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Research Article

The Flipped Classroom: Enhancing Students' Learning in Teaching Calculus

Engr. Joven C. Cablas*

Guimaras State College, Buenavista, Guimaras, Philippines

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**Corresponding author:*
E-mail:
ananda.406202121@stu.untar.ac.id

ABSTRACT

Educators have faced difficulties in efficiently teaching within the present regular school system. State, university, and college officials have been pressed to shift from face-to-face classes to teaching methodologies that address the constraints of the traditional method of instruction. Digital natives, also known as modern educators, spend more class time connecting with students and filling learning gaps with technological tools. To assist the development of learning, they began using interactive movies, interactive in-class activities, and video conference technologies. This includes utilizing a Flipped Classroom. This effort determined the effect of employing the flipped classroom technique in teaching Calculus in order to solve the issues experienced in teaching Mathematics during the new normal. The study included 20 first-year Electrical and Mechanical Engineering students who were enrolled in the second semester of the academic year 2019-2020 students whose problem-solving abilities and Calculus ability were assessed using a researcher-created test. A One-Group Pretest-Posttest Experimental Design was used by the researcher. The experimental study used four sessions of video instruction during pandemic season before the online class interactions. The researchers feel that flipped classrooms are appropriate for teaching Calculus since slow learners can watch the video repeatedly until they understand the material. As a result, assignments in the classroom focused on collaborative learning. As seen by the posttest findings, the use of the flipped classroom technique helped students enhance their problem-solving skills and mastery of solving Calculus issues. Thus, the flipped classroom method was found to be helpful in improving students' problem-solving skills and performance in Calculus among Guimaras State College's College of Engineering and Industrial Technology students.

Keywords: *Calculus teaching, Engineering Education, Flipped Classroom, Learning Strategies*

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Introduction

Background of the Study

The primary goal of this study is to investigate the influence of flipped classroom in teaching Calculus to B.S. students. in Electrical Engineering and B.S. Students of Mechanical Engineering. As a result, Calculus is one of the most diverse and intricate subjects in higher education, and it is frequently cited as the most difficult course in any engineering license exams. Calculus, meanwhile, is regarded to be the cornerstone of all advanced engineering curricula. In addition, Calculus is trademarked as the most difficult Mathematics subject, labeled as the least in terms of student demands and interests, and distributed as the course with the least connection to real-life circumstances. However, some students lack the necessary mathematical ability to complete and pass Mathematics courses. As a result, some students experience anxiety because they are terrified of failing these classes. Mathematics teachers struggle to determine which pedagogical method to use within the classroom environment. As a result, mathematics professors must innovate in order to maintain students' interest.

Currently, flipped classroom techniques are being used in several parts of Asia to improve students' Calculus achievement. The flipped classroom is an educational technique in which activities that have historically taken place inside the classroom take place outside the classroom and vice versa. In comparison to typical classrooms, the flipped classroom atmosphere assures that students become more active participants (Huseyin Uzunboylu, Damla Karagozlu, 2015). Granata (2014) defines flipped classroom as "the use of Web-enabled instructional strategies that allow educators to spend class time interacting with students rather than lecturing." It has emerged as a new catchphrase in the realm of education. This includes sending students an instructional video to watch online prior to the class as an assignment, while problem-solving or other hands-on work occurs during the session. Furthermore, it is a sort of blended learning that reverses the usual learning context by presenting instructional content outside of the learning setting, generally online. It is used by teachers to review and reinforce classroom activities. Furthermore, flipping the classroom means substituting group or individual activities that promote dynamic and interactive learning for long and tedious lecture time.Furthermore, the concept behind this is that professors may spend more time in the classroom dealing with students who need their support, and students can work together to solve difficulties rather than sitting alone at home (Nwosisi, 2016). Furthermore, most students viewed the flipped classroom favorably, citing the flexibility to pause, rewind, and review lectures, as well as increased individualized learning and teacher availability. Flipped classrooms are an instructional technology concept that has gained traction in high school and middle school settings, using the potential of technology to create student-centered classes.

This study intends to determine the usefulness of flipped classrooms in increasing students' mathematical achievement while decreasing their anxiety. The researcher argues that flipped classrooms are appropriate for teaching Calculus since students can watch the video over and over again until they understand the material. Because guided training through videos is now available, parents will no longer have to worry about how to teach their children. The researchers then considered conducting an experimental study on the usage of Flipped Classroom in teaching Calculus among Guimaras State College's College of Engineering and Industrial Technology students.

Motivation and Objectives

The purpose of this study was to use a flipped classroom method as an intervention to help first-year electrical/mechanical engineering students improve their problem-solving skills in Calculus. As a result, the researchers will assess the effectiveness of flipped classrooms in teaching Calculus.

It specifically tried to answer the following questions:

1. What was the experimental group's Calculus performance prior to the intervention?
2. What is the experimental group's posttest Calculus performance after the intervention?

3. How do students feel about the flipped classroom technique?
4. Is there a significant difference between the pretest and posttest results of the respondents utilizing flipped classroom in teaching Calculus?

Statement of Contribution

H_1: There is no significant difference between the pretest and posttest results of subjects utilizing flipped classroom in teaching Calculus.

