LEARNING TRIGONOMETRIC FUNCTIONS WITHGEOMETER'S SKETCHPAD FORIMPROVING LEARNING RESULTSSTUDENT MATHEMATICS IN CLASS X SMA/MA

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Abstract
There are many factors that cause low mathematics learning outcomes, including trigonometric function material, including the difficulty of illustrating images of trigonometric functions concretely, taking a long time to draw graphs on the blackboard, and less attractive images presented manually. For this reason, learning innovations are needed that can develop visual abilities. students through Geometer's Sketchpad software learning media. The aim of this research is to find out how student learning outcomes with the help of Geometer's Sketchpad software can be better than student learning outcomes without Geometer's Sketchpad in class X SMA/MA. This research is a quantitative research with a pretest-posttest control design research design. Sampling in this research was taken by total sampling. Based on the results of data analysis, conclusions can be drawn (1) Learning trigonometric functions in class with the help of Geometer's Sketchpad. The teacher uses infocus and guides students in the process of drawing graphs and students are also able to explain the amplitude, period, maximum and minimum values and are able to write equations that match the graph. It is stated that the application of Geometer's Sketchpad software in learning trigonometric function material is better than learning trigonometric functions without using software. Proven by the posttest score which significantly increased compared to the pretest score for the experimental class (2) The results of the posttest data for the experimental and control classes were carried out and obtained t_count>t_table, namely 5.87 > 1.68, so it can be concluded that H_0 is rejected, thus accepting H_1 . This means that the learning outcomes of trigonometric function material with the help of Geometer's Sketchpad can be better than the learning outcomes of students without Geometer's Sketchpad in class X SMA/MA.

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Keywords: *Learning, Trigonometric Functions, Comparing Learning Results Student Math,Geometer's Sketchpad*

INTRODUCTION

Many factors cause low mathematics learning outcomes, including trigonometric function material, including difficulty in illustrating trigonometric function images concretely, taking a long time to draw graphs on the blackboard, and less attractive images presented manually. These three things are the cause of many students who are less motivated in learning mathematics, which has an impact on their learning outcomes.[1]

To foster students' motivation to learn mathematics, teachers need to develop learning through the use of learning media that is in line with developments in digital technology. This is in accordance with opinionLemi Indriyani, he said that the use of learning media during teaching and learning can foster motivation and desire to learn and also have a psychological influence on students. The use of learning media can help learning effectiveness and be able to convey targeted lesson content. This means that learning media can arouse students' enthusiasm and interest, and can also increase students' understanding in studying mathematics, including trigonometric function material.[2]

A mathematics learning media related to graphic illustration is Geometer's Sketchpad software. This software application is dynamic mathematics software which is quite interactive and easy to use in the learning process. Function drawing illustrations assisted by Geometer's Sketchpad software help students understand the concept of trigonometric functions. The image and animation features that appear during the process of drawing trigonometric functions help students imagine to concretize the concept of trigonometric functions. This is in line with the research results of Hordiyanto and Danar Santoso that learning assisted by the Geometer's Sketchpad (GSP) application significantly influences understanding of analytical geometry concepts.[3]

Based on the background description, which becomes the formulation of the problem in This research is whether the learning outcomes of trigonometric function material with the help of Geometer's Sketchpad can be better than the learning outcomes of students without Geometer's Sketchpad in class X SMA/MA.

RESEARCH METHODS

Types of research

This quantitative research uses experimental methods and Quasi Experimental Design. Researchers took two classes that would be given different treatments, namely the control class and the experimental class. The experimental class and the control class were given a pretest to see the initial abilities of students and then given treatment for the experimental class while the control class only did learning with the conventional system. At the end of the two classes, a posttest was given to see the effect of the comparison of the media on their learning outcomes.[4]

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[1] Vani Rahmayani, "*Strategi Peningkatan Motivasi Siswa dalam Pembelajaran Matematika di Kelas"*, Jurnal Pendidikan Guru, Vol.2, No.1, 2020, h.18.

[2] Slameto, *Belajar dan Faktor-faktor yang Mempengaruhinya,* (Jakarta: Rineka Cipta, 2003), h. 91.

