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The Influence of the Demonstration Method with the Help of Geogebra Software on the Ability to Understand Mathematical Concepts

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ABSTRACT

The background of this research is the need for students to understand mathematical concepts. The researcher chose the demonstration method with the help of GeoGebra Software to overcome the need for more understanding of mathematical concepts. The purpose of this research is to find out whether the demonstration method has an effect with the help of GeoGebra Software on the ability to understand mathematical concepts. This research is a Quasi-experimental study where the design applied is Nonequivalent Control Group Design. The population of this study was 79 students of class IX at SMP Muhammadiyah 2 Purwokerto. The research sample consisted of 26 students from class IXA which was used as the experimental class and 27 students from class IXB which was used as the control class. The test instrument is used to measure the ability to understand each student's mathematical concepts. The N-Gain test shows that the control group has an average N-Gain of 0.29 in the low category, while the experimental group has an average N-Gain of 0.61 in the medium category. From the t-test, the value of sig = 0.004 < α = 0.05 means a difference in the experimental class's average N-Gain value and the control class's average N-Gain value. The conclusion from this study is that there is an influence of the demonstration method with the help of GeoGebra Software on the ability to understand mathematical concepts in class IX SMP Muhammadiyah 2 Purwokerto.

Keywords: Ability to Understand Mathematical Concepts, Demonstration Methods, Geogebra Software

ABSTRAK

Hal yang melatarbelakangi penelitian ini adalah ketidakmampuan siswa dalam memahami konsep matematika. Peneliti memilih metode demonstrasi dengan bantuan *Software GeoGebra* untuk mengatasi kurangnya pemahaman konsep matematika. Tujuan dari penelitian ini adalah untuk mengetahui apakah terdapat pengaruh metode demonstrasi dengan bantuan *Software GeoGebra* terhadap kemampuan pemahaman konsep matematika. Penelitian ini merupakan penelitian *Quasi-experiment* dimana desain yang diterapkan adalah *Nonequivalent Desain* Grup Kontrol. Populasi penelitian ini adalah 79 siswa kelas IX SMP Muhammadiyah 2 Purwokerto. Sampel penelitian adalah sebanyak 26 siswa dari kelas IXA yang dijadikan sebagai kelas eksperimen dan 27 siswa dari kelas IXB yang dijadikan sebagai kelas kontrol. Instrumen tes digunakan untuk mengukur kemampuan pemahaman konsep matematika setiap siswa. Uji N-Gain menunjukkan bahwa kelompok kontrol mempunyai rata-rata N-Gain sebesar 0,29 yang masuk pada kategori rendah, sedangkan kelompok eksperimen mempunyi rata-rata N-Gain sebesar 0,61 yang masuk pada kategori sedang. Dari uji t yang dilakukan nilai sig = 0,004 < α =0,05 yang berarti bahwa terdapat perbedaan nilai rata-rata N-Gain kelas eksperimen dan nilai rata-rata N-Gain kelas kontrol. Kesimpulan dari penelitian ini adalah terdapat pengaruh metode demonstrasi dengan bantuan *Software GeoGebra* terhadap kemampuan pemahaman konsep matematika siswa kelas IX SMP Muhammadiyah 2 Purwokerto.

Kata Kunci: Kemampuan Pemahaman Konsep Matematika, Metode Demonstrasi, *Software Geogebra*

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Introduction

Education is an essential effort, cyclical, forming a learning atmosphere so that the potential in a person has the spiritual, self-control, personality, intelligence, and skills needed in society, nation, and state (Depdiknas, 2006). Education is also called a learning process regarding knowledge, development, and maturation in science, way of life, society, and religion. There are various and various kinds of education, one of which is mathematics education (Purnomo, 2019).

Mathematics is a deductive science because mathematics is organized from elements that are not defined, definitions, axioms, and propositions where the propositions are generally valid. Mathematics is also a structured and organized science because mathematics starts from undefined elements, then elements that are defined into hypotheses, and finally to theorems with various concepts (Noer, 2017). Each idea of each theorem has a method for solving it, so the accuracy of the method used by the teacher is very influential. But in fact, the teacher's ability to use learning methods still needs to improve so that such learning results in low students' ability to understand mathematical concepts.

The ability to understand mathematical concepts is one of the skills or proficiency that is expected to be achieved in learning mathematics, namely by showing an understanding of the mathematical concepts they are studying, explaining the interrelationships between concepts, and applying concepts in a flexible, accurate, efficient and precise way in solving problems (Aprienti, 2020). Santrock states that conceptual understanding is a crucial aspect of learning; besides, the ability to understand mathematics is very supportive of developing other mathematical abilities (Hendriana et al., 2018).

