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The Effect of Mathematics Learning with the Creative Visualization Technique on the Geometry Ability Level of Students at SMP Islam Wonopringgo

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ABSTRACT

Students often face difficulties in understanding geometric concepts, particularly in the Pythagorean theorem as well as in plane and solid geometry, necessitating innovation in teaching methods. This study aims to examine the effect of problem-based mathematics learning using the Creative Visualization technique on improving the geometry skills of eighth-grade students at SMP Islam Wonopringgo, based on Van Hiele's theory. The study employed a quasi-experimental method with a pretest-posttest control group design. The sample consisted of two purposively selected classes: the experimental class, which received instruction using the Creative Visualization technique, and the control class, which followed conventional teaching. The research instrument was a geometry skills test based on Van Hiele's five levels of geometric thinking. The results showed a significant difference in the improvement of geometry skills between the two groups. Students in the experimental class showed more significant progress, particularly at the analysis and informal deduction levels. Thus, the Creative Visualization technique is proven to be effective in enhancing students' geometry skills and can be considered an alternative method in geometry instruction.

ABSTRAK

Kesulitan Siswa dalam memahami konsep geometri, khususnya pada materi teorema Pythagoras maupun pada materi bangun datar dan bangun ruang, mendorong perlunya inovasi dalam metode pembelajaran. Penelitian ini bertujuan untuk mengkaji pengaruh pembelajaran matematika berbasis pemecahan masalah dengan teknik Creative Visualization terhadap peningkatan kemampuan geometri Siswa kelas VIII SMP Islam Wonopringgo, berdasarkan teori Van Hiele. Penelitian ini menggunakan metode kuasi-eksperimen dengan desain pretest-posttest control group. Sampel terdiri dari dua kelas yang dipilih secara purposive, yaitu kelas eksperimen yang mendapatkan pembelajaran dengan teknik Creative Visualization dan kelas kontrol dengan pembelajaran konvensional. Instrumen penelitian berupa tes kemampuan geometri berdasarkan lima tahap berpikir Van Hiele. Hasil penelitian menunjukkan adanya perbedaan signifikan dalam peningkatan kemampuan geometri antara kedua kelompok. Siswa di kelas eksperimen mengalami peningkatan yang lebih signifikan, terutama pada tahap analisis dan deduksi informal. Dengan demikian, teknik Creative Visualization terbukti efektif dalam meningkatkan kemampuan geometri Siswa dan dapat dijadikan metode alternatif dalam pembelajaran geometri.

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INTRODUCTION

According to Zainal (2020), geometry plays an important role in the secondary school mathematics curriculum due to the various geometry concepts contained within it. Psychologically, geometry represents visual and spatial experiences in an abstract form, such as measurement patterns and mapping. From a mathematical perspective, geometry provides solutions in problem-solving (Zainal, 2020). In addition to helping solve problems in various branches of mathematics, geometry is also effective in developing students' logical thinking abilities. However, the reality in the field shows that many students still face difficulties in understanding geometry concepts, particularly the material on flat-sided solids (Rahmawati, et al., 2022).

According to Lusyana & Lestari (2022), students' difficulties in understanding geometry are closely related to their level of geometric thinking. Students can only understand the material according to their thinking level, as explained in the Van Hiele theory. This theory divides the learning process of geometry into five levels of thinking: 0 (visualization), 1 (analysis), 2 (ordering/informal deduction), 3 (deduction), and 4 (rigor/precision) (Cesaria, et al., 2014). Therefore, teachers need to understand students' thinking levels in order to design lessons that match their cognitive needs.

One challenge in teaching geometry is that teachers tend to teach using a memorization approach rather than conceptual understanding. This leads to low visualization skills in students, as the memorization method fosters verbality, where students recognize terms and formulas but fail to understand their meaning and application in real contexts (Cesaria, et al., 2021). To address this issue, one technique that can be used is Creative Visualization. This technique involves the use of imagination to create mental images in an effort to solve problems, and it has been proven to enhance students' visual thinking abilities (Gawain, 1978).

In previous research, Roberts and colleagues highlighted the importance of designing visualization activities based on the interaction between teachers and students, as well as the importance of clear learning objectives. The lack of visual literacy in students is often caused by the absence of concrete teaching goals

(Roberts, et al., 2019). By utilizing the Creative Visualization technique, it is expected that students will improve their geometric visualization abilities, which in turn will contribute to an enhancement in their understanding and creativity in solving mathematical problems (Susanto, 2019; Fayesa et al., 2023).

Although research on creative thinking abilities and geometric visualization has been widely conducted at the high school and elementary school levels, there is limited research targeting middle school students. Additionally, previous studies often used physical teaching aids in the learning process. This study will use Geogebra software technology as a learning tool to improve the geometry abilities of students at SMP Islam Wonopringgo. Based on observations during teaching practice, it was found that the geometry abilities of students at this school were still relatively low, which makes this study relevant and necessary to examine how the Creative Visualization technique can improve their abilities. To provide a clearer picture of this, the following table presents the geometry scores of students observed during the teaching practice.

