The Effect of the Flipped Classroom Learning Model on Students' Learning Outcome in Multivariable Calculus Course

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ABSTRACT

The COVID-19 pandemic that occurred starting in early December 2019 had a major impact on the world of education. Therefore, it is necessary to develop a flipped classroom-based mathematical learning model. The purpose of this study was to find out the effect of flipped classroom-based mathematical learning model on students of the Mathematics Education study program on Multivariable Calculus courses. This research is a pseudo-experimental study. The subject of this study is a mathematics education student who is pursuing multivariable calculus courses that are directly involved in the learning model applied at West Kalimantan which is divided into two classes with each class consisting of 15 students. Experimental classes are given learning using Flipped Classroom-based learning models while control classes are given learning with online learning using *google classroom*. This research design uses a randomized control group posttest only design. Data analysis techniques also use *Mann-Whitney* nonparametric hypothesis tests. The results of the study that has been conducted show a significance value of 0.015 less than the significance level of 0.05 so it can be concluded that there is a real difference between the control learning model and the Flipped Classroom model or the flipped classroom learning model effective to improve student learning outcomes.

Keywords: Flipped Classroom, Mathematics, Multivariable Calculus

ABSTRAK

Pandemi COVID-19 yang terjadi mulai awal Desember 2019 memberikan dampak yang besar di dunia pendidikan. Oleh karena itu, perlu untuk mengembangkan model pembelajaran matematika berbasis *Flipped Classroom.* Tujuan dari penelitian ini adalah untuk mengetahui pengaruh model pembelajaran matematika berbasis *Flipped Classroom* pada mahasiswa program studi Pendidikan Matematika pada mata Kuliah Kalkulus Lanjut. Penelitian ini merupakan penelitian eksperimental semu. Subjek penelitian ini adalah mahasiswa Pendidikan matematika yang sedang menempuh mata kuliah kalkulus lanjut yang terlibat secara langsung terhadap model pembelajaran yang diterapkan di salah satu perguruan tinggi di Kalimanta Barat yang terbagi menjadi dua kelas dengan masing-masing kelas terdiri dari 15 orang mahasiswa. Kelas eksperimen diberikan pembelajaran dengan menggunakan model pembelajaran berbasis *Flipped Classroom* sedangkan kelas kontrol diberikan pembelajaran dengan pembelajaran daring menggunakan google classroom. Desain penelitian ini menggunakan *randomized control group posttest only design.* Teknik analisis data juga menggunakan uji hipotesis non parametrik Mann-Whitney. Hasil penelitian yang telah dilakukan menunjukkan nilai signifikansi sebesar 0,015 kurang dari taraf signifikansi 0,05 sehingga dapat disimpulkan bahwa terdapat perbedaan yang nyata antara model pembelajaran kontrol dengan model Flipped Classroom atau model pembelajaran Flipped Classroom efektif untuk meningkatkan hasil belajar siswa.

Kata kunci: *Flipped Classroom*, Matematika, Kalkulus Lanjut

Introduction

Ministerial Regulation of the Minister of Education of Indonesia Permendikbud No,41 in 2007 concerning Process Standards states that in the implementation of education teachers must develop the potential and creativity of students. Meanwhile, Permendikbud No 65 of 2013 states that the characteristics of learning in each educational unit are closely related to the Content Standards. Content Standards provide a conceptual framework for learning and learning activities derived from the level of competence and the scope of the material. To

achieve the above objectives, it is necessary to understand the teacher's understanding and skills of learning models (Damayanti & Sutama, 2016).

In education, there are two important things, namely cognitive aspects and affective aspects. When students learn something, it is not only thoughts that play a direct role but the feelings that exist in students such as feelings of pleasure, confusion, difficulty, enthusiasm, and other feelings that exist in students when learning. Humans do not automatically enter the world of work without going through the stages of learning obtained in the level of education carried out in schools. One of the stages of learning in completing education at a level of education is learning mathematics (Walidah et al., 2020).

The development of digital technology today has provided many advantages for anyone in accessing various information and connecting without crossing borders, without being limited by space and time (Farida et al., 2019). Educators today are showing great interest in innovative teaching approaches that address the needs of today (Santosa et al., 2020). Innovation in learning demands students to collaborate and communicate with each other to achieve desired to learn objectives so that students expected to be able to develop their communication skills. One such approach is the flipped classroom model. The flipped classroom is a relatively new learning strategy. This learning strategy is growing with technological advances, such as internet access and other supporting software (Susanti & Hamama Pitra, 2019).

