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USING GEOGEBRA TO ASSIST UNDERSTANDING IN TEACHING AND LEARNING REFLECTION

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Abstract

The concept of reflection in geometry is quite difficult to teach and so teachers often leave this concept out and move on to the next concept. This happens because the teachers are not capable of using creative teaching-learning techniques to promote the understanding of mathematics by students. Conceptually understanding reflections is one of the concepts in Mathematics which students are expected to master. It is likely that students, who understand a concept completely will show comprehension regarding the concept, be able to explain interrelation on concept and able to apply the concept or algorithm flexibly, accurately and efficiently for solving problems. GeoGebra is an IT program that can facilitate learning by students in order to lessen their difficulties in studying mathematics. This research was done with the purpose of studying the use of the GeoGebra Software for teaching-learning the concept of Reflection by students from grade XI at a Senior High School in Aceh. Based on the results from one-meeting where this software was used, it can be conclude that students' understanding about Reflections collectively averaged 88 % points, which is in the category of very good and individually some students scored 90 to 95 % points which is in the very good or excellent category. Meanwhile, based on the results from the questionnaire, 82.8% of the students were pleased to use the GeoGebra software program for studying the subject of Matrix Transformation or Reflections. However, from the group discussions many students still found it difficult to conclude and note down the characteristics of Reflections which showed a lack of ability to communicate about mathematics.

Keywords: *GeoGebra, mathematical understanding, reflections.*

INTRODUCTION

Understanding mathematics is a competence that has to be developed (National Council of Teachers of Mathematics, 2000). The purpose of learning mathematics in school is not merely to memorize formulae but it is expected that students will develop their understanding of mathematical concepts. According to Rudhito, *et al.* (2013), conceptual understanding means that students are capable of explaining a concept, applying the concept in various situations and getting some outcomes based on the existence of that concept. The National Council of Teachers of Mathematics (2000) has stated that the understanding of a mathematical concept can be seen from the ability to restate the concept that has already been learnt, the ability to classify objects based on the presence of pre-requirements needed to establish the concept, the ability to apply the concept in an algorithm, the ability to give an example related to the concept, the ability to provide the concept in the form of a different mathematical representation, the ability to relate various concepts

(internal and external mathematics) and the ability to develop requirements that are sufficient enough to form a concept.

Furthermore, Mashingaidze (2012) has noted that Transformations are a somewhat difficult topic in the beginner level mathematics syllabus. It usually comes towards the end of the syllabus, and as such the concept is either skipped or hurriedly done by most teachers of mathematics. Students and teachers, both, exhibit serious shortcomings in their understanding of transformations.

Daryanto (2010) has said that the media for learning must be familiar with every single thing that can convey the message from the source strategically arranged so that an appropriate and effective learning environment emerges and consequently lets the learner study efficiently and effectively. The media must not only be enjoyable but must also give some addition benefit or experience to the students and fulfil the needs of the students which are diverse. One medium that can lessen the difficulty students have in learning complex concepts is the use of computer programs. This is in accordance with the 2013 Curriculum (Permendikbud No. 59, 2014), which suggests that computers be used to provide a teaching-learning medium because the development of computer technology has had a huge influence on the world of education especially in mathematics. One of many software programs that can be used as a learning medium for mathematics, especially for geometry, is called GeoGebra. Hohenwarter (2008) has said that GeoGebra is a computer program designed for the study of mathematics especially for studying geometry and algebra.

Based on relevant research on the subject of the utilization of GeoGebra software to promote student learning, Widyaningrum and Murwanintyas (2013) have pointed out that the motivation and the results achieved by students who use GeoGebra in the subject Quadratic Equations are higher than those who do not use it. Other research conducted by Arbain and Nurbiha (2015) concluded that the mathematics learning process using GeoGebra offered a significant positive influence towards better results in Statistics. In addition, GeoGebra transfers positive perceptions to students so that they develop enthusiasm, confidence and encouragement. Along with that, Hohenwarter (2008) has noted that GeoGebra is very useful for both teachers and students. It can be obtained freely from this site, https://www.geogebra.org/. For teachers, GeoGebra provides an effective opportunity to create an interactive learning environment that will allow students to explore lots of mathematical concepts. Hohenwarter (2008) also added that a number of researchers have showed that GeoGebra can improve the ability of students for discovery and experimentation. The visual features very effectively help students in presenting various mathematical concepts.

