IJSSR
International Journal of Social Service and Research

Vol. 03, No. 06, June 2023
e-ISSN: 2807-8691 | *p*-ISSN: 2807-839X

The Effect of Using the Geogebra Application on the Learning Outcomes of Applied Mathematics Courses at Merchant Marine Polytechnic of Makassar

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Keywords

Geogebra, Learning Outcomes, Mathematics

ABSTRACT

GeoGebra is an application used to visualize mathematical concepts with the advantages of being easy to use, available in Indonesian, quite complete features in learning mathematics, and suitable for teaching tangent circle material. Therefore, the GeoGebra application makes it easier for students to visualize mathematical concepts on circle tangent material. The type of research used in this study is experimental research. Experimental research can be interpreted as a research method used to look for the effect of certain treatments on others under controlled conditions.

INTRODUCTION

The development of science and technology is a need as well as a demand in the era of globalization, especially in the field of education. The use of technology in the field of education requires educators to be more creative and innovative to utilize technology as an effort to improve the quality of education to achieve learning goals. In the field of education, the use of information technology is focused on improving the quality of learning so as to improve the quality of education. In today's era of rapid development of science and technology, the professionalism of teachers or lecturers is not enough only with the ability to learn, but also must be able to manage information and the environment to facilitate learning activities.

Quality education requires the role of lecturers in learning as facilitators and mentors so that teaching and learning activities can take place effectively and efficiently. The quality of education can also be seen from the mastery of the material by students in doing assignments from lecturers. Efforts to improve the quality of education require innovations in teaching and learning activities to overcome the difficulties of students in mastering learning materials. Innovation in accordance with technological advances is a support in helping and facilitating teaching and learning activities, namely as a means of learning media. Growing technology has influenced the use of various types of media as aids in the learning process.

Based on the rapid development of technology, it opens up new opportunities and paths in doing many things, including to develop the world of education. Currently, there have been many developments in various technologies that can be used to develop the world of education, including to support mathematics learning, such as mathematics learning media. One of the learning media that has currently grown so rapidly is technology-based media with various relevant programs. One

https://doi.org/10.46799/ijssr.v3i5.416

program or software that can be used as a medium for learning mathematics is the GeoGebra application.

GeoGebra was developed by Markus Hohenwarter in 2001. Hohenwarter (2008) stated GeoGebra is software used in learning mathematics, especially geometry and algebra. In this research in the form of Mathlet (Mathematical applet) GeoGebra which is an exploration medium for students, especially on the mathematical concepts studied. Mathlet GeoGebra has a very strategic function in learning. This is shown from several studies that have shown that Mathlet GeoGebra plays an important role in learning, including research by Dr. Gede Suweken, M.Sc stated that the role of Mathlet is very relevant to student learning outcomes (Ekawati, 2016).

GeoGebra is an application used to visualize mathematical concepts with the advantages of being easy to use, available in Indonesian, quite complete features in learning mathematics, and suitable for teaching tangent circle material. Therefore, the GeoGebra application makes it easier for students to visualize mathematical concepts on circle tangent material.

In other studies also stated that the use of Mathlet GeoGebra in the learning process has a positive impact on the mathematical representation of students. GeoGebra-based interactive programs provide improvements to learning outcomes and learner motivation. In conclusion, the use of Mathlet GeoGebra turns out to have a positive impact on learning which is reflected in the learning outcomes of students. A good Mathlet GeoGebra should be able to help students demonstrate and visualize the material they are learning, can be used as a tool in finding a concept they are learning, and can help students in constructing new concepts they learn.

Related to GeoGebra-based mathematics learning media, Asngari (2015) research states that GeoGebra can be used as a mathematics learning medium to demonstrate or visualize mathematical concepts and as a tool to construct mathematical concepts. The results of Sukmawarti's research (2015), the use of information technology in learning using GeoGebra software is able to create an interesting mathematics learning atmosphere for students, where students can be interactive and motivated to know more clearly about the benefits of GeoGebra in mathematics learning. Both studies show that alternative learning media that are in accordance with technological developments in the delivery of circle tangent material are computer programs (software). One software that can be used in learning mathematics on the material is GeoGebra.

Based on the description above, researchers are interested in researching the application of GeoGebra to cadet learning outcomes, especially in geometry materials. So that the title of the research raised is "The Effect of Using the Geogebra Application on the Learning Outcomes of Applied Mathematics Courses at Merchant Marine Polytechnic of Makassar".

