

STUDENT'S VISUAL THINKING ABILITY IN LEARNING LINEAR PROGRAMS USING GEOGEBRA ASSISTED LIVEWORKSHEETS

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Abstract

This research aims to describe students' visual thinking abilities when learning linear programming using LiveWorksheets assisted by GeoGebra for class XI students at SMA Negeri Ngoro. This research uses a quasi-experimental method with the research design used is Pre-Test Post-Test One Group Design. And the data analysis technique used is descriptive and inferential analysis. The sample for this research was 21 students of class XI IPA 3. The results of this research using descriptive analysis showed that students' visual thinking abilities increased after being taught with GeoGebra. This can be seen from the difference in the increase in pre-test and post-test scores obtained. In the "Looking" stage there was an increase of 9.86, in the "Seeing" stage there was an increase of 22.38, in the "Imagining" stage there was an increase of 19.05, and in the "Showing and Telling" stage there was an increase of 35.24. Meanwhile, inferential analysis using the t-test also shows that there is an influence of using GeoGebra on students' visual thinking abilities. This can be seen because the Sig value obtained is 0.001 which is smaller than 0.05.

Keywords: visual thinking ability, linear programs, geogebra

Abstrak

Penelitian ini bertujuan untuk mendeskripsikan kemampuan berpikir visual siswa pada pembelajaran program linear dengan menggunakan LiveWorksheet berbantuan GeoGebra pada siswa kelas XI SMA Negeri Ngoro. Penelitian ini menggunakan metode eksperimen kuasi dengan desain penelitian yang digunakan adalah Pre-Test Post-Test One Group Design. Dan teknik analisis data yang digunakan adalah analisis secara deskriptif dan inferensial. Sampel penelitian ini adalah 21 siswa kelas XI IPA 3. Hasil penelitian ini secara analisis deskriptif diperoleh bahwa kemampuan berpikir visual siswa meningkat setelah diberikan pengajaran dengan GeoGebra hal itu dapat dilihat dari perbedaan kenaikan nilai pre-test dan post-test yang diperoleh. Pada tahap "Looking" mengalami kenaikan sebesar 9.86, tahap "Seeing" mengalami kenaikan sebesar 22.38, tahap "Imagining" mengalami kenaikan sebesar 19.05, dan pada tahap "Showing and Telling" mengalami kenaikan sebesar 35.24. Sedangkan analisis inferensial dengan menggunakan t-test juga menunjukkan adanya pengaruh penggunaan GeoGebra terhadap kemampuan berpikir visual siswa hal ini dapat dilihat karena nilai Sig yang diperoleh 0.001 lebih kecil dari 0.05.

Kata kunci: kemampuan berpikir visual, program linear, geogebra

INTRODUCTION

Thinking is a person's mental activity that usually arises when someone faces a problem or difficulty and needs a solution to solve it (Aini & Hasanah, 2019). Thinking can also be interpreted as a method for generating new mental representations through the process of changing information with mental involvement, such as judgment, solving a problem, and imagination with a more complex interaction process (Trisnawarni & Yunianta, 2021). Therefore, thinking is a mental representation of a person to solve a particular problem.

Every human being has a different way of thinking. According to Swords (Permani, 2019). There are three main ways of thinking that connect the brain's abilities and processes, namely auditory thinking, visual thinking, and kinaesthetic (Sholihah & Maryono, 2020). Of the three ways of thinking, one of the most interesting ways of thinking for students to use in the learning mathematics is visual thinking. As stated by Thornton (A. C. Kusuma et al., 2020) that the ability to think visually (visual thinking) is important for students because visual thinking is an activity of representing (visualizing) a situation or concept in learning mathematics with a simpler, easier, more flexible and very powerful approach to developing solutions and problem-solving. Visual thinking also has an important role in solving mathematical problems that require high reasoning so that students will have no difficulty understanding concepts (Trisnawarni & Yuniarta, 2021). Visual thinking is also related to how students represent their thinking skills in visualization in a concrete form. Visualization in learning mathematics is very necessary in understanding and presenting mathematical solutions related to visual problems.