Table 1. Geometry Scores of Students during Teaching Practice

NO	NAME	SCORE	NO	NAME	SCORE
1	X1	70	17	X17	60
2	X2	60	18	X18	40
3	X3	50	19	X19	50
4	X4	65	20	X20	80
5	X5	50	21	X21	60
6	X6	70	22	X22	75
7	X7	60	23	X23	60
8	X8	65	24	X24	55
9	X9	60	25	X25	65
10	X10	65	26	X26	45
11	X11	70	27	X27	60
12	X12	65	28	X28	55
13	X13	55	29	X29	75
14	X14	50	30	X30	35
15	X15	75	31	X31	50
16	X16	55	32	X32	80

This study aims to determine the pattern of development in students' geometry skills and whether there is a significant difference in the improvement of skills between students using this technique and those using conventional learning

methods. Thus, this study is expected to contribute to the development of more effective teaching methods to improve students' geometry skills, as well as address the gap between ideal conditions and the reality of mathematics learning in the field.

METHOD

This study uses a quantitative approach with a quasi-experimental method to examine the effect of problem-based mathematics learning with the Creative Visualization technique on students' geometry skills (Gopalan, et al., 2020). The research design involves two groups: the experimental group using the Creative Visualization technique and the control group receiving conventional learning. Data were collected through pre-tests and post-tests to measure students' geometry skills before and after the treatment.

The pre-test was conducted in both groups before the learning began to assess students' initial abilities. After the learning process, a post-test was administered to measure the improvement in students' geometry skills based on the five levels of geometry thinking in Van Hiele's theory, which include visualization, analysis, informal deduction, formal deduction, and rigor.

Data analysis was performed using a t-test to compare the pre-test and post-test results in both groups, to determine if there were significant differences between the group receiving learning with the Creative Visualization technique and the group receiving conventional learning. In addition, normality and homogeneity tests were conducted to ensure that the data were normally distributed and the variances of both groups were homogeneous, as a requirement for conducting the t-test.Tables and Figures are presented center, as shown below and cited in the manuscript.

RESULTS AND DISCUSSION

This study was conducted in the eighth-grade classes of SMP Islam Wonopringgo with two groups: the control class (VIII B) and the experimental class (VIII A), each consisting of 32 students. The control class followed the conventional teaching method, while the experimental class followed problem-based learning using the Creative Visualization technique. Data were collected through pre-tests

and post-tests to evaluate the development of students' geometry skills. The students' scores were then categorized based on Van Hiele's theory, which classifies students' understanding of geometry into five levels: Level 0 (visualization), Level 1 (analysis), Level 2 (informal deduction), Level 3 (formal deduction), and Level 4 (rigor)(Cesaria, et al., 2014).

The pre-test data show that the initial geometry skills of students in both classes were almost equivalent. The average pre-test score in the control class was 46.72, while in the experimental class it was 46.56. After the learning process, a significant improvement was observed in both groups, with the experimental class showing a higher increase.

Table 2. Results of Descriptive Statistical Test

Descriptive Statistics

	N	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Pre-Test Eksperiment	32	30	75	46,56	12,011
Post-Test Eksperiment	32	55	85	72,66	9,157
Pre-Test Control	32	30	70	46,72	11,116
Post-Test Control	32	40	85	63,91	11,759
Valid N (*listwise*)	32				

From the table above, it can be seen that the average post-test score in the experimental class increased more significantly compared to the control class. The average post-test score in the experimental class reached 72.66, while in the control class it only reached 63.91. The smaller standard deviation in the experimental class indicates that the score improvement in this class is more evenly distributed.

To measure the effectiveness of the treatment, an N-Gain analysis was used, which measures the difference between the pre-test and post-test scores. The results show that the improvement experienced by the experimental class was more significant compared to the control class. The N-Gain analysis results show that the average gain score in the control class was 0.3276 or 32.76%, which falls into the moderate category. Meanwhile, the experimental class had an average gain of

0.4869 or 48.69%, which falls into the moderate-high category. This indicates that learning using the Creative Visualization technique is more effective in improving students' geometry skills compared to conventional methods.

Before conducting the t-test, normality and homogeneity tests were performed to ensure that the data was normally distributed and homogeneous. The normality test results showed that the pre-test and post-test data for both classes were normally distributed, and the homogeneity test results indicated that the variance between the two groups was equal. Subsequently, a t-test was conducted. The t-test was used to test the hypothesis of whether there was a significant difference between the post-test results of the control class and the experimental class.