METHODS

The approach in this study is quantitative research. Quantitative research is a study that basically uses an inferential approach. This approach departs from a theoretical framework, expert ideas, or researchers' understanding based on their experience, then developed into problems and solutions proposed to obtain justification in the form of empirical data support in the field. Or in other words, quantitative research departs from the theoretical paradigm to data and ends in acceptance or rejection of the theory used (Sugiyono, 2016)

The type of research used in this study is experimental research. Experimental research can be interpreted as a research method used to look for the effect of certain treatments on others under controlled conditions. In this experimental study, the form of design used is Posttest-Only Control Design. The location of this research is at the Makassar Shipping Science Polytechnic in April – September 2022. The data collection method in this study consisted of questionnaires to determine cadets' responses to the use of the *GeoGebra* application and for cadets' learning outcomes using written learning outcomes tests.

RESULTS

Research Results

The data in this study consisted of data related to the use of the GeoGebra application and data related to cadet learning outcomes both in the control class and experimental class. The use of *the GeoGebra* application *in this study was carried out online using* the zoom meeting *application*.

The difference in treatment is done by dividing the class into a control class and an experimental class.

Figure 1. Comparison Graph of Average *Pretest Scores of* Cadets

Before learning using the *GeoGebra* application is applied, an initial ability measurement is first carried out in the form of *a pretest* for each cadet in Applied Mathematics learning. The *pretest* is an initial description of cadet learning outcomes and is carried out in both the control class and the experimental class. Figure 1. is a comparison of the average initial data of cadet learning outcomes. In table 1 below, a statistical comparison of the *pretest results of the* control class and the experimental class is displayed.

Table 1. Statistical Comparison of *Pretest Results*

Statistics			
		K.Kontrol	K.Eksperimen
N	Valid	24	24
	Missing	0	0
Mean		68.83	70.42
Median		68.00	70.00
Mode		68	68

If the results of the graph are grouped in a category scale, then the data in table 2 is obtained. for the control class and table 2 for the experimental class

Table 2. *Pretest* Value Interval Scale in Control Class

Interval					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 60	1	4.2	4.2	4.2
	60 – 69	12	50.0	50.0	54.2
	70 – 79	9	37.5	37.5	91.7
	80 – 89	2	8.3	8.3	100.0
	Total	24	100.0	100.0	

Table 3. Pretest Value Interval Scale in Experimental Class

Interval					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 60	1	4.2	4.2	4.2
	60 – 69	12	50.0	50.0	54.2
	70 – 79	9	37.5	37.5	91.7
	80 – 89	2	8.3	8.3	100.0
	Total	24	100.0	100.0	

The results of the analysis of research data that have been obtained are as follows:

Normality Test

Using *Kolmogorov Smirnov's One Sample* test. Data is declared normally distributed if the significance is greater than 5% or 0.05. Table 4. shows that the significance for the use of the *GeoGebra* application in applied mathematics learning is 0.2. So it can be concluded that the variable data is normally distributed with a variable significance greater than 0.05.

Table 4. Results of Normality Test Analysis for the Use of *Geogebra Applications*

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		24
Normal Parameters	Mean	.0000000
	Std. Deviation	4.33846056
Most Extreme Differences	Absolute	.118
	Positive	.088
	Negative	-.118
Test Statistic		.118
Asymp. Sig. (2-tailed)		.200

Correlation Test

The correlation test aims to determine the level of influence between the use of the *GeoGebra application* on applied mathematics learning outcomes in cadets. The results of the correlation test are shown in table 5.

Table 5. Correlation Analysis Results

Correlations			
		Use of Geogebra Application (X)	Mathematics Learning Outcomes (Y)
Use of Geogebra Application (X)	Pearson Correlation	1	.518**
	Sig. (2-tailed)		.010
	N	24	24
Mathematics Learning Outcomes (Y)	Pearson Correlation	.518**	1
	Sig. (2-tailed)	.010	
	N	24	24
**. Correlation is significant at the 0.01 level (2-tailed).			

Based on the results of the correlation coefficient analysis of 0.01. In accordance with the correlation coefficient interpretation guidelines, the value shows that the influence between *the use of the GeoGebra application on learning outcomes is positive so that the better the use* of the GeoGebra application during learning, the higher the learning outcomes of cadets in the Applied Mathematics course. Furthermore, the correlation value also shows that the influence between the two variables is in the medium category.

