The Effectiveness of Software GeoGebra to Improve Visual Representation Ability

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Abstract. GeoGebra is a mathematical software that supports learning mathematics to make it easier to visualize geometric shapes. Geography software can create geometric images that are 2 dimensional or 3 dimensional so that GeoGebra can help students to represent real geometric shapes. This research aims to view the effectiveness of GeoGebra software in improving students' visual representation ability. This study used a one-group pre-test/post-test design pre-experiment. The sample in this ability were students of eight grades SMP Negeri Sukoharjo who studied the material of flat-sided building. The instruments used in this study were the pre-test with and post-test of mathematical representation abilities. The results showed that there was an effectiveness of using GeoGebra in improving students' visual representation skills with the difference in the mean score of students after being given GeoGebra treatment was 61.3 for the pre-test and 70.5 for the post-test.

1. Introduction

GeoGebra is a mathematical software designed by combining several branches of mathematics such as calculus, algebra, and geometry [1-3]. Points, lines, vectors, shapes can be shown in a dynamic graphic representation in the software [4,5]. GeoGebra software be expanded by Markus Hohenwarter in 2001 is very easy to practice learning and easy to use because it can be downloaded at www.geogebra.org and free [6].

GeoGebra is a computer program that functions as a tool for visualizing mathematical concepts that are useful as a medium for learning [7]. GeoGebra is very useful as a medium for learning mathematics with a variety of activities as follows [8]: (1) As a demonstration and visualization medium, in which teachers can use GeoGebra to visualize and demonstrate certain concepts mathematics, (2) As a construction aid. GeoGebra is able to visualize a construct of mathematical concepts, for example, constructing the outer and inner circles of a triangle, or to construct tangents; (3) As a tool for the discovery process. GeoGebra is used to assist students in finding a mathematical concept, for example, the position of the points or the characteristics of a parabola. Students’ mathematical understanding can be improved by using GeoGebra software [9].

GeoGebra can make mathematics learning media because it has several interactive alternative applications [4]. At this time, learning mathematics using computer technology has been widely practiced. GeoGebra plays a role in achieving various student competencies. Several studies have been conducted, and the results state that GeoGebra software is an effective learning medium [10]. Besides, GeoGebra can improve basic mathematical concepts and mathematical content [11,12].

GeoGebra can assist students in the process of problem-solving or problem solving through reasoning [13]. GeoGebra is also able to facilitate the process of abstraction from the situation between geometric
models and algebraic models [14]. GeoGebra can also assist students in investigating and representing geometry [15].

As explained above, one of the uses of GeoGebra is being able to help study geometry. The integrated GeoGebra helps students to better reflect how to find parts in a difficult geometry [16]. GeoGebra can also assist students in investigating and representing geometry [15]. Zengin said the ability of representation is one of the mathematical abilities that students must master in learning mathematics [16] because representation is indispensable for students and is related to communication skills and problem-solving abilities [17-21]. Mathematical representation is the depiction, translation, disclosure, reappointment, symbolization or even modelling of ideas, ideas, mathematical concepts, and the relationships between them which are contained in a configuration, construction or specific problem situation presented by students, which students will get clarity and show understanding or find a solution to the problem it faces [22]. One of the factors that affect students' mathematical representation ability is the use of instructional media that supports students in visualizing or representing the mathematical problems presented. This is in accordance with research [23] that using technology-based learning media will facilitate the learning process so that it can improve the quality of learning and can improve students' mathematical representation skills.

A flat-sided space consisting of cubes, blocks, prisms and pyramids is an example of geometry. This material requires sharper visualization to understand it, and teacher learning usually only focuses on calculations such as finding area, volume or surface area. Mathematics teachers should support the development of technology because they have representations in the form of visuals, graphs, diagrams, tables, numeric and verbal because technology is more effective than just direct learning [24]. Many studies show that representations can help students understand concepts more quickly than simply through text [25]. The indicator of the ability of visual mathematical representations used in this study is to use visual representations to solve problems and create pictures to clarify problems and facilitate their solutions. This study is focused on seeing the effectiveness of using GeoGebra software in supporting students' visual representation abilities.

2. Method
This research is a quantitative research with a pre-experimental design in the form of one-group pre-test-post/test design, that is a group that was given treatment with a pre-test before treatment and post-test after treatment [26]. The research was conducted at SMP Negeri 2 Sukoharjo with the population being all grade VIII students of the 2019/2020 school year. Sampling with a cluster random sampling technique and selected 30 students of class VIII A as the sampling class.

The data collection technique used was a written test. This data collection is done by giving a pre-test before learning and post-test after using GeoGebra in learning. The test instruments used were the description test of the flat shape material for the pre-test, and the test of the flat shape material for the post-test, both of which have been validated by experts. So that the pre-test and post-test questions can be used to measure students' visual representation skills. Visual representation indicators used in this study are to use visual representations to solve problems, and create pictures to clarify problems and facilitate their solutions. Testing the effectiveness using the mean difference test (paired-t test) on paired data, but previously had to meet normal requirements. Normality testing uses the Lilliefors method. The normality test is used to determine whether the sample comes from a population with a normal distribution or not.