The indicators of the ability to understand students' mathematical concepts (Eka & Ridwan, 2018) are a) restating the concepts learned; b) grouping objects according to the conditions studied; c) identifying the characteristics of the operation or concept; d) apply concepts logically; e) present the concept of various mathematical concepts (tables, charts, etc.); and f) linking various concepts inside and outside of mathematics. Extrinsic factors that affect the ability to understand mathematical concepts consist of the role of the teacher, methods, facilities (facilities and infrastructure), and family environment.

Many students' ability to understand mathematical concepts is still low, including class VIII students of MTs Al-Hikmah Bandar Lampung, whose ability to understand concepts is still low due to a lack of understanding of the basic concepts of teaching material, especially in everyday life problems (Tama, 2017). The results of the study (Hernaeny et al., 2021) also show that students' ability to understand mathematical concepts in class VIII flat-sided geometric material at SMP Darrosta Jakarta is still meager, where from the nine samples analyzed, it can be seen that almost all students fall into the category of ability to understand mathematical concepts. The low one. It can be seen from the nine students who have been analyzed that these students still experience problems in solving the questions tested according to the two indicators, namely computational understanding and functional understanding. Furthermore, the research results from (Gusmira & Nasution, 2022) also show that class VIII students of MTs PP Saifullah need better conceptual comprehension skills. Of the 30 students who were taken as research subjects, 15 had low conceptual understanding abilities, 12 had moderate conceptual understanding abilities, and 3 had high conceptual understanding abilities. These students can understand different concepts and are included in the low category.

Based on the results of interviews with mathematics teachers at SMP Muhammadiyah 2 Purwokerto on April 7, 2022, there were problems in the teaching and learning process. Indirectly, many students cannot restate a concept, need help classifying objects based on their nature according to the idea, and have difficulty transforming these concepts into other forms such as tables, charts, and so on. It shows that the ability to understand mathematical concepts in class IX students of SMP Muhammadiyah 2 Purwokerto still needs to improve.

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The low ability to understand mathematical concepts can be overcome by using the right learning strategy, namely by choosing the proper learning method. The demonstration method was taken as a way out from the observations obtained. The demonstration method is a learning method that demonstrates and shows students a process, concept, or situation, both actual and imitation (Noer, 2017). The steps for using the demonstration method (Ariska, 2018) are; 1) provide objectives to be achieved; 2) provide illustrations of the material to be delivered; 3) provide the necessary tools or materials; 4) direct students to demonstrate the scenarios that have been presented; 5) all students describe the results of the analysis and demonstrate their experiences; 6) teachers and students make a conclusion; and 7) cover.

Some advantages of applying the demonstration method are: a) ease of explanation; b) help clearly understand the course of a process by presenting the actual object so that students can understand the concept or material being studied (Shoimin, 2014). In using a demonstration method, a tool is needed to demonstrate learning, one of which is the Geogebra Software. one of the factors in increasing the ability to understand mathematical concepts is the role of the teacher, methods, and facilities (facilities and infrastructure). In educational terms, facilities and infrastructure are called educational aids (Jakaria, Widjaja dkk, 2019).

Geogebra software is a computer program for learning mathematics (Priantna & Arsani, 2019). Geogebra software can be used to demonstrate mathematical concepts because it provides representations of mathematical objects in algebraic and geometric forms. This program can also be used to solve linear programming problems, calculus, and statistics (Fernandez, 2020). Gogebra software can be used as a tool for demonstrating mathematical concepts due to the availability of representations of mathematical objects in the form of algebra, geometry, and worksheets so that the demonstration method is considered suitable to be used to improve the ability to understand mathematical concepts. Some of the benefits of Geogebra software in learning mathematics (Priantna & Arsani, 2019) are: 1) it can be used for simulations or demonstrations; 2) as a tool in learning mathematics activities; and 3) it can be used to solve questions or verify.

Given the low ability to understand mathematical concepts in class IX students of SMP Muhammadiyah 2 Purwokerto and the demonstration method, which is suspected of influencing the ability to understand mathematical concepts, the researcher is interested in conducting research with the title "The Influence of the Demonstration Method with the Help of Geogebra Software on the Ability to Understand Mathematical Concepts".

Research Methods

This research is quasi-experimental research with a quantitative approach. The population in this study was all of class IX at SMP Muhammadiyah 2 Purwokerto consisting of 26 students in class IX A, 27 students in class IX B, and 26 students in class IX C. The samples used in this study were class IX A as the experimental class, where the demonstration method was applied with the help of GeoGebra software, and class IX B as the control class, where the class used conventional methods. Class determination is done by lottery and randomly selected.

