USING PHOTOMATH APPLICATIONS ON STUDENT LEARNING OUTCOMES IN ADVANCED CALCULUS COURSES

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A r t i c l e   I n f o

A b s t r a c t s

Along with the development of the times, the world of education is much influenced by advances, especially in the field of information and communication technology. Many educators use technology as a learning medium to help students learn and solve problems, especially math problems. There are several applications that students use to help them complete lecturer assignments. Photomath is one of the applications used by students in mathematics lessons. This application can be accessed via a smartphone and has features that help students solve math problems. This study aims to determine the effect of using the Photomath application on the learning outcomes of Tadris Mathematics students in semester 4 of the State Islamic Institute (IAIN) Kediri. The number of samples used in this study were 45 students, which were divided into two groups. The experimental group consisted of 24 students and the control group consisted of 21 students. The analysis used in this study is a t-test to compare whether there are differences in student learning outcomes in advanced calculus courses when solving problems using the Photomath application and not using these tools. The results obtained show that there are significant differences between students who use the help of the Photomath application and those who do not. So it can be concluded that the use of the Photomath application has an effect on student learning outcomes at IAIN Kediri's mathematics tadris in advanced calculus courses.

Keyword:
Advanced Calculus, Learning Outcomes, Photomath

Introduction

In recent years, artificial intelligence has helped humans a lot in solving cognitive problems in all fields, education is one of them. It cannot be denied that the effects of the Covid-19 pandemic have made many changes in the world of education (Nesi, et al, 2021). During the Covid-19 pandemic, students were required to do online or online learning so as to make students' technological abilities more sophisticated. Online learning is learning that uses the internet with accessibility, connectivity, flexibility and the ability to produce various learning interactions (Effendi, et al, 2021). The use of internet and multimedia technology can change the delivery of information and provide an alternative for learning in the classroom. During online or online learning, apart from using internet technology to access online classes, students

also often use internet technology to find answers to assignments given by lecturers. In online learning (online), digital technology has a very important contribution so that learning can be achieved properly. Digital technology that is currently developing rapidly is making very significant changes to the world of education, especially in the process of learning mathematics (Scientist, et al. 2022).

Learning in the era of the Covid-19 pandemic requires additional work from mathematics lecturers to present abstract mathematical objects to students, especially since learning is not carried out directly in class. To overcome this, lecturers need media that can convey abstract mathematical concepts to students (Damayanti & Qohar, 2019). Calculus course is a compulsory subject that must be taken by students of the Mathematics or Mathematics Education study program. For mathematics education students as teacher candidates, this course is not only basic material, but also teaching material for prospective high school students. Calculus is a very important branch of mathematics and is widely applied in other fields such as science and technology, agriculture, medicine, economics, and others (Susilo, et al. 2021). Advanced calculus courses cover Differential Calculus and Integral Calculus material but discuss higher variables.

In the current 4.0 revolution era, more emphasis is placed on artificial intelligence models, digital economy, robotics, etc. known as disruptive innovation (Rahman, 2019). Muttaqin (2023) conducted research on the use of the Math way application as a tool to help students in facilitating learning activities and solving math problems because the Math way application can see the process of solving problems up to the final result. Fikri (2023) conducted quantitative descriptive research regarding the implementation of learning mathematics with the help of the Photomath application in solving Mathematics problems which can be carried out in 4 stages, namely: planning, implementation of the Photomath application, evaluation results, and constraints/weaknesses in using the Photomath application. Therefore, the researcher wanted to examine the effectiveness of using the Photomath application in working on advanced calculus problems done by Mathematics students of the Tadris Mathematics Study Program. In this study, the effectiveness of the Photomath application will be seen by comparing the two methods of working on the problems, namely by working on the questions manually and working on them using the help of the Photomath application.

Methods

The data used in this research is primary data. The data collection technique is by taking the grades of advanced calculus course assignments. The grades for the advanced calculus course taken were Tadris Mathematics students at the State Islamic Institute (IAIN) Kediri semester 4 class of 2020/2021. The number of samples in this study were 45 students, where class A students consisted of 24 students and class B consisted of 21 students. Where there is class A which is an experimental sample that is working on advanced calculus questions using the photomath application and class B samples that are not given treatment. The questions tested for students are shown in Figure 1.