Based on the results of the researchers' initial observations on students about the mathematics learning model. Students passively wait for the material to be delivered by the teacher. The learning model is monotonous so that students are less motivated to learn. Most of the learning patterns are still teacher center learning. Students are required to listen to and memorize the subject matter given by the teacher. Learning like this causes students to be unable to compose their knowledge and skills. Learning activities should use an approach that is a student-centered learning model. To increase interest and learning potential, students made active learning subjects. Students are directed to actively develop knowledge and skills according to their ability.

Based on the description above, the researcher feels the need to develop a flipped classroom-based mathematics learning model for students to examine the extent to which students' effectiveness in learning mathematics is. The Flipped Classroom-based Learning Model is one of the student-centered learning models to improve learning effectiveness (Ishak et al., 2019). In the past, educators generally used the lecture learning model, where the lecture learning model reflected teacher-centered learning. Learning then switches to an alternative model called Flipped Classroom (Suhendri & Andriyani, 2019). Flipped Classroom is a learning strategy that combines traditional learning (in the classroom) with learning outside the classroom (online) (Susanti & Hamama Pitra, 2019). The Flipped Classroom learning model changes the teacher's explanations and directions into explanations that can be accessed online by students outside and inside the classroom (Imania & Bariah, 2020). The Flipped Classroom learning model utilizes technology that supports material and can be accessed online (Usmadi & Ergusni, 2019). This Flipped Classroom strategy takes advantage of supporting technology learning materials for learners who can be accessed online. On approach, this lesson material must be studied by the participants educated at home before learning. Educators while in class did not explain the material in detail, but only review the video which has been given and the student working on question sheets. The researcher hopes that the development of the Flipped Classroom-based mathematics learning model will be an

alternative to develop students' creative potential, foster a sense of responsibility, and improve learning skills.

Research Methods

This research is aquasi-experimental research. The purpose of quasi-experimental research is to obtain information that is an approximation to the information that can be obtained by actual experimentation under conditions that do not allow to control and/or manipulate all relevant variables (Budiono, 2003). The research design used in this study was a Randomized Control Group Posttest Only Design. The subjects of this study were students who took Multivariable Calculus courses who were directly involved in the learning model. Subjects were divided into two classes, namely the experimental class and the control class. The experimental class was given learning using the Flipped Classroom-based learning model while the control class was given online learning using Google Classroom.

This research was carried out in the even semester of the 2020-2021 academic year at the Mathematics Education study program. The study was conducted in 5 meetings and at the end of the meeting, a posttest was given to measure the difference in the mastery of the material between the experimental class and the control class. The research instrument used was a description test. The research data is presented in the form of a table of values in the experimental class and the control class. The data analysis technique also uses the Mann-Whitney non-parametric hypothesis test to test the effectiveness of the Flipped Classroom-based learning model.

Result and Discussions

The results of this study are mathematics learning outcomes of students in the Multivariable Calculus courses. Over all the results of mathematics learning outcomes of the experimental class and the control class there are differences in the average value. The description of mathematics learning outcomes data is presented in Table 1 below.

Table 1. Description of Mathematics Learning Outcome Test Data

	N	Minimum	Maximum	Mean	Std. Deviation
Kontrol	15	7	80	35.60	24.292
Flipped Classroom	15	27	100	60.13	30.059
Valid N (listwise)	15				

From Table 1 it can be seen that the average value of the mathematics learning outcomes of the experimental class is higher than mathematics learning outcomes of the control class. It means that there are differences in mathematics learning outcomes of the experimental class and the control class. To find out the different significance of the mathematics learning outcomes of the experimental class and the control class, a statistical test was performed using the t-test. Formally the statistical hypothesis (Ho) and research hypothesis (H1) are as follows:

Ho: There is no significant difference in the mathematics learning outcomes of the experimental class and the control class
H_1: there is a significant difference in the mathematics learning outcomes of the experimental class and the control class

Hypothesis testing criteria that Ho is rejected the value of p-value (Sig.)<α. To conduct the analysis, an analysis prerequisite test is needed in the form of normality and homogeneity data tests. Test the normality of both data by using the Kolmogorov-Smirnov and Shapiro-Wilk test with the test criteria that the data are normally distributed if the p-value (Sig)> 0.05.The normality test is a prerequisite test for the analysis before inferential statistics is performed. The normality test is presented in Table 2.

