Visualisation Ability of Senior High School Students with Using GeoGebra and Transparent Mica

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Visualisation Ability of Senior High School Students with Using GeoGebra and Transparent Mica

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Abstract. Visualisation ability is an ability to process, inform, and transform object which suitable for geometry topic in math. This research aims to describe the influence of using software GeoGebra and transparent mica for student’s visualisation ability. GeoGebra is shortness of geometry and algebra. GeoGebra is an open source program that is created for math. Transparent mica is a tool that is created by the author to transform a geometry object. This research is a quantitative experiment model. The subject of this research were students in grade XII of science program in Annajah Senior High School Rumpin with two classes which one as an experiment class (science one) and another one as a control class (science two). Experiment class use GeoGebra and transparent mica in the study, and control class use powerpoint in the study. Data of student’s visualisation ability is collected from posttest with visual questions which are gifted at the end of the research to both classes with topic “transformation geometry”. This research resulted that studying with GeoGebra and transparent mica had a better influence than studying with powerpoint to student’s visualisation ability. The time of study in class and the habit of the students to use software and tool affected the result of research. Although, GeoGebra and transparent mica can give help to students in transformation geometry topic.

1. Introduction
In mathematics, there are so many topics such as algebra, logic, calculus, and geometry. This geometry topic is as same as with some ideas of National Council of Teachers of Mathematics (NCTM). The standard of geometry topic is to analyze the characteristic and feature D-2 and D-3 and to develop mathematics argument about geometry connection, establish location, and describe the spatial connection with using geometry coordinates and other representation system, doing transformation and using symmetrical to analyze the mathematics situation, and using visualization, spatial thinking, and geometry model to solve problem. Based on that standards, visualisation and spatial thinking are a primary skill in geometry topic [1].

In case, teachers and parents still think that visual thinking or visual ability is just limited in arts. In geometry topic at school, start with mathematics conceptual comprehension until problem-solving was almost used counting concept. However, if we saw NCTM’s standards, there was another alternative way to solve geometry problems that are exercise student’s visualisation ability to understand lessons in a different way.

Howard Gardner divided intelligence into some kinds [2], one of them is visual/spatial intelligence. This visual intelligence can be trained and developed in geometry topic to solve geometry problems by using visualisation ability. Mental Imagery and Human-Computer Interaction Laboratory or called
“Imagery Lab” is a lab which is built by Kozhevnikov [3] and her friends did the research and developed many things about education and education media. One of their research is about visualisation ability. They divide visualisation ability into two sections, spatial visualisation and object visualisation. Spatial visualisation is an ability to process visual information about spatial relations between objects or their parts and perform mental spatial transformations and manipulations. Object visualisation is an ability to process visual information about appearances of objects and scenes regarding their pictorial properties (e.g., shape, colour and textures).

To develop the using of this visualisation ability, one of the indicator is the using assist tools in study geometry topic [1]. In this era, the technology especially computer is very needed to help people in many activities [14]. One of the software which can be used to help teachers and students in geometry topic is GeoGebra. GeoGebra is an open source and dynamic mathematics software in one easy-to-use package which can be used for learning and teaching at all levels of education [6][7]. It joins interactive 2D and 3D geometry, algebra, tablets, graphing, calculus, and statistics [4][5]. GeoGebra facilitates the creation of mathematical constructions and models by students. It allows interactive exploration by dragging objects and changing parameters that can be useful to develop visualisation ability in geometry topic. Later, NCTM said about direct using of geometry tools, so in this research, we add transparent mica that can be used by students to understand the process while transformed geometry objects. This transparent mica has excess in price, cheap, light, and easy to use [9][10] to give an image process of geometry transformation by the students directly.

Furthermore, the research problems of the study were as followed, how influence GeoGebra and transparent mica was, how students activities were, how test result of experimental class and control class compared. Then, considered on the research resulted that there is a positive influence of spatial ability towards student’s achievement in math [11]. So, the researcher tries to more exercise this visual/spatial ability with using various tools. So we research the influence of using GeoGebra and Transparent Mica to visualisation ability of Senior High School students.