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DOSEN PENGAMPU : KURNIA AHADIYAH, S. SI., M. SI   WAKTU QUIZ: 13.00 WIB – 15.00 WIB
MATA KULIAH   : KALKULUS LANJUT

1. Sketsalah grafik fungsi $f(x,y) = \sqrt{96 - x^2 - y^2}$ [POIN : 15]
2. Sketsalah grafik fungsi $f(x) = x^2 - 4y^2 - 7x + 24y - 25$ [POIN : 15]
3. Sketsalah grafik fungsi $f(x,y) = \frac{x^2 + y^2 - 9}{5}$ [POIN : 15]
4. Sketsalah grafik fungsi $f(x,y) = \sqrt{114 - x^2 - 4y^2}$ [POIN : 15]
5. Hitunglah turunan parsial dibawah ini dengan menggunakan definisi turunan parsial melalui pendekatan limit !
   [POIN : 30]
   a. $f(x,y) = x^{10}y^{-2} - 7yx^2$, tentukan $f_y(x,y)$ dan $f_y(2,-5)$
   b. $f(x,y) = \frac{2x^2 + y^2}{\sqrt{x}}$, tentukan $f_x(x,y)$ dan $f_x(0,-2)$

Figure 1. The questions tested for students

This research is a quantitative study using an analysis of the difference in the means of two independent samples with the t-test. The method used in this study consists of several steps as follows:

1. Conduct descriptive analysis of student grade data, descriptive analysis can use numerical or visual methods.
2. Test the normality of the data in each group using the Kolmogorov-Smirnov normality test.
3. Test the homogeneity of variance to find out whether the variance is homogeneous or heterogeneous. If the variance to be tested is only two groups, then the homogeneity test of variance with the F test can be used.
4. Based on the homogeneity test, then the average difference test is then carried out using the independent t-test. If it shows homogeneous results then use the independent t-test formula with a combined variance (equal variance) usually called the student t test. When showing heterogeneous results, use the independent t-test formula with a different variance (unequal variance) which is usually called the t-welch test.
5. Making decisions and conclusions on the results of the analysis.

The analysis in this study used a statistical software tool, namely Minitab.

Results and Discussion

In this research, the first step is descriptive analysis. Descriptive analysis is used to find out the general score of Tadris Mathematics students at the State Islamic Institute (IAIN) Kediri semester 4 class of 2020/2021. The following are the results of the descriptive analysis which can be seen in Table 1.

Table 1. Descriptive Statistics

Group	Number of Students	Average value	Max Value	Min Value
Experiment	24	81	87.7	72.8
Control	21	76.8	88	55

Based on the table above, information can be obtained about the number of samples in each group, the average value, and the maximum and minimum values. The number of students in the control group was 24 students while in the control group there were 21 students. The average student score in the experimental group was 81 and the control group was 76.8, where the average experimental group was higher than the control group. The experimental group had the highest score of 87.7 and the lowest score of 72.8, while the control group had the highest score of 88 and the lowest score of 55.

Apart from looking at descriptive analysis numerically, you can also use a visual method. Data visualization is used to get an overview easily and quickly. One of the data visualizations that is usually used is the boxplot to see the distribution of data between the two groups. The following is a boxplot of student learning outcomes in advanced calculus courses between the experimental and control groups which can be seen below.
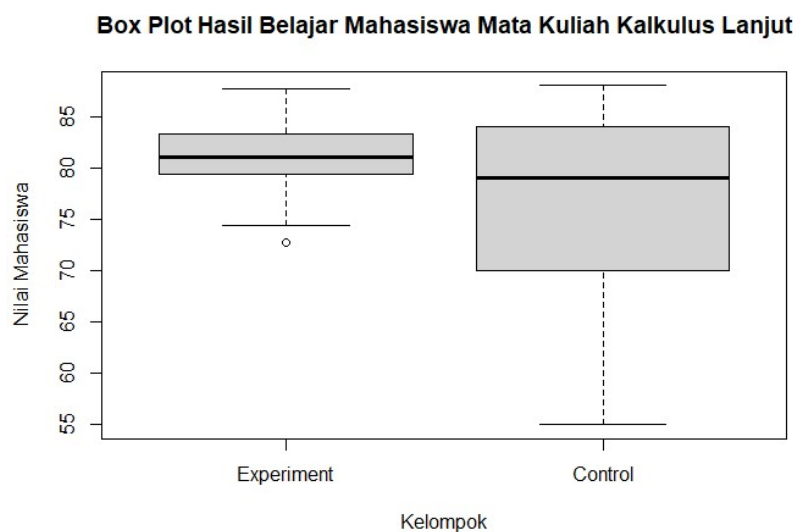