Homogeneity Test

The homogeneity test aims to see whether the research data in both the control class and the experimental class are normal or not. Based on the results of the homogeneity test, the following data were obtained:

Table 6 Homogeneity Test Results

Test of Homogeneity of Variances			
Mathematics Learning Outcomes			
Levene Statistic	df1	df2	Itself.
.662	1	46	.420

Based on the homogeneity test in table 6 shows that the significance value of 0.42 is greater than 0.05 which means that the research data is normally distributed so that it can be continued with *independent sample test* analysis (t test).

Test t

The t test aims to determine whether there are differences in cadet learning outcomes in the control class with experimental classes with research hypotheses. If the significance value is greater than 0.05, then the learning outcomes of cadets in the experimental class are not higher than those of the control class. But if the significance value is less than 0.05, then the average learning outcomes of cadets in the experimental class are higher than the control class. Based on the results of the t-test analysis, the value in table 7 is obtained.

Table 7. Test t Analysis Results

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Itself.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mathematics Learning Outcomes	Equal variances assumed	.662	.420	-3.938	46	.000	-5.500	1.397	-8.311	-2.689
	Equal variances not assumed			-3.938	-45.558	.000	-5.500	1.397	-8.312	-2.688

Based on the results of the analysis on the t test above, it shows that the significance value (*2-tailed*) is 0.00 or less than 0.05, so it shows that the learning outcomes in the experimental class are higher than the learning outcomes in the control class. Figure 2. is the result of a comparison of *postest scores* which is a description of cadets' learning outcomes after the learning process.

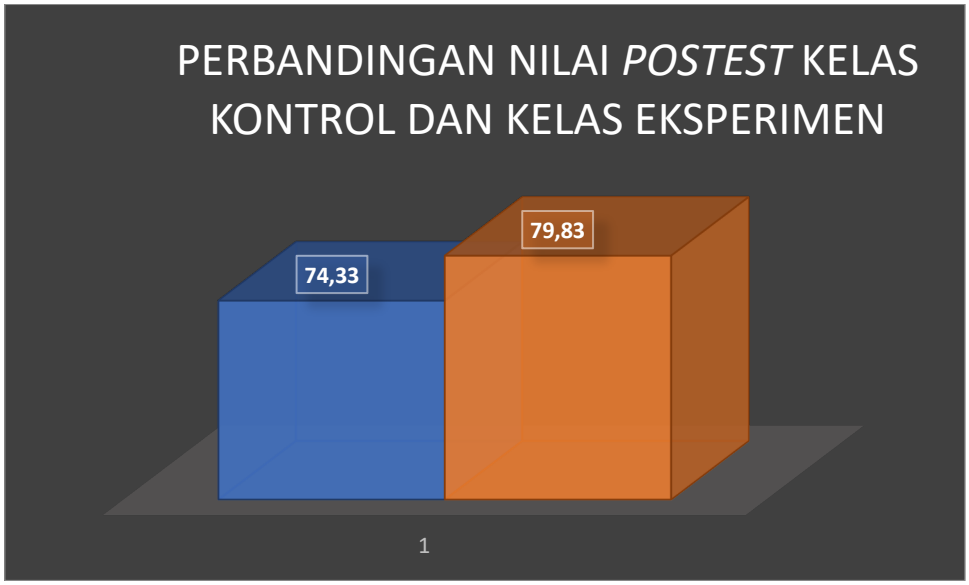

Figure 2. Comparison Graph of Average *Postest Values*

A comparison of *pretest and* postest *values in each control class and experimental class is presented in figure 3 below.*