On research (Sholihah & Maryono, 2020) revealed that there were students who could not fulfill the indicators of visual thinking, namely in translating information from a diagram or graph, presenting and interpreting problems (or concepts) graphically, and understanding mathematical transformations visually. Previous researchers also found that the result of inappropriate visual representations resulted in students experiencing limitations and difficulties in solving problems, making diagrams, reading graphs correctly, and difficulties in understanding mathematical concepts and solving mathematical problems (Indriani et al., 2020). The facts discovered by Surya (Diharto et al., 2021) also revealed that less than 25 percent of junior and senior high school students could visualize their thoughts. With the facts that illustrate the lack of students' visual thinking skills, a solution is needed to overcome them. One of them is by using Geogebra as a learning medium in mathematics.

So far, visual thinking is accommodated by using learning media in the form of learning videos, power points, and teaching aids, which are used in research to support and see the process of solving mathematical problems (A. C. Kusuma et al., 2020). Research conducted by Rama Yunita et al., shows that visual thinking is only facilitated by the development of learning tools such as Teacher Books (BG), Student Books (BS), Learning Implementation Plans (RPP), and Student Activity Sheets (LAS) (Arvianto & Ardhana, 2020; Rama Yunita et al., 2020).

GeoGebra is a mathematical software that can be used in learning mathematics to help students visually understand abstract mathematics (Simbolon, 2020). Geogebra is also software that is very easy to use and has complete features that can visualize objects so it can be used as an alternative learning media that can help develop students' visual thinking skills (Dhoruri et al., 2021). Using Geogebra will make it easier for students to visualize the settlement area in a linear program to determine the optimum value, which is usually indicated by determining the probe line in its completion (Y. J. Kusuma et al., 2020).

Several previous studies related to the use of geogebra in mathematics learning were used to examine students' abstract thinking skills, measure student achievement, develop learning media, and solve practical problems (Latifi et al., 2021; Qohar, 2022; Roskaputri et al., 2021; Shabanova et al., 2020). As for the use live worksheets as e-modules that can be used for independent learning, to increase student learning outcomes, measure mathematical problem-solving abilities, understand mathematical concepts, and train students' critical thinking skills (Amalia & Lestyanto, 2021; Haqiqi & Syarif, 2021; Prastika & Masniladevi, 2021; Rasuh, 2021; Rohmah, 2022).

By seeing that visual thinking is very important for students to have, as well as the low ability of students' visual thinking and the use of learning media that is still insufficient to support students' visual thinking, research will be carried out which aims to describe students' visual thinking skills in learning linear programming with GeoGebra assisted liveworksheets.

METHODS

Types of Research

This research uses a quasi-experimental method with the research design used is Pre-Test Post-Test One Group Design. This research was conducted on a research sample, namely the experimental group which was given a pre-test and post-test. The research design used can be seen in Figure 1.

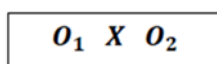


Figure 1. Pre-Test Post-Test One Group Design

O_1 = Pre – Test

X = Treatment

O_2 = Post – Test

Research Subject

The subjects of this research were 21 class XI MIPA 2 students of Ngoro State High School. Class XI students were chosen because the material to be used in the research was at the class XI high school level.

Data and Data Collection

The data used in this research is students' visual thinking data. Visual thinking data is obtained through essay tests. The test used is in the form of pre-test and post-test descriptive questions. The pretest was given before the learning process in this research began, while the posttest was given after the learning process was completed. The pre-test is given with the aim of seeing students' initial abilities. And the post test was given with the aim of finding out the extent of the influence of the learning provided on improving students' abilities, seeing whether there were significant differences in abilities between the students in the class.

Research Instrument

The test sheet given is in the form of essay questions that contain visual thinking skills. The test sheet has been validated by mathematics lecturers and mathematics subject teachers, and the results obtained are valid. Test sheets are given to determine students' visual thinking abilities.

Data Analysis

The data analysis technique used in this research was carried out using descriptive and inferential analysis. Descriptive analysis was carried out to describe the situation before and after treatment for students' visual thinking abilities, using the average and standard deviation formula. Next, categories are created with the following conditions: 1) high category if the data is more than and equal to the average plus the standard deviation, 2) medium category if the data lies between the average minus the standard deviation and the average plus the standard deviation, 3) low category if the data is less than the average minus the standard deviation. Next, inferential analysis was carried out to see whether there were differences in students' visual thinking abilities after being given treatment using the paired data t-test formula or what is called a pre t-test, after the data met the t-test requirements, normality.