2. Material and Methods

This research is a quantitative experiment model. The subject of this research were students in grade XII of science program in Annajah Senior High School Rumpin-Bogor with two classes which one as an experiment class (science one) and another one as a control class (science two). The students of experiment class were 20 students, and the students of control class were 30 students. Experiment class used GeoGebra and transparent mica in the study, and control class used powerpoint in the study.

The researcher arranged study plan, chose a school, asked permission letter, looked for a teacher to give some advice and guidance, and prepared to learn instruments. The learning instruments have validated by author’s lecturers. Data of student’s visualisation ability is collected from posttest with visual questions which are gifted at the end of the research to both classes with topic “transformation geometry”. All question of visualisation ability posttest have validated by five math teachers with content validity ratio (CVR), with CVR formula [12]:

\[
CVR = \frac{n_e}{N} \frac{N}{2}
\]

With \(n_e\) = expert who said “essential”, and \(N\) = how many experts

The experimental stage did 8 times for learning and 1 times for doing a visual test. The students in experiment class and control class divided into some groups to make all of the students can participate in active learning and the students can help other students to understand the lesson. Both classes were divided into some group with 3-4 students/group. In experiment class, each group used 1 notebook to study with GeoGebra and transparent mica.

3. Result and Discussion

Based on research by Hohenwarter resulted that GeoGebra can be used in classrooms to explore basic calculus concepts, research by Widyaningrum and Murwanintyas resulted that GeoGebra made a better influence on student’s motivation and score [8] and research by Tambunan resulted that spatial
ability made a better influence to student’s score [11]. So in this research, researcher combined GeoGebra and transparent mica to find out this tools influence to student’s visual/spatial ability.

The experimental stage began with the using of GeoGebra and transparent mica in experiment control while study and using powerpoint in control class. The experimental stage did 8 times for learning and 1 time for doing a visual test. The topic for this research was “Transformation Geometry” in twelve classes. While studying, the students in experiment class and control class divided into some groups to make all of the students can participate in active learning and the students can help other students to understand the lesson.

Both classes were divided into some group with 3-4 students/groups. In experiment class, each group used 1 notebook to studied with GeoGebra and transparent mica. At the first time, the researcher gave them module how to use GeoGebra step by step to solve transformation geometry problems like translation, rotation, reflection, and dilatation. They confused to used GeoGebra because they never used the software in math, but step by step they tried to learn it and got better to used it. They used GeoGebra to made dot, polygon, and line. Then they tried to transform it with translation, reflection, rotation, and dilatation.

Beside of using GeoGebra, they used transparent mica to transformed object geometry directly. They could transform object geometry step by step so they could understand what the main purpose of transformation geometry. They could see how dot, polygon, or line is moving from the first position to transformed position. This activity with used GeoGebra and transparent mica could train their visualisation ability. They could try to solve transformation geometry problems without used counting formula.

After the students had been given treatment, at the end the students were given a test with twelve questions about visualisation ability, and they must answer it with pictures like dots, shapes, or lines. Some answers were chosen for the most answers from each class which appropriated with kinds of transformation geometry.

1-Translation

**Question:** “ΔPQR is a translation from ΔABC by \( T = \left( \begin{array}{c} -5 \\ 4 \end{array} \right) \), draw ΔPQR!”

![Figure 1. The Most Answers in Experiment Class (A), Control Class (B)](image)

2-Reflection

**Question:** “Draw a reflection of line-a toward line y=x as a line-b!”
Figure 2. The Most Answers in Experiment Class (A), Control Class (B)

3-Rotation
Question: “If line-a was rotated by 180° towards central point (4,2) results line-b, draw the line-b!”

Figure 3. The Most Answers in Experiment Class (A), Control Class (B)

4-Dilatation
Question: “If dilatation polygon ABCD toward a central point (0, -2) with scale 2 results polygon WXYZ, draw the polygon WXYZ!”

Figure 4. The Most Answers in Experiment Class (A), Control Class (B)

Based on all answers of the students, Figure 5 was the data recapitulation of visualisation ability scores by experimental class and control class.
Figure 5A showed that coefficient slope 0.41 (slightly right slope), and sharpness 2.95 (platykurtic curve). Because the coefficient slope was positive, it means the student’s score were still many below the average. Figure 5B showed that coefficient slope 0.31 (slightly right slope), and sharpness 3.29 (leptokurtic curve). Because the coefficient slope was positive, it means the student’s score were still many below the average. Then the difference between experiment class and control class can be seen in Table 1.