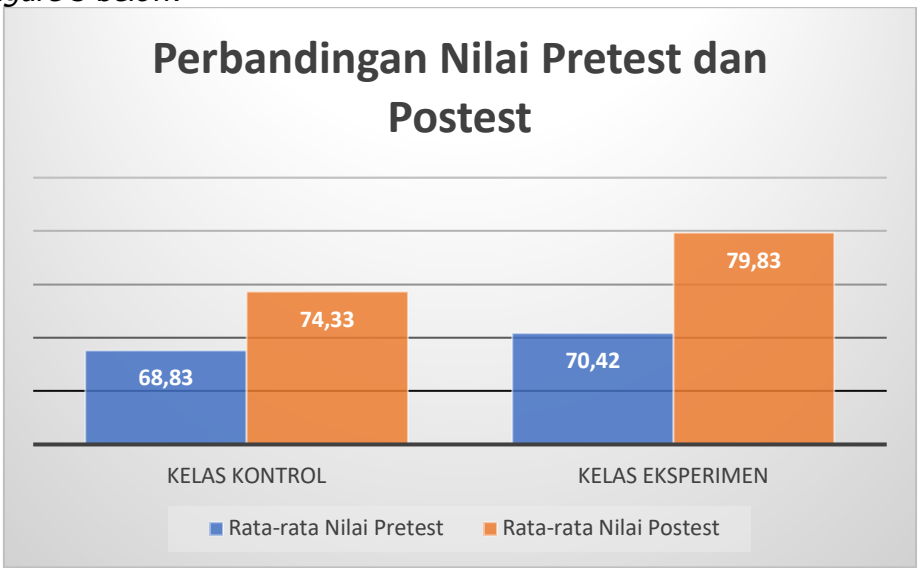

Figure 3. Comparison Graph of Average *Pretest* and *Postest scores*

In table 8 the following statistical comparison of postest results of *the control class and experimental class* is displayed.

Table 8. Statistical Comparison of *Postest Results*

Statistics			
		Control Class	Experimental Class
N	Valid	24	24
	Missing	0	0
Mean		74.33	79.83
Median		74.00	79.00
Mode		74	76

If the results of the graph are grouped in a category scale, then the data in table 9 is obtained. for control classes and table 10 for experimental classes

Table 9. Postest Value Interval Scale on Control Class

Interval					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	60 – 69	3	12.5	12.5	12.5
	70 – 79	17	70.8	70.8	83.3
	80 – 89	4	16.7	16.7	100.0
	Total	24	100.0	100.0	

Table 10. Postest Value Interval Scale in Experimental Class

Interval					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	70 – 79	12	50.0	50.0	50.0
	80 – 89	9	37.5	37.5	87.5
	90 – 100	3	12.5	12.5	100.0
	Total	24	100.0	100.0	

Based on the graph above, it can be seen that there are differences in learning outcomes between the experimental class and the control class.

Discussion

Overview of Research Implementation

This research was carried out at the cadets of the Engineering Study Program in the second semester of the 2021/2022 Academic Year of the Makassar Shipping Science Polytechnic. This research uses experimental methods conducted in the Applied Mathematics course with Geometry material. The research subjects were divided into 2 (two), namely the experimental class consisting of 24 cadets and the control class consisting of 24 cadets. The research was conducted through several stages, namely:

Experimental Class

Before applying the *GeoGebra application* to learning, in the experimental class, the level of initial understanding of cadets was measured. The measurement is in the form *of a pretest* that lasts for approximately one hour of learning. After the *pretest,* researchers made non-systematic observations without using observation sheets to determine the level of readiness of cadets in receiving material. The lecturer then gave an explanation to the cadets about the tangent material of the circle in accordance with the learning guide.

At the next meeting, before learning begins, cadets are asked to install the *Geogebra* application on their respective laptops. Then briefly the lecturer gave an explanation of *the tools* that are likely to be used and gave examples of using the *GeoGebra* application in circle calculations.

Furthermore, cadets were asked to solve problems related to circle tangents mathematically and using the *GeoGebra application*. Lecturers will carry out *a postest* as a final measurement of the level of understanding of cadets after the learning process ends.

Control Class

In the control class, *a pretest was carried out* as an initial measurement of cadet understanding. Furthermore, the lecturer delivered the material to be taught, namely the tangent material of the circle. In this activity, the learning process is carried out conventionally, namely by explaining the material using *virtual whiteboard* media and doing sample questions jointly between cadets and lecturers. After the activity is completed, the *postest is carried out* again as a measurement of cadet learning outcomes.

Overview of Cadets' Early Learning Outcomes

The description of the initial learning outcomes in this study is the level of understanding of cadets before the application of *Geogebra* as a cadet learning medium. This initial picture is obtained from the *pretest* results given to cadets before the start of learning. Based on the results that have been obtained in figure 4.1 regarding the *cadet prestest chart,* it shows that the *pretest values* in the control class and the experimental class are almost the same. This shows that in general the level of understanding of cadets in geometry material to be taught is relatively the same, considering that geometry material in semester II is a continuation of the material taught previously in semester I.