Table 3. Results of the Independent Sample t-test for Control and Experimental Classes

Independent Samples Test				
			Equal variances assumed	*Equal variances not assumed*
Levene's Test for Equality of Variances	*F*		2,705	
	Sig.		,105	
t-test for Equality of Means	*t*		-3,321	-3,321
	df		62	58,487
	Sig. (2-tailed)		,002	,002
	Mean Difference		-8,750	-8,750
	Std. Error Difference		2,635	2,635
	95% Confidence Interval of the Difference	*Lower*	-14,017	-14,023
		Upper	-3,483	-3,477

The results of the Independent Sample t-test in Table 2 show a t-value of -3.321 with a significance value of 0.002. Since the significance value is less than 0.05, it can be concluded that there is a significant difference between the post-test results of the control class and the experimental class. Therefore, it can be concluded that the Creative Visualization technique is significantly more effective in improving students' geometry skills compared to conventional teaching methods.

Furthermore, the development of students' geometry skills was analyzed based on Van Hiele's theory, which classifies students' geometric understanding into five levels: visualization, analysis, informal deduction, formal deduction, and rigor.

Table 4. Pattern of Geometry Ability Development in Experimental and Control Classes

Pre-test Level	*Post-test level*	Experiment Class Development	Number of Students
Level 1	Level 2	Increased by 1 level	3 Students
Level 1	Level 3	Increased by 2 level	10 Students
Level 1	Level 4	Increased by 3 level	1 Students
Level 2	Level 2	No increase	1 Students
Level 2	Level 3	Increased by 1 level	11 Students
Level 2	Level 4	Increased by 2 level	4 Students
Level 3	Level 4	Increased by 1 level	2 Students

Pre-test Level	*Post-test level*	Control Class Development	Number of Students
Level 1	Level 1	No increase	1 Students
Level 1	Level 2	Increased by 1 level	8 Students
Level 1	Level 3	Increased by 2 level	4 Students
Level 2	Level 2	No increase	6 Students
Level 2	Level 3	Increased by 1 level	9 Students
Level 2	Level 4	Increased by 2 level	1 Students
Level 3	Level 3	No increase	2 Students
Level 3	Level 4	Increased by 1 level	1 Students

In Table 3 above, it can be seen that in the experimental class, the majority of students experienced significant improvement to higher levels, with 21 students reaching level 3 (formal deduction) and 7 students reaching level 4 (rigor). In the control class, most students only reached level 3, with only 2 students reaching level 4. This shows that the Creative Visualization technique was more successful in enhancing students' deductive thinking abilities.

Based on statistical analysis, it is evident that the Creative Visualization technique has a significant impact on improving students' geometry skills. Students who learned with this technique were able to achieve a higher level of geometry understanding, particularly in terms of deduction and rigor. Furthermore, the more even improvement in the experimental class suggests that this technique is effective across various student ability levels. In line with this, the research conducted by

Žakelj (2014) states that “visual representations and the use of multimedia, such as animations, are crucial in enhancing students' understanding of geometric concepts. By engaging students visually, these tools help improve problem-solving skills and foster creativity, which significantly contributes to their ability to grasp geometric ideas". The Creative Visualization technique enables students to understand geometric concepts more deeply through visualization and creative problem-solving. This helps students develop deductive and analytical thinking skills, which are crucial foundations for studying geometry at higher levels. Overall, these results are in line with Van Hiele’s theory, which states that the development of geometric understanding follows systematic stages. The Creative Visualization technique has proven to facilitate students’ progression through these stages more effectively than conventional teaching methods.

In a relevant study by Hermosisima & Sunga (2016), the research focused on the use of creative visualization in science education for 6th-grade students. The visualization involved various forms of art, dramatization, and role-playing, aiming to enhance students' understanding of scientific concepts. The results indicated a significant improvement in post-test scores compared to pre-test scores, suggesting that creative visualization helped students better understand and retain scientific concepts.

Roberts et al.’s (2019) research presented reflections and strategies for implementing creative visualization activities in various educational contexts. The researchers proposed nine key strategies for conducting visualization activities, such as breaking tasks into smaller parts and using diverse learning materials. The results showed that creative visualization effectively promoted student engagement, critical thinking, and collaboration, ultimately enhancing concept understanding.

Similarly, this research shows a comparable pattern. Students who participated in the Creative Visualization-based learning showed significant improvement in their geometry skills compared to the control class, which used conventional teaching methods. Visualization techniques helped students understand geometric concepts in a deeper and easier way. The findings from these three studies are consistent. Whether in science or geometry education, the use of creative visualization has proven effective in improving student understanding,

engagement, and critical thinking skills. Creative visualization techniques have a positive impact on learning outcomes across various fields of study.

CONCLUSION

Based on the research results, it can be concluded that the Creative Visualization technique significantly improves students' geometry skills compared to conventional teaching methods. Students in the experimental class showed a higher increase in formal deduction and rigor abilities, in line with Van Hiele's theory, while students in the control class tended to only reach the levels of analysis and informal deduction. The t-test showed a significant difference between the two groups, indicating that the Creative Visualization technique is more effective in helping students understand geometric concepts more deeply and encouraging them to reach higher levels of thinking.

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