Table 1. The Difference Between Experiment Class and Control Class

| Class       | Experiment | Control |
|-------------|------------|---------|
| Amount of students | 20         | 30      |
| Maximum ($X_{\text{max}}$) | 82.61      | 58.70   |
| Minimum ($X_{\text{min}}$) | 34.78      | 26.09   |
| Average ($\bar{x}$) | 52.10      | 38.90   |
| Median (Me) | 50.30      | 38.17   |
| Modus (Mo)  | 46.25      | 36.64   |
| Varians     | 169.67     | 51.97   |
| Standard deviation | 13.03     | 7.21    |
| Slope       | 0.41       | 0.31    |
| Sharpness   | 2.95       | 3.17    |

Table 1 showed that the highest score was in experiment class and the lowest score was in control class. The experiment class had range 47.83 from the maximum score to minimum score. The control class had range 32.61 from the maximum score to minimum score. As we can see, because the range score of experiment class was longer than control class, it made variance and standard deviation of experiment class higher than control class. The spreading scores of both classes can be seen in Figure 6.
Figure 6. The Spreading Scores of Both Class

Figure 6 showed that many students of experiment class had scores between 30 – 60, whereas many students of control class had scores between 30 – 45. Figure 1, 2, 3 and Table 1 showed that visualisation ability score of experiment class which studied with GeoGebra and transparent mica were better than control class which studied with powerpoint. However, with just this data, we cannot conclude that visualisation ability of students who used GeoGebra and transparent mica were better than students who used Powerpoint. So researcher did a statistical test like normality test, homogeneity test, and hypothesis test [13]. The normality test result was presented in Table 2.

Table 2. Normality Test Result

| Class    | n  | $\chi^2_{\text{count}}$ | $\chi^2_{\text{table}}$ | Conclusion |
|----------|----|-------------------------|---------------------------|------------|
| Experiment | 20 | 6,225                   | 7,815                     | Normal Distribution |
| Control | 30 | 2,645                   | 7,815                     | Normal Distribution |

Table 2 showed that normality test with chi-square $\alpha= 0.05$ and df= 3 resulted both classes had normal distribution because of both $\chi^2_{\text{count}} < \chi^2_{\text{table}}$. Because both classes had a normal distribution, then researcher did next test. The next test is homogeneity test, and the result was presented in Table 3.

Table 3. Homogeneity Test Result

| Class    | n  | Varians | $F_{\text{count}}$ | $F_{\text{table}}$ ($\alpha=0.05$) | Conclusion |
|----------|----|---------|-------------------|---------------------------------|------------|
| Experiment | 20 | 169.674 | 3.26              | 1.96                            | Not homogeny |
| Control | 30 | 51.972  |                   |                                 |            |

Table 3 showed that homogeneity test with Fisher $\alpha= 0.05$, df numerator = 19 and df denominator = 29 resulted that this class was not homogeny because of $F_{\text{count}} > F_{\text{table}}$. Because it was not homogeny, then researcher did next test. The next test is hypothesis test with normal and not homogeny type, and the result was presented in Table 4.

Table 4. Hypothesis Test Result
Table 4 showed that hypothesis test with normal and not homogeneity type \( \alpha = 0.05 \) and \( df = 19 \) resulted that average of experiment class which studied with GeoGebra and transparent mica was better than average for control class which studied with powerpoint. It means GeoGebra and transparent mica can make positive influence toward student’s visualisation ability.

4. Conclusion

Considered on the purpose of the study that has been explained, the using of tools such as a computer, visual model must be maximised to help various students, especially in geometry. The teachers are supposed to create learning activity and use tools that is adjusted with student’s ability or learning style. So, the schools and teachers can try to use this GeoGebra and transparent mica as alternative tools to create learning activity that more variation. According to these whole research, One of the tools that can be used in geometry to help or develop visualisation ability was GeoGebra or transparent mica.

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