Figure 2. Experimental and Control Group Boxplots

Based on the boxplot above, it can be seen that the boxes formed in the experimental group are smaller than the controls. This means that the distribution of scores in the experimental group, namely those working on advanced calculus questions using the help of photomath, is narrower with not too large a diversity compared to the control group who worked on the questions manually. The lines at the top and bottom end show the maximum value and minimum value. On this line the maximum value in the experimental and control groups is almost the same, while the minimum value shows the difference that the minimum value in the experimental group is higher than the control group.

After the descriptive analysis is carried out, the next step is to test the assumption of the difference in the mean of the two independent samples, namely the data normality test. The data normality test was carried out for each group. In this study, the data normality test was carried out using the Kolmogorov-Smirnov test in the control group and the group with the following treatments.

Table 2. Kolmogorov-Smirnov Normality Test Results

	Experiment	Control
Test Statistics	0.132	0.130
Asymp. Sig. (2-tailed)	0.150	0.150

Based on the results of the data normality test in table 2 above the Asymp value. Sig. (2-tailed) for the experimental group a value of 0.150 was obtained and for the control group a value of 0.150 was obtained for both groups producing the same value and greater than the

significance level of 0.05. So based on the decision-making guidelines, it can be concluded that the two groups, namely the experiment and the control, fulfill the assumption of data normality. The normality assumption is important, if the normality assumption is met in each group then it can be continued with parametric statistical tests. One of the parametric statistical tests is the test of the average difference of two independent samples or independent t-test.

Furthermore, the assumption that must be carried out is the homogeneity test of variance. Homogeneity test is used to determine whether several population variants are the same or not. This test is carried out as a prerequisite in the independent sample t test analysis. There are several formulas that can be used to test the homogeneity of variance including the F test, Bartlett's test, Levene's test, Cochran's test, and Harley's test. The following is a homogeneity test of variance using the F test.

Table 3. Variety Homogeneity Test

Method	Statistic	p-Value
F Test	6.227	0.000

Based on table 3 above, it can be seen that based on the homogeneity test of variance using the F test method it produces a p-value of 0.000. This value is less than the significance level of 0.05, so it can be concluded that the homogeneity of variance is not met. If the homogeneity test of variance for the experimental and control groups is not fulfilled, it can still be continued to the independent t test, because the homogeneity test is not a reference for absolute assumptions that must be fulfilled in the independent t test. In several studies, it is stated that the homogeneity test of variance does not absolutely have to be fulfilled. Because when the variance between the two groups is not homogeneous, an independent t test can still be carried out using the unequal variance t-test or usually called the Welch t test.

From the results of the assumption test that has been carried out, namely the assumption test of normality and homogeneity of variance, then a test of the average difference of two mutually independent groups can be carried out. The following is the result of a comparison test of two averages using the t-welch test.

Table 4. *Welch's* t test results

t-Value	DF	p-Value
2,19	25	0.038

The results of statistical hypothesis testing were carried out using the Independent test with the Welch t-test which can be seen in table 4 above. Based on the table it can be seen that the p-value of the t-welch test yields a value of $0.038 < $ a significance level of 0.05 so that according to the hypothesis testing rules this shows H0. It can be concluded that there is a significant difference between the experimental group and the control group. This means that there are differences in the learning outcomes of students in semester 4 of Tadris Mathematics at IAIN Kediri between class A (experimental group) who are given advanced calculus questions using potomath assistance and class B (control group) who work on advanced calculus questions manually.

Conclusion

Based on the results of the analysis that has been carried out by testing using the average difference test of two independent samples with the t-welch test. Where the t-welch test produces a significance value of $0.038 < 0.05$ (significance level). So it can be concluded that there are differences in the learning outcomes of students who work on advanced calculus

questions using the help of photomath and students who work on them manually. Utilization of the photomath application as a media for solving mathematical problems can help students solve mathematical problems, especially in advanced calculus courses.

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