Methods

The flipped classroom model employs a mastery learning concept, which requires each student to master one topic before moving on to the next. Benjamin Bloom's Mastery Learning Theory will be used in this investigation. According to this approach, teachers first construct the concepts, principles, and skills they want their students to master, which usually takes approximately a week or two of classroom time (Guskey, 2005). Following the initial instruction of the unit, teachers provide the first formative assessment based on the unit's set of particular learning outcomes. Similarly, the goal of the first formative evaluation is to provide feedback on the students' progress.

It may provide information to students to help them identify what they have learnt and what they need to learn. The teacher then gives the students "corrective" assignments to work on the area they have not yet mastered. Furthermore, the teacher may differentiate between alternate learning resources such as textbooks, handouts, CDs, films, or electronic instructional lessons, which may or may not be combined with activities. Corrective measures are "personalized." The second formative evaluation will take done after the feed backing and completion of "corrective" exercises. The second evaluation is similar to the first assessment's principles and skills, but with minor variations on the offered tasks or questions. As a result, the second evaluation verifies whether or not the correctives were successful and gives pupils a second opportunity at success. Furthermore, Bloom advocated that these kids be supplied with "enrichment" activities to enhance their knowledge, abilities, and learning experiences in order to continue their learning growth. Teachers may assign projects, reports, academic games, or problem-solving activities.

Conceptual Framework

The experimental group served as the independent variable in this study, which involved first-year Electrical and Mechanical Engineering students. In addition, the Flipped Classroom technique is an intervening variable. Furthermore, the dependent variable is to improve students' capacity to solve mathematical calculus issues.

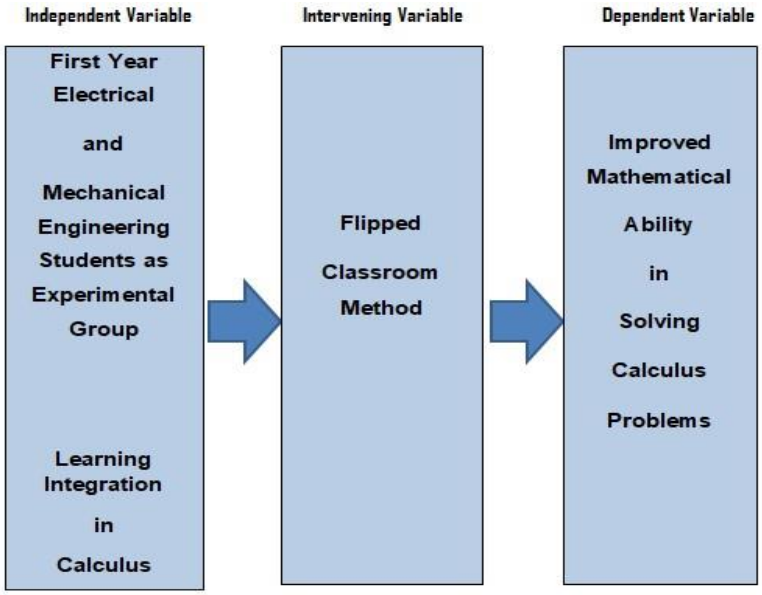


Figure 2. Conceptual Paradigm showing the independent, intervening and dependent variables

Results and Discussion

Via posttest scores and satisfaction of the students toward the flipped classroom approach, an appraisal was made to determine its efficacy. This section covers the result of students' performance before the intervention, the result of students' performance after the intervention, attitude of the students toward flipped classroom, and the determination of significant difference between pretest and posttest outcomes of the respondents utilizing flipped classroom in teaching Calculus in Mathematics using Statistical Package for the Social Sciences version 22 (SPSS v.22).

An evaluation of the efficacy of the flipped classroom approach was done using posttest scores and student satisfaction. This section discusses the results of students' performance before and after the intervention, the students' attitudes toward flipped classroom, and the determination of a significant difference between pretest and posttest outcomes of respondents using flipped classroom in teaching Calculus in Mathematics using the Statistical Package for the Social Sciences version 22 (SPSS v.22).

Discussions

Students' Academic Performance Before the Intervention

Table 1 provides the information on the students' academic performance before the intervention in terms of pretest score, percentage equivalent, description, numerical equivalent, percentage, and frequency.

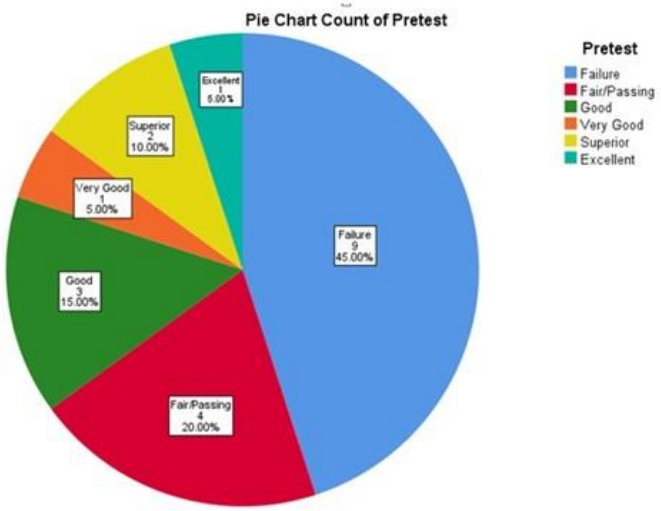


Table 1. Students' Academic Performance Before the Intervention in the Experimental Group