Data collection techniques are carried out using test instruments. The test method used is Pretest and Posttest. The pretest is carried out before learning is carried out to measure the ability to understand mathematical concepts. At the same time, the Posttest is carried out after learning activities to see how much the ability to understand mathematical concepts has increased.

Researchers compiled six items to measure students' ability to understand mathematical concepts. The researcher tested this question in class X Putri MA El Qosimi Purbalingga to determine whether the instrument could be used for research and was declared valid and reliable. Pearson's Product Moment Correlation carried out the validity test with a significance level of 5%. The test instrument is said to be valid if $r \geq r\,table$, whereas if $r < r\,table$ then the instrument is declared invalid. After being tested on 33 students, with the help of SPSS 22.0 For Windows, the test instruments were declared valid, all with the acquisition $r \geq r\,table$ =0.344, which totals six questions.

Furthermore, the six questions will be tested for reliability to determine the consistency of the research instrument. The reliability test was carried out using the Cronbach Alpha test with a significance level of 5%. The test instrument is said to be reliable if $r \geq r\,table$. Based on the results of the reliability test using SPSS 22.0 for Windows, the test instrument was declared reliable, where r= 0.619$>r\,table$= 0.602.

After the items are declared valid and reliable, the questions can be used for research. Normalized Gain (N-Gain) is one of the stages that provides information about increasing students' understanding of mathematical concepts (Eka & Ridwan, 2018) as formula 1.

$$N - Gain = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \qquad (1)$$

where
S_{post} : posttest score
S_{pre} : pretest score
S_{max} : ideal maximum score

From the N-Gain values in the experimental class and control class, it will be known whether there is an influence of the demonstration method with the help of Geogebra Software on the ability to understand mathematical concepts and interpret N-Gain (Prasetyono dan Haryono, 2020).

Table 1. Category of N-Gain

N-Gain	Category
-1,00 ≤ *N-Gain* < 0,00	Decline
N-Gain = 0,00	Constant
0,00 < *N-Gain* < 0,30	Low
0,30 ≤ *N-Gain* < 0,70	Moderate
0,70 ≤ *N-Gain.* ≤ 1,00	High

After obtaining the pretest and posttest data in the experimental and control classes, the researcher looked for the N-Gain value for the experimental and control classes. Furthermore, the N-Gain values will be categorized based on the categories in Table 1. After the research data is obtained, it is followed by the analysis of the data, namely the analysis prerequisite test, which consists of a normality test and a homogeneity test. The normality test is used to determine whether the data is normally distributed or comes from a normal population. This

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normality test uses the Kolmogorov-Smirnov test, where the significant value < $\alpha = 0.05$ means that the data is not normally distributed. If the significant value ≥ $\alpha = 0.05$, the data is normally distributed. The normality test hypothesis is H_0: data is normally distributed, H_1: data is not normally distributed. Furthermore, the homogeneity test is a test carried out to determine whether the variance of the data from the sample being analyzed is homogeneous (same) or not. This homogeneity test was carried out using the Levene test. The homogeneity test hypothesis is σ_1^2=σ_2^2 (N-Gain variance of Experiment class = N-Gain variance of control class) and $\sigma_1^2 \neq \sigma_2^2$ (N-Gain variance of Experiment class G variance of control class N-Gain). H_0 is accepted if the significant value ≥ 0.05.

Next, test the hypothesis, which consists of t-test and N-Gain. The t-test was used to determine that the average N-Gain of the experimental and control classes was significantly different. The hypothesis in this test is $H_0: \mu_1 = \mu_2$ (there is no difference in the average N-Gain of the experimental class with the average N-Gain of the control class). $H_1: \mu_1 \neq \mu_2$ (there is no difference in the average N-Gain of the experimental class with the average N-Gain of the control class). H_0 is accepted if the significant value ≥ 0.05.

Result and Discussions

Researchers carried out research from 19 September 2022 to 30 September 2022. The learning process was carried out in five meetings. The learning process occurs in class IX A and class IX B, SMP Muhammadiyah 2 Purwokerto. From the research conducted, the results of the Pretest and Posttest values in the experimental class and control class were as follows:

Table 2. Pretest and Posttest Score of Experimental and Control Class

		E	C	E	C
1	Higest Score	83,33	83,33	100	100
2	Lowest Score	44,44	50	50	50
3	Score Average	64,32	63,33	85,68	74,89

Table 2 shows the results of the experimental class pretest: the highest score was 83.33, the lowest score was 44.44, and the average was 64.32. Posttest results in the experimental class, namely, the highest score was 100, the lowest score was 50, and the average was 85.68. Furthermore, the results of the pretest in the control class, namely, the highest score was 83.33, the lowest score was 50, and the average was 63.33. Posttest results in the control class, namely, the highest score was 100, the lowest score was 50, and the average was 74.89.