RESULTS AND DISCUSSION

Results

The data analysis in this section describes students' visual thinking abilities before and after being given treatment. A total of 21 students were involved in this research. The average results of the pre-test and post-test show that students' visual thinking abilities after being taught geogebra increased after being given treatment. The average pre-test result obtained was 42,85, while the average ppost-test was obtained at 65, which means the average post-test was greater than the pre-test. A complete presentation of the data is presented in Table 1.

Tabel 1. Data Description of Pre-Test adn Post-Test Visual Thinking Ability

Group	Mean	Std.Deviation
Pre-Test	42.85	7.34
Post-Test	65	5.76

Based on Table 1. The Student's visual thinking ability of pre-test data obtainde a mean score of 42,85 and std. Deviation of 7.34. At the same time, the post-test data of student's visual thinking ability obtained a mean score 65 and std. Deviation 5.76.

From this data then use the average plus std. deviation then the student is in the high category, and if the average is subtracted from the std.deviation then the student is in the low category, and if it is in between then the student is in the medium category, can be seen in Table 2.

Tabel 2. Results Criteria for Visual Thinking Ability

Category of Students Visual Thinking Ability	Number of Students (Person)		Presentage (%)	
	Pre-Test	Post-Test	Pre-Test	Post-Test
High	5	7	23	33
Medium	3	8	14	38
Low	13	6	63	29
Amount	21	21	100	100

Based on table 2. The results of this research include analysis of the total score of answers from 21 students which were collected based on the overall score obtained from all indicators of the visual thinking stage. There are 3 main groups identified in this research, namely high, medium and low groups, based on students' visual thinking abilities.

(1) Students who have high visual thinking abilities, in the pre-test there are 5 students with a percentage of 23% and in the post-test there are 7 students with a percentage of 33%, (2) Students who have visual thinking abilities are in the medium category, in the pre-test there were 3 students with a percentage of 14% and in the post-test there were 8 students with a percentage of 38%, (3) while students who had visual thinking skills were in the low category, in the pre-test there were 13 students with 63% and in the post-test there were 6 students with a percentage of 29%.

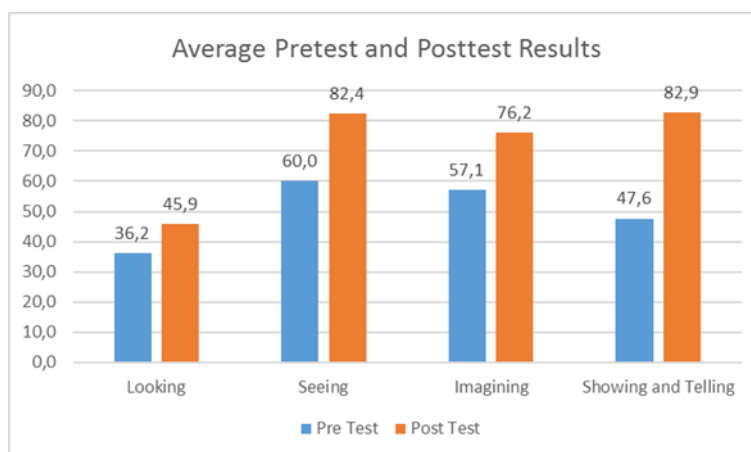


Figure 2. Pre-Test and Post-Test Average Score

Based on Figure 2. The significant difference between visual thinking abilities before and after treatment is also reflected in the average pretest and posttest results for each indicator of critical thinking skills. The following is a comparison of the average pretest and posttest results for each stage of visual thinking ability.

The "Looking" stage shows a difference of 9.68. This indicates a significant increase in students' visual thinking abilities after treatment. The "Seeing" stage shows a difference of 22.38. This indicates a greater improvement in visual thinking abilities at this stage after treatment. The "Imagining" stage shows a difference of 19.05. These results indicate that students experienced a significant increase in visual thinking abilities at this stage after treatment. The "Showing and Telling" stage shows a difference of 35.24. This shows the most significant improvement in visual thinking ability at this stage after treatment.