Table 2. Normality Test of Mathematics Learning Outcome Test Data

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Kontrol	.273	15	.004	.864	15	.028
Flipped Classroom	.269	15	.005	.818	15	.006

Therefore, the Shapiro Wilk test shows the value of Sig. < 0.05 then the data is not normally distributed. Figure 1 is the Normal Q-Q Plot of the Control Class which shows the data is not normally distributed. While Figure 2 is a Normal Q-Q Plot from Flipped Classroom which shows the data is not normally distributed.
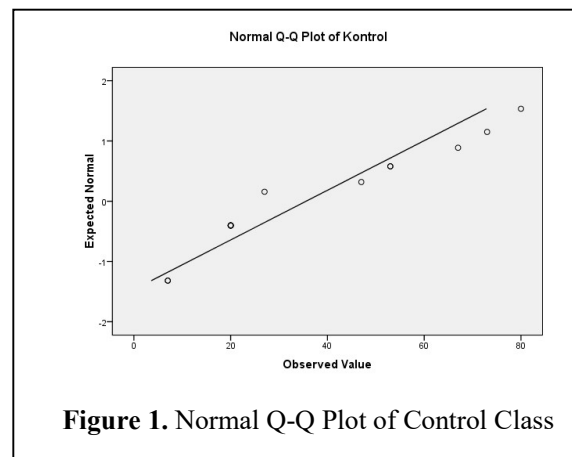

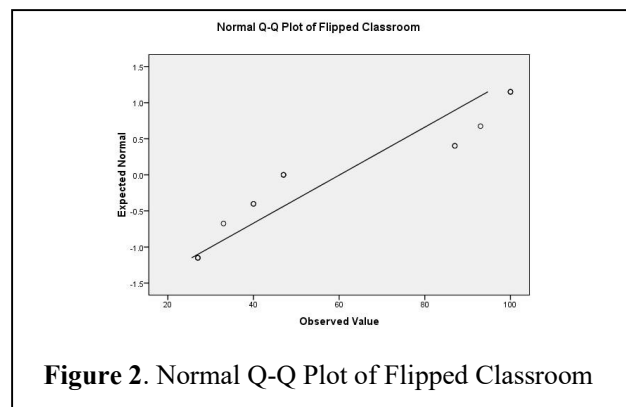**Figure 1.** Normal Q-Q Plot of Control Class

Figure 2. Normal Q-Q Plot of Flipped Classroom

Therefore, a non-parametric Mann-Whitney test will be carried out.

Table 3. Mann-Whitney Test Data on Mathematics Learning Outcomes

Grup	N	Mean Rank	Sum of Ranks
Kontrol	15	11.60	174.00
Flipped Classroom	15	19.40	291.00
Total	30		

Table 4. Statistical Test Results

	data
Mann-Whitney U	54.000
Wilcoxon W	174.000
Z	-2.444
Asymp.Sig (2-tailed)	0.15
Exact Sig.[2*(1-tailed Sig.)	0.015[a]

    a.   Not corrected for ties
    b.   Grouping Variable:grup

Based on the statistical tests in Tables 3 and 4, it can be seen that the significance value of 0.015 is less than the 0.05 significance level, so it can be concluded that there is a significant difference between the control learning model and the Flipped Classroom model or the Flipped Classroom learning model is effective for improving student learning outcomes. . This research is in line with research that examines the effectiveness of two teaching methods (Traditional Lectures and Flipped Classroom) in intermediate level Linear Sophomore algebra courses at Metropolitan University (Love et al., 2014). Other research shows that Flipped Classroom learning affects student learning outcomes in Integral Calculus material because it gives students a longer time to understand the material (Ario & Asra, 2018).

The flipped classroom in mathematics is an instructional strategy that requires a reconceptualization of traditional approaches to teaching and learning (Pharamita & Muchtar, 2013). This transition requires significant investment on the part of teachers and students; the time it takes to make the video; time to adjust class time; and time for students to get used to the new teaching and learning model. Flipped classroom learning combines learning models with technology so that learning becomes active and efficient which can form interactions between students and students and students with teachers to able to evoke independence and confidence of students who have tried to find and explore learning resources not only from teachers. (Purwitha, 2020). In flipped classroom learning, you can implement observing, gathering information, negotiating, and communicating activities (Yulianti & Wulandari, 2021). The flipped classroom turned the usual teaching model on its head. The idea is that students learn new content outside of class (usually online) and then tackle assignments within the lesson, giving teachers more time to help students with aspects they don't understand (Farida et al., 2019). Learning outcomes will be better with the activeness and independence of students in studying the material at home first (Kurniawati et al., 2019). Technology can make their level of achievement better and improve the teaching and learning of mathematics to students. The integration of technology in learning can help in improving the quality of learning because students become more skilled in utilizing technology in the learning process (Ramadhani & Fitri, 2020).

Conclusion
The results of the research that have been carried out show a significant difference between the control learning model and the Flipped Classroom model or the Flipped Classroom learning model is effective for improving student learning outcomes. This shows that there is an effect of Flipped Classroom learning on students' Multivariable Calculus learning outcomes in Multivariable Calculus courses. This effect can be seen in the average difference in student learning outcomes where the average student learning outcomes taught using the Flipped Classroom model are higher than the average Multivariable Calculus learning outcomes of students taught online learning using Google Classroom.

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