[3] Dodi Syamsuduha, *Pengaruh Pembelajaran Kooperatif Berbantuan Program Geometer's Sketchpad terhadap Peningkatan Kemampuan Berpikir Kritis Matematik Siswa SMP,* http: core.ac.uk, diakses pada tanggal 23 April 2022 pukul 14.25 WIB.

[4] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*, (Bandung: Alfabeta, 2016), h. 7.

Research Time and Place

The school's data collection schedule is from 27-31 May 2022. The target school is SMAN 1 Bakongan which is located at Jalan Skep Keude Bakongan, Bakongan District, South Aceh Regency.

Population and Sample

The population in this study was all students in class The learning process carried out by teachers is still conventional and does not use digital learning media including Geometer's Sketchpad (GSP). This research uses nonprobability sampling, namely a sampling technique that does not give each element or member of the population the same opportunity to be selected as a sample, so the researcher will use a total sampling technique where all members are sampled (Sugiyono, 2016). What is meant by random here is in terms of selecting the class using a random number table. One class is given treatment, usually called the experimental class, and the other one is monitored or called the control class.

Research Instruments and Data Collection Techniquesa

Some of the instruments needed by researchers to conduct this research are test questions and observation sheets.While the observation sheet is divided into two, namely the observation sheet of student activities while studying and the observation sheet of the teacher's ability when teaching.

The data collection technique used is the test questions used to determine student learning outcomes. The test questions were tested at the beginning of learning (pretest) and at the end of learning (posttest) after using Geometer's Sketchpad as a learning medium for material on trigonometric functions. The test questions are in the form of essay questions as many as 5 questions where the questions used have gone through a validation test.

While the observation sheet is divided into two, namely the observation sheet of student activities while studying and the observation sheet of the teacher's ability when teaching. The observation sheet is in the form of a rubric that has been determined according to the learning process carried out by the teacher and students.

Data analysis technique

The data analysis technique for the learning outcome test used the t-test.The hypothesis testing with t-test as follows:

- Hypothesis testing

  The formula used is: $=t_{hitung}\frac{\bar{x_1}-\bar{x_2}}{S\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}$

- Normality test

  The formula used is:$X_h{}^2=\sum\frac{(f_0-f_h)^2}{f_h}$

- Homogeneity Test

  The formula used is:$F=\frac{S_1{}^2}{S_2{}^2}$

While the observation sheet for student activities while studying and teacher activities while teachingthe results will be analyzed using the formula:

$$P_{\text{student activities}} = \frac{skor\ yang\ diperoleh}{skor\ maksimal} \times 100\%^{5}$$

RESEARCH RESULTS AND DISCUSSION

Research result

The pretest and posttest scores obtained by students during the study in the control and experimental classes can be seen in the following table:

Table 1
Mastery of Control Class Students

Minimum Standard	Category	*Pretest*		*Posttest*	
		Frequency	Percentage	Frequency	Percentage
70	Not Complete	18	81.8%	19	86.4%
70	Complete	4	18.2%	3	13.6%
Total		22	100%	22	100%

Table 2
Experimental Class Student Completeness

Minimum Standard	Category	*Pretest*		*Posttest*	
		Frequency	Percentage	Frequency	Percentage
70	Not Complete	20	90.9 %	6	27.3%
70	Complete	2	9.1%	16	72.7%
Total		22	100%	22	100%

So the researchers made a bar chart to make it easier to see the differences in the results of the control and experimental class students' learning mastery from the posttest results, as follows:

[5] Riduwan, *Dasar-Dasar Statistika*, (Bandung: Alfabeta, 2015), hlm. 104.

