the D value is negative (-) then the graph will shift downward.

S1 Work Results

S3 subjects are representatives of 5 other subjects who use written verbal representation to represent their understanding of changes in constant D on graphs of functions displayed in GeoGebra software. This data is in line with the results of research by Clement & Batista (1992) which states that most students will use images or mathematical expressions to solve problems related to graphics. Judging from the overall results, very few children use visual representation to express the results of their work. But through a

form of visual representation, graph changes will be easier to see. According to Arcavi (2003) a visual representation will be able to represent various forms of representation. These results are shown in the following figure 7:
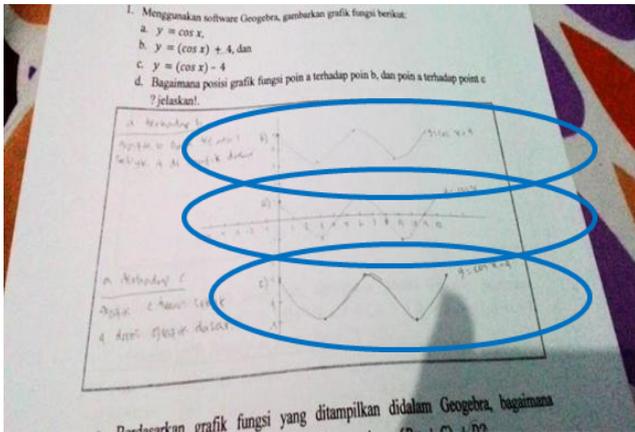

Figure 7. S3 work results

Figure 7 shows that students use image representation to solve problems. The image is a representation of the GegoGebra display which is the functional graph y = cos x, y = cos x + 4 and y = cos x -4. Based on the description given to support the image created, S3 writes "graph points (b) go up by 4" and "graph point (c) drops by 4". Although S3 does not make generalizations such as S1 and S2, S3 has been understood to understand the changes that occur when the D coefficient changes. This is in accordance with the research of Maulyda (2017) which states that image representation will be followed by verbal representation or mathematical expressions to support the images made.

4. CONCLUSION

Based on the results of research and discussion, it can be concluded that: (1) In representing the results of their work, students tend to use three forms of representation, namely a). verbal representation seen from representations in the form of sentences, b). representation of mathematical expressions seen from the use of mathematical symbols in representing Geogebra's appearance, and c). visual representation that can be seen from the form of graphic images made. (2) Mathematical expressions are the most widely used form of representation by students, while visual representation is the least used form of representation by students.

5. Acknowledgements

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