Tabel 3. Output Normality Test

Class	Shapiro-Wilk		
	Statistic	df	Sig.
Pre-Test	0.916	21	0.072
Post-Test	0.924	21	0.105

Based on Table 3. It can be seen that the pre-test significance score (0.072). While the significance score of the post test (0.105). All data has a sig score > 0.05 , so the pre-test and post-test data for visual thinking ability are declared to be normally distributed. After the normality test is fulfilled, the t-test is carried out; the result for visual thinking ability are presented in Table 4.

		Paired Sample Test		
		t	df	Sig.
Pair 1	Pre-Test Post-Test	-3.839	20	0.001

Based on the calculation in Table 8, it can be seen that the sig score is 0.001. The sig score is less than 0.05, meaning that there was a difference between visual thinking ability before and after being given treatment.

Discussion

Based on research on students' visual thinking abilities in learning linear programs using live worksheets assisted by Geogebra. The results of this research are data on students' visual thinking abilities obtained through pre-test and post-test test instruments. The average results of the post-test show that students' visual thinking abilities after being given treatment by teaching geogebra increased. This shows that students' visual thinking abilities from the post-post test results are better than the pre-test results. In the "Looking" stage, students can collect and identify the core of the problem, where at this stage there is an increase of 9.86. In the "Seeing" stage, students were able to sort out problems and group them, increasing by 22.38. In the "Imagining" stage, students were able to determine solutions and recognize problems, which increased by 19.05. And at the "Showing and Telling" stage, students were able to explain what they had learned and communicate it, at this stage an increase of 35.24 was obtained. This means that the use of geogebra can improve students' visual thinking abilities. This is in line with research conducted by (Azizah et al., 2021; Subakti & Listiani, 2022).

GeoGebra is an application that allows students to actively describe mathematical concepts, visualize relationships between variables, and better understand geometry concepts (Fauziah, 2023; Kurniandani Rosaida, Agus Setiyadi, 2022; Rahadyan et al., 2023; Silva et al., 2023; Surgandini et al., 2019). Additionally, GeoGebra enhances the teaching and

learning of geometry, improves learners' interest and motivation, and increases students' academic performance. GeoGebra enables interactivity in learning, allowing students to actively participate in creating graphs, designing models, and changing parameters to see their impact (Putra et al., 2023; Zutaah et al., 2023). This interactive nature of GeoGebra motivates students to be more involved in the learning process (Silva et al., 2023). As well as the effectiveness of using GeoGebra with GeoGebra features such as points, lines, algebraic input, and pens that can be easily used to improve learning and activate indicators of mathematical visual thinking abilities and this also shows that students have experienced consistent improvements in their visual thinking abilities (Mendonça et al., 2023). Overall, GeoGebra is an effective tool for mathematics education, which has features such as points, lines, algebra input, and pen that can be used easily to enhance learning and activate students' visual thinking indicators, as well as allowing students to actively engage with mathematical concepts and develop their understanding of graphing solution areas in learning geometric linear programming and other mathematics topics.

The use of GeoGebra has a significant impact on students' visual thinking skills, as evidenced by the differences between the average pre-test scores obtained and the average post-test scores obtained for each respective indicator. These results indicate that the treatment given to students has had a significant positive impact on their visual thinking abilities at every stage (Wilis et al., 2023). Additionally, a study found that GeoGebra was effective in improving their visual representation skills, especially in representing real geometric shapes. These findings suggest that GeoGebra can be a valuable tool for improving students' visual thinking abilities in mathematics (Asare & Atteh, 2022).

CONCLUSION

Research shows that there is a significant difference between the results of the post-test and pre-test on students' visual thinking abilities. This is shown by the results of a significance value of <0.05 in the Paired Sample t-test so that there are differences before and after learning using GeoGebra. Students' visual thinking abilities before learning using GeoGebra had a fairly low average score. Judging from the post-test results of teaching using GeoGebra in learning linear programming on the visual thinking abilities of class XI Ngoro State High School students, it has a good influence. For further research, it is hoped that this can be studied more broadly and examine students' visual thinking more deeply.

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