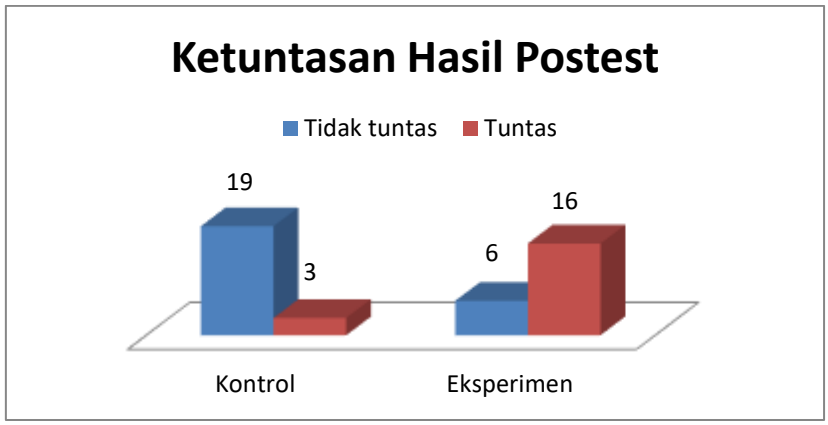

Image 1
Control and Experiment Class Posttest Results Completeness Bar Chart

So the experimental class students have higher mastery results compared to the control class. There were 16 students who completed the experimental class while the other 6 did not complete. In the control class, there were 3 students who completed while the other 19 did not complete.

After the analysis, it was concluded that all the data used were normally distributed and there was no difference in variance between the pretest of the control and experimental classes as well as between the posttest of the control and experimental classes. Then the hypothesis test is carried out, while the statistical hypothesis is:

H_0: $\mu_{1=}$ μ_2= The result of learning mathematics taught with *Geometer's Sketchpad*on the material of trigonometric functions there is no difference with the results of learning mathematicsstudents who are taught with learning without Geometer's Sketchpad on trigonometric functions material in class X SMA/MA

H_1: $\mu_1 > \mu_2$: Learning outcomes of mathematics taught with *Geometer's Sketchpad*on the material of trigonometric functions better than the mathematics learning outcomes of students whotaught by learning without Geometer's Sketchpadon the material of trigonometric functions in class X SMA/MA

Based on the above calculations, the value t_{hitung}= 5.87 with dk = 42. At the significant level = 0.05 with 42 degrees of freedom from the t distribution table, it is obtained t_{tabel}= 1.68. Because $t_{hitung} > t_{tabel}$ that is 5.87 > 1.68, it can be concluded that the learning outcomes of trigonometric function materials with the help of Geometer's Sketchpad can be better than the learning outcomes of students without Geometer's Sketchpad in class X SMA/MA.

Based on the research conducted by applying the Geometer's Sketchpad software in learning trigonometric functions, the researcher emphasizes that students are able to use the Geometer's Sketchpad software independently with teacher guidance in solving trigonometric function problems. At the first meeting, the teacher taught students how to graph the functions sin x, cos x, and tan x using the unit circle. Students are required to be able to understand the meaning of the unit circle in the graph of trigonometric functions. At the second meeting, the teacher taught how to determine the amplitude, period, maximum value and minimum value of trigonometric functions with Geometer's Sketchpad software. At the third meeting, the teacher taught how to form an equation from a graph of trigonometric functions.

Based on the percentage of student activity, it was found that observation-I was 87.5% so it was categorized as active, observation-II was 95.31%, it was categorized as very active and observation-III was 98.44%, it was categorized as very active. While the percentage of teacher activities managing learning in observation-I is 93.75%, which is categorized as very active, observation-II is 93.75%, which is categorized as very active, and observation-III is 100%, categorized as very active.

Discussion

The study was conducted on two classes, namely the experimental class consistingof 22 students and the control class consisting of 22 students. The implementation of the research began by giving pretest questions for the control class and the experimental class. The purpose of giving the pretest is to determine the variance of student learning outcomes in the control class and the experimental class. The results of the pretest data analysis of the control class and the experimental class showed that the learning outcomes of the control class and the experimental class were homogeneous, meaning that there was no significant difference in results between the control class and the experimental class. Therefore, the increase in student learning outcomes in the control class and experimental class can be seen from the results of the posttest.

Research in the experimental class was carried out using Geometer's Sketchpad as a medium for trigonometric functions, while in the control class it was carried out in a conventional way, using a blackboard as the medium. The learning process runs for 3 meetings. The next day, the researcher gave posttest questions for the control class and the experimental class to measure the learning outcomes of students after being given different treatments. The difference in the average learning outcomes of students in the pretest and posttest is used to measure the increase in student learning outcomes.