Based on the background above, the research question that was examined was: "Can GeoGebra assist the understanding by students of the subject of transformations by reflection and what will be their responses regarding the characteristics of transformations by reflection which are assisted with GeoGebra?"

METHODS

This research was an investigation into the use of GeoGebra to assist the understanding by students of the mathematical concept of Reflection. It was an experimental research study which was conducted during a single meeting session. The indicators included in this research consisted of finding the transformation characteristics and matrix of reflection by using GeoGebra as directed on LAS. The sample for this research was selected by taking one class at random from all the grade XI science classes at one of the senior high schools in Lhokseumawe, Aceh on May 4th 2016. There were 28 students in the experimental class who were divided into 7 groups. Each group had to bring at least 2 laptops to class that had had GeoGebra installed. Before starting the research, the students had already been introduced to GeoGebra in the previous lesson, Translation.

To collect the data, the researcher used 3 instruments. They were student worksheets (*lembar aktivitas siswa*/LAS), a test and a questionnaire. The worksheets were provided to the students during the learning process and then a test was given at the end of the lesson to assess the students' understanding regarding the discoveries they had made. Afterwards, the questionnaires were distributed to find out the motivation of the students for learning using GeoGebra. The assessment column enclosing features for understanding mathematics is shown in Table 1, overleaf:

Table 1. Assessment column of mathematical understanding which was obtained from the student's answers on the worksheets.

No	*Criterion*	*Score*
A1 & B1	Be able to make a polygon on the GeoGebra screen in accordance with the given reflections and to write down all the coordinate points that exist in the table for results from making observations.	2
	Able to make a polygon on the GeoGebra screen in accordance with the given reflections and to write down some coordinate points that exist in the table for results from making observations.	1
	Unable to make a polygon on the GeoGebra screen in accordance with the given reflections.	0
A2 & B2	Writing down all the conclusions and characteristic of the reflections based on observations.	2
	Writing down some conclusions and some characteristic of reflections based on observations.	1
	Did not write down any conclusions and/or characteristic of reflections based on observation.	0
A3 & B3	Found matrix transformation reflections from the given mathematical concepts.	1
	Unable to find matrix transformation reflection from the given mathematical concepts.	0
A4 & B4	Checking all coordinate points into an intended matrix transformation reflection.	2
	Checking some of the coordinate points into an intended matrix transformation reflection.	1
	Do not check any coordinate points into an intended matrix transformation reflection.	0
A5 & B5	Wrote down all the conclusions from all the group discussions about the matrix transformation reflections.	2
	Wrote down some of conclusions from some group discussions about matrix transformation reflections.	1
	Do not write down any conclusions from any group discussions about matrix transformation reflections.	0

Scores that were obtained from the results from the table above were categorized based on Permendikbud No. 104 (2014), see Table 2, below:

Table 2: Criteria of students' mathematical understanding.

Score %	*Category*
86 - 100	Very Good (A)
70 - 85	Good (B)
59 - 69	Satisfactory (C)
< 59	Lacking (D)

The questionnaire for the students had 7 statements and was analysed based on a Likert scale. The indicators for answers to the questionnaire were score 5 for 'strongly agree', score 4 for 'agree', score 3 for 'satisfactory', score 2 for 'disagree' and score 1 for 'strongly disagree'.