The *pretest* results in the control class have a minimum score of 50 and a maximum value of 84, the most score is 50% or 12 people in the range of 60-69 values or with less category (D). Overall, the average total score for the 24 cadets in the control class was 68.83 or included in the good category.

The results of the *pretest* in the experimental class have a minimum score of 52 and a maximum score of 84. The range of scores in the experimental class of 32 is not much different from the range in the control class of 34. However, the most scores obtained by cadets in the experimental class are more varied, as many as 41.7% or 10 cadets are in the range of 70 – 79 scores and are included in the sufficient category (C), while as many as 37.5% or 9 cadets are in the range of 60 – 69 or fall into the less category (D). Overall, the average *pretest* results obtained by 24 cadets in the experimental class was 70.41, which was in the good category.

The Effect Between the Use of *GeoGebra* on Cadet Learning Outcomes

The effect between the use of *GeoGebra* on cadet learning outcomes in experimental classes was obtained through a correlation test illustrated in table 4.5. Based on Table 4.5. It can be observed that the correlation coefficient value is positive. This shows that the better the use of the *Geogebra* application in learning, the better the learning outcomes of cadets in the Applied Mathematics course.

Furthermore, in the correlation analysis table, it is also obtained that the value of the correlation coefficient is 0.518. This value means that the influence between the use of *the GeoGebra* application is in the strong category. The level of influence between the use of the *GeoGebra* application which is in the strong category shows that cadet learning outcomes after the use of the application increase significantly.

Differences in Achievement Levels of Cadet Learning Outcomes

The differences in the level of achievement of cadet learning outcomes in the control class and experimental class are illustrated in table 4.6. Table 4.6 related to the results of the t-test analysis shows that the significance value (*2-tailed*) is 0.016 or less than 0.05, so it shows that the learning outcomes in the experimental class are higher than the learning outcomes in the control class.

Furthermore, to see the achievement of cadet learning outcomes after learning, a *postest was carried out* for each cadet in the control class and experimental class. The Postest result value provides an overview of cadet learning outcomes after obtaining circle tangent learning materials both conventionally and using the *GeoGebra application.*

The implementation of *the postest* in the control class was attended by 24 cadets. Based on the results of *the postest*, the highest score obtained by cadets is 86 and is included in the good category while the lowest score obtained is 68 and is included in the less category. Based on the table above, in the control class as many as 12.5% or as many as 3 cadets get *postest* scores in the range of values 60 – 69 or in the less category, then as many as 70.8% or as many as 17 cadets are in the range of values 70 – 79 or in the sufficient category, and the remaining 4 cadets or 16.7% are in the range of values 80 – 89 or in the good category. Overall, the average *postest* score of cadets in the control class was 74.33 (rounded to 75) or included in the good category.

The implementation of *the postest* in the experimental class, the same as in the control class, was also carried out by 24 cadets. The *postest* results showed that the range of scores obtained by cadets was 24 with the minimum score achieved was 74 included in the sufficient

category while the maximum score was 90 which was included in the very good category. Based on the table above, as many as 50% or 12 cadets in the experimental class get *postest* scores in the range of 70 – 79 or in the sufficient category, then as many as 37.5% or as many as 9 cadets get scores in the range of 80 – 89 or are included in the good category. While the remaining 3 cadets or as many as 12.5% who scored in the very good category with a range of values of 90 – 100. Overall, the average *postest* score of cadets in the experimental class was 79.83 (rounded to 80) or included in the very good category.

Based on the results of the comparison of *postest results in the control class and the experimental class above, it can be seen that* in the experimental class the average postest score achieved by cadets is in a higher category than the results of the *cadet* postest in the control class. This result is in line with the results of correlation testing in the table above, which shows the influence of using the *Geogebra* learning application on cadet learning outcomes. The increase *in postest* scores in experimental classes shows that the use of *the GeoGebra* application has a more significant impact on cadets than conventional learning.

The learning experience using the *GeoGebra* application based on the results above, is able to provide more understanding for cadets in receiving circle tangent material so as to increase the value of cadet *postests* in experimental classes compared to cadets in control classes who only get learning with conventional methods.

CONCLUSION

Based on the results of the research that has been obtained, the conclusions in this study are as follows:

1. The use of the GeoGebra application has a positive effect on the learning outcomes of Makassar Shipping Science Polytechnic cadets with a correlation coefficient of 0.518
2. There are differences in learning outcomes in the control class with the experimental class. The average learning outcomes in the control class were in the good category and in the experimental class were in the very good category.

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