3. Result and Discussion
This study aims to determine the effectiveness of GeoGebra software utilization on students' visual representation ability in the material of flat-sided shapes. The results of the normality test are shown in Table 1.
Table 1. Results of the pre-test/post-test data normality test

| Group   | The number of students | \( L_{obs} \)  | \( L_{table} \) | Test Decision                                      |
|---------|------------------------|-----------------|-----------------|---------------------------------------------------|
| Pre-test| 30                     | 0,139           | 0,161           | \( H_0 \) was accepted (Samples from normally distributed populations) |
| Pos-test| 30                     | 0,088           | 0,161           |                                                   |

Based on Table 1, it is found that the \( L_{obs} \) for the sample in the pre-test and post-test groups do not exceed \( L_{table} \). Based on the critical area standard, namely \( DK = \{ L | L > L_{0.05;30} \} \), then \( L_{obs} \notin DK \), so that the \( H_0 \) test decision is accepted, which means that each sample comes from a normally distributed population. After the population is normally distributed, the effectiveness test can be carried out. The effectiveness test used the paired-t test on paired data. The paired-t test results can be seen in Table 2.

Table 2. Paired-t test results

| Result  | Value   | N  | Variance | \( t_{obs} \) | \( t_{0.05;29} \) | Decision   |
|---------|---------|----|----------|----------------|-----------------|------------|
| Pre-test| 1838,89 | 30 | 368,95   | 2,64           | 1,69            | \( H_0 \) was rejected |
| Post-test| 2116,67 |     |          |                |                 |            |

The results of hypothesis testing are in Table 2 with the calculation results of \( t_{obs} = 2,64 \) with \( t_{0.05;29} = 1,699 \). Based on the critique area standard, namely \( DK = \{ t | t > t_{0.05;29} \} \), then \( t_{obs} \in DK \), then the \( H_0 \) test decision is rejected. This means that students’ post-test results are better than students’ pre-test results. Based on these calculations, it can be concluded that the use of GeoGebra software on the flat side space material is effective to use.

Furthermore, Figure 1 will be shown for pre-test questions with flat shape material and Figure 2 with material on flat-sided shapes for post-test questions on the visual representation abilities that have been given to students.

It can be seen in Figure 1 and Figure 2 that the question is a question to quantify of visual representation ability. In Figure 1, it refers to the indicators making pictures to clarify the problem and facilitate the solution. In this question, some sentences are given that tell about a garden that has a predetermined size and has a pond and a saung that has the same size. The problem that arises is that students are asked to make complete pictures and their measurements. Students are asked to take pictures to solve existing problems. Whereas in Figure 2 it refers to indicators using visual representations to solve problems. In this question, several names of flat-sided shapes are given and several images of spatial nets (cubes, blocks, prisms, and pyramids), then students are asked to match the names of the spatial shapes with the nets in the choice.
There is a garden in the shape of a rectangle measuring. In every corner of the garden a bamboo hut is made. Meanwhile, in the middle of the park a fish pond is built, the rest is planted with grass.

Draw a sketch of the park and its measurements!

Figure 1. Students' visual representation ability pre-test questions

Furthermore, for examples of exploration in using GeoGebra software, it can be seen from Figure 3 to Figure 5 below.

Figure 2. Problem post-test students' visual presentation ability

Figure 3. Cubes and beams with diagonal planes
Figure 3 shows a cube and a block with each diagonal area. Because this GeoGebra software has a demonstration of rotating a plane up to 360°, it enables students to see the diagonal plane from various directions. So that it makes students understand more about the diagonal plane. Next to Figure 4 is a cube-shaped 3D, while Figure 5 is a grid of cubes from the previous image. In a visual representation, students will find it easier to imagine the shape of flat-shaped nets. For Figure 6, there are various kinds of n-sided prisms whose nets are being opened. In visual representation, students be better can imagine and better grasp the kinds of webs from various shapes.

The overall results of the calculation and analysis of GeoGebra on students' visual representations show that there is effectiveness, which shows that GeoGebra can improve students' visual representation skills. The results of the calculation show that there is a mean difference in the comparison of the results of the pre-test and post-test students' representation ability, and according to the results of descriptive statistics, it shows that the post-test results are higher than the pre-test results. GeoGebra software is one of the technological developments in many branches of mathematics. In the study [27] it was concluded that GeoGebra can be used in secondary schools and is an effective software for learning geometry, representations can be generated from GeoGebra [28], in visual terms and numerical, like as calculations, geometric figures, graphs, equations, and tables [29]. Considering its influence on certain materials, [30] stated that users of GeoGebra software can explore various kinds of representations of a mathematical concept.

4. Conclusion

Based on the results of research in class VIII SMP Negeri 2 Sukoharjo, it is obtained an illustration that the use of GeoGebra software can improve students' visual representation skills. From the calculation of the paired-t-test, the result is $t_{obs} = 2.64$, with the decision that the $H_0$ test is rejected. This means that students' post-test results are better than students' pre-test results. Based on these calculations, it can be concluded that the use of geogebra software on the flat side space material is effective to use.
Based on the research results, the ability of visual representation increased after the use of GeoGebra software. This research implies that teachers should use more technology for learning mathematics so that students’ mathematical abilities can improve and students are not bored with conventional learning.

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