RESULTS AND DISCUSSION

Based on the students worksheets, it was found that students understanding on the subject of reflection in group study was in the *very good* category with a criteria of A, average score 88. This is in accordance with research by Xenia and Pantazia (2013) who have stated that GeoGebra can be used by teachers to develop new techniques for connecting, intensifying and enriching mathematics teaching-learning activities that consequently improve student understanding of mathematical concepts.

Based on the test of mathematical understanding that was given at the end of the lesson, it was shown that:

1. Students' understanding about the characteristics of reflection was 97%
2. Students' understanding about matrix transformations towards the y axis was 93%
3. Students' understanding about matrix transformations towards the x axis x = k was 97%.

Overall, the average score in the test from the 28 students was 95%. This means that individually, the students were in the *very good* category for understanding about reflections after using the GeoGebra software program.

Based on the results from the questionnaire, the responses of the students towards the learning process using the GeoGebra program were as shown in Table 3 that follows:

Table 3. Results from questionnaire.

No.	*Statements*	*Response*					
		1	*2*	*3*	*4*	*5*	*Average*
1.	I like using GeoGebra software.			3	19	6	4.11
2.	GeoGebra helped me understand the transformation reflection concept.			2	14	12	4.36
3.	I feel comfortable studying with GeoGebra.		2	4	12	10	4.07
4.	I was able to think creatively, to do matrix transformation reflections by using the GeoGebra program.			7	13	8	4.04
5.	I learned a lot about reflections when using the GeoGebra program.			2	15	11	4.32
6.	I am pleased that the teacher used GeoGebra for the teaching-learning of mathematics.		1	4	14	9	4.11
7.	GeoGebra gave me more motivation to learn about mathematics.		1	5	16	6	3.96
Average Response							4.14

Description:
1. Not Good/Disagree
2. Not So Good/ Disagree a little
3. Fair Enough/Passable
4. Good/Agree
5. Very Good/Very strongly Agree

Based on the data and the *rating scale* the overall average obtained was 4.14 (82.8%) which is in the category of good/agree. In general, based on the questionnaire it can be concluded that after following the learning process using discovery learning with the assistance of GeoGebra, the students showed more interest, were more eager and more motivated during the learning process using GeoGebra. This result is also in line with previous research conducted by Arbain and Nurbiha (2015) who noted that teaching-learning using GeoGebra gives a positive influence to the achievements by students and it also develops their sense of enthusiasm, confidence and encourages them to learn mathematics.

Students' Comments

Based on their written comments, the students got more benefits in learning with the assistance of GeoGebra. The following are some of their comments:

- *Learning using GeoGebra is much more interesting and helps me to get used to IT. I think this learning must be applied in all schools so that our knowledge about IT is widened and it also attracts students attention toward Mathematics because Mathematics is actually fun.*
- *In my opinion, using GeoGebra software in class in quite interesting, practical and easy. GeoGebra also has very good features in its program especially for learning about reflection in mathematics. I can understand the difference between a real object and its shadow after being reflected.*
- *GeoGebra makes the learning process more efficient and eco-friendly, no need to use pencil and paper; GeoGebra makes it faster to determine coordinates.*
- *Awesome. Not only did it help us to make transformations for reflection but it also motivated other students to learn by using technology such as computer programming. This is good and necessary so that we will not just use computers for games but they can help us in learning too.*

Thus, the GeoGebra software was very useful and it made the students more enthusiastic in getting information because they had to try to seek and find the matrix transformation by themselves.

CONCLUSIONS

With the assistance of GeoGebra, the students in grade XI at a senior high school were able to learn the concepts of reflection in mathematics very well. Results from the Questionnaire showed that 82.8% of the students used GeoGebra for the discovery of matrix transformation or reflection although some students still had difficulty in writing their conclusions about reflections that were obtained in the group discussions which showed signs of poor ability to communicate about mathematical concepts. Collectively, the understanding about reflections by the students in the experimental group got an average score of 88 which is in the category of very good and individually some students got scores of 90 to 95 within is in the category of very, very good or excellent (over 90).

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