The N-Gain test was applied to determine the effectiveness of the treatment given. The N-Gain statistical data for the experimental class and the control class is as follows:

Table 3. N-Gain Statistical Data

	E	C
The Number of Students	26	27
Higest Score	1	1
Lowest Score	-0,33	-0,67
Score Average	0,61	0,29

From the statistical data in Table 3, it was obtained that the average experimental class was 0.61, with the highest value 1 and the lowest value -0.33. As for the acquisition of the average value in the control class of 0.29, with the highest value 1 and the lowest value -0.67.

Table 4. Category of N-Gain in Experimental dan Control Class

Class	N-Gain Average	Category
Experimental	0,61	Moderate
Control	0,29	Low

Table 4 shows that the experimental class experienced an increase in the ability to understand mathematical concepts in the medium category. In contrast, the control class experienced an increased ability to understand mathematical concepts in the low category. Based on the explanation, the average N-Gain of the experimental class and the control class is insignificant, namely from low to medium level, based on the calculation of the percentage of pretest and posttest scores on each indicator of the ability to understand mathematical concepts.

Table 5. Percentage of Pretest and Posttest Scores for Each Indicator

Indicator	E			C		
	Pre	Post	Percentage Difference Score	Pre	Post	Percentage Difference Score
1	78,20%	87,18%	8,98%	70,37%	76,5%	6,17%
2	69,23%	84,61%	15,38%	79,01%	92,59%	13,58%
3	75,64%	83,33%	7,69%	58,02%	69,13%	11,11%
4	79,49%	88,46%	8,97%	60,49%	65,43%	4,94%
5	64,10%	85,90%	21,8%	62,96%	75,31%	10,35%
6	65,38%	84,61%	19,23%	50,62%	62,96%	12,34%
Average			13,68%			9,75%

From table 5, the difference in the percentage score of the control class on the first indicator is 6.17%, on the second indicator is 13.58%, the third indicator is 11.11%, the fourth indicator is 4.94%, the fifth indicator is 10.35%, and the sixth indicator is 12, 34%. In the experimental class, the difference in the percentage score of the control class on the first indicator was 8.98%, the second indicator was 15.38%, the third indicator was 7.69%, the fourth indicator was 8.97%, the fifth indicator was 21.8%, and on the sixth indicator 19.23%.

The percentage of pretest and posttest scores for each indicator has an average difference in percentage scores of 9.75% in the control class. In comparison, the average difference in percentage scores in the experimental class is 13.68%. With an average difference in the percentage score that is not too significant, it is only natural that the effect of the demonstration method with the help of Geogebra Software on the ability to understand mathematical concepts is categorized from low to moderate. So it is evident that the treatment in the form of a demonstration method with the help of Geogebra Software during learning has increased the ability to understand mathematical concepts.

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Analysis prerequisite test is used to analyze whether the data obtained meets the requirements to be tested using predetermined data analysis techniques. The normality test is one of the prerequisite analysis tests aiming to determine whether the data obtained is normally distributed.

Table 6. Normality Test Results

		Kolmogorov-Smirnov		
	Class	Statistic	df	Sig.
N-Gain	Experimental	0,148	26	0,146
	Control	0,163	27	0,063

Based on Table 6 data, the significance value for the experimental class was $0.146 \geq 0.05$, and the significance value for the control class was $0.063 \geq 0.05$. From the predetermined decision criteria, $H0$ is accepted. So it can be concluded that the data obtained is normally distributed.

Furthermore, the homogeneity test is used to ensure no significant difference between the two classes used. Homogeneity test hypothesis to determine the ability to understand homogeneous mathematical concepts.

Table 7. Homogeneity Test

		Levene's Test for Equality of Variances	
		F	Sig.
N-Gain	Equal variances assumed	.342	.561
	Equal variances not assumed		

Based on Table 7, H_0 is accepted if the significant value ≥ 0.05. Because the sig value is $0.561 \geq 0.05$, so H_0 is accepted, meaning that the N-Gain variance of the Experiment class = the N-Gain variance of the control class.