Research in the experimental class was very well done, students were more active in the learning process as indicated by the direct discovery of the graphs of sin x, cos x and tan x using Geometer's Sketchpad software assisted by the teacher. So that the creation of a pleasant classroom atmosphere in the learning process is strengthened by the observation sheet which states that it is increasing day by day.

In the experimental class, the use of LKPD when learning with Geometer's Sketchpad on trigonometric function material, the use of this LKPD can train students in solving problems using Geometer's Sketchpad. LKPD is done by students in groups, so students can discuss with their friends and be guided by the teacher if they have difficulties.

The results of learning trigonometric functions with Geometer's Sketchpad have increased, this can be seen from the calculation of the value of= 5.87 with dk = 42. At the significant level = 0.05 with 42 degrees of freedom from the distribution table t obtained = 1.68. Because > that is 5.87 > 1.68, it can be concluded that there is an increase in student learning outcomes with the help of Geometer's Sketchpad on trigonometric function material in class X SMA/MA.

In the journal Agung and Rizal, the results of their research entitled “Utilization of Geometer's Sketchpad in Painting Trigonometric Functions”, namely learning by using Geometer's Sketchpad can help students in painting trigonometric functions. So, it can be concluded that learning trigonometric functions with Geometer's Sketchpad is one way that can be taken in dealing with the problem of low learning outcomes (Agung & Rizal, 2017).

The results showed that students were very enthusiastic and took an active role in participating in learning with the help of Geometer's Sketchpad software, this made a difference

from before. Where in mathematics learning there has never been using software so students are very interested in carrying out learning.

There are several things that cause the use of Geometer's Sketchpad to help improve student learning outcomes, including because by using Geometer's Sketchpad students are able to visualize trigonometric graphs that are abstract and can understand the material clearly (Agung & Rizal, 2017). This is reinforced by the results of the researchers' findings when the posttest results were different from the control class and the experimental class.

*Geometer's Sketchpad*which is a geometric exploration tool that is applied with modern hardware, allowing students to be able to explore relationships dynamically so that students can see changes in geometric shapes when manipulating them (Dan Bennett, 2002). Based on Dan Bennett's research, he concludes that there are three important aspects to the effectiveness of Geometer's Sketchpad in the classroom, namely: ease of use Geometer's Sketchpad can be put to good use if the initial commands only require simple shapes, Sketchpad can integrate different geometry topics in a book way. , and become an opportunity for students to add insight from the form they do (Dan Bennett, 2002).

Based on the posttest data analysis of the control class students in table 4.6 regarding the mastery of the control class students, it was found that 86.4% were still categorized as incomplete and only 13.6% were completed from the specified KKM score. There are still many students whose learning outcomes are still below average.

While the posttest data analysis of experimental class students in table 4.7 regarding the experimental class students' completeness, it was found that 27.3% were still categorized as incomplete and 72.7% had reached the complete value of the KKM scores applied. It can be seen that more than 50% of students in the experimental class are able to understand learning trigonometric functions with the help of Geometer's Sketchpad, which is indicated by their improved learning outcomes.

Based on the explanation above, it can be concluded that the low student learning outcomes in trigonometric function material can be overcome by using Geometer's Sketchpad. Thus, it is clear that student learning outcomes with the application of Geometer's Sketchpad software in learning material on trigonometric functions are better than student learning outcomes without Geometer's Sketchpad in class X SMA/MA.

CONCLUSION

Based on the results of the research carried out regarding learning trigonometric functions with Geometer's Sketchpad, the researcher drew several conclusions: The teacher demonstrates learning trigonometric functions in class with the help of Geometer's Sketchpad. The teacher uses infocus and guides students in the process of drawing graphs and students are also able to explain the amplitude, period, maximum value and minimum value and are able to write equations that match the graph. It is stated that the application of Geometer's Sketchpad software in learning trigonometric function material is better than learning trigonometric functions by not using software. It is proven by the posttest value which is significantly increased from the pretest value of the experimental class. And From the calculation and analysis

of posttest data for experimental and control students, so $t_{hitung} > t_{tabel}$ is 5.87 > 1.68, the student learning outcomes with application Geometer's Sketchpad software in learning trigonometric function material is better than the learning outcomes of students without Geometer's Sketchpad in class X SMA/MA.

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