Next, test the hypothesis. The t-test was conducted to determine whether the average N-Gain of the experimental and control classes differed significantly.

Tabel 8. t-test

		t-test for Equality of Means						
							95% Confidence Interval of the Difference	
		t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
N-Gain	Equal variances assumed	3.055	51	.004	.34950	.11440	.11982	.57918
	Equal variances not assumed	3.071	48.152	.003	.34950	.11379	.12073	.57827

Based on Table 8, because the N-Gain variance of the Experiment class = the control class N-Gain variance, the significance value t-test refers to Equal variances assumed. The significance value is 0.004 < 0.05, so that H_1 is accepted, meaning that there is a difference in the average N-Gain between classes using the demonstration method with the help of Geogebra software and N-Gain classes using conventional methods. Thus, it can be concluded that there is an influence of the demonstration method with the help of Geogebra Software on the ability to understand mathematical concepts in class IX students of SMP Muhammadiyah 2 Purwokerto.

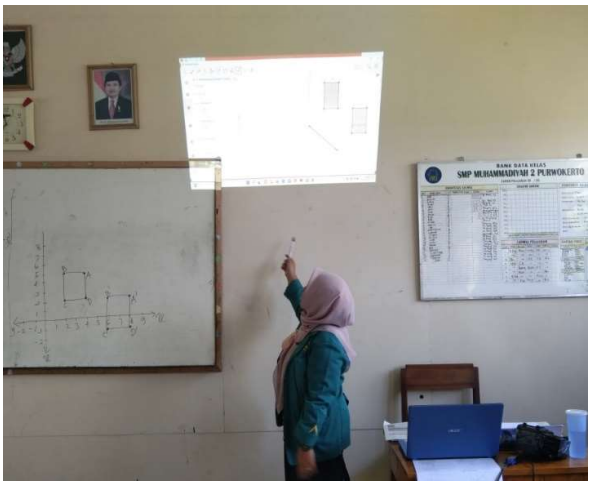

Figure 1. The use of the Demonstration Method
with the help of GeoGebra Software in Learning Mathematics

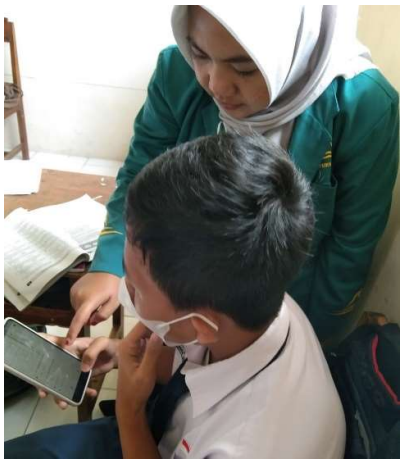

Figure 2. Demonstration of the use of Geogebra Software
to Improve Students' Understanding of Mathematical Concepts

Figure 1 and figure 2 shows that demonstration method can improve mathematics learning outcomes (Arifuddin & Arrosyid, 2017; Nugraha & Suyatmin, 2021; Purba, 2022; Tini, 2020; Toruan, 2021), student learning activities (Nugraha & Suyatmin, 2021), and student motivation (Tini, 2020). This demonstration method allows students to work together in analyzing social

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situations, especially problems involving the relationship between students' personalities (Endayani et al., 2020). The increase in students' understanding of mathematical concepts using the guided discovery method assisted by Geogebra Software is higher than the improvement in students' knowledge of mathematical concepts using the guided discovery method without Geogebra Software Geogebra (Asmiati, 2016). The use of Geogebra software can also increase students' interest in learning (Nugroho, 2013) and students' mathematical representation abilities (Oktaria et al., 2016). Geogebra-based learning videos are compelling and have a positive effect on increasing students' understanding of mathematical concepts (Nurdin et al., 2019). Problem-based learning in Geogebra-assisted Geometry material has a more significant impact than conventional methods on students' spatial abilities (Haris et al., 2018). In addition, the application of problem solving methods and jigsaw cooperative learning can also improve students' understanding of mathematical concepts (Turrizkiyah & Utomo, 2016; Widyastuti, 2015).

Conclusion

Based on the research results, it is known that the average gain of the N-Gain test results for the control class is 0.29 and is included in the low category, while in the experimental class, the average N-Gain test results are 0.61, included in the medium category. From the results of the t-test, the significance value is 0.004 <0.05, which means that there is a difference in the average N-Gain of the experimental and control classes. Thus, there is an influence of the demonstration method with the help of Geogebra Software on the ability to understand mathematical concepts in class IX students of SMP Muhammadiyah 2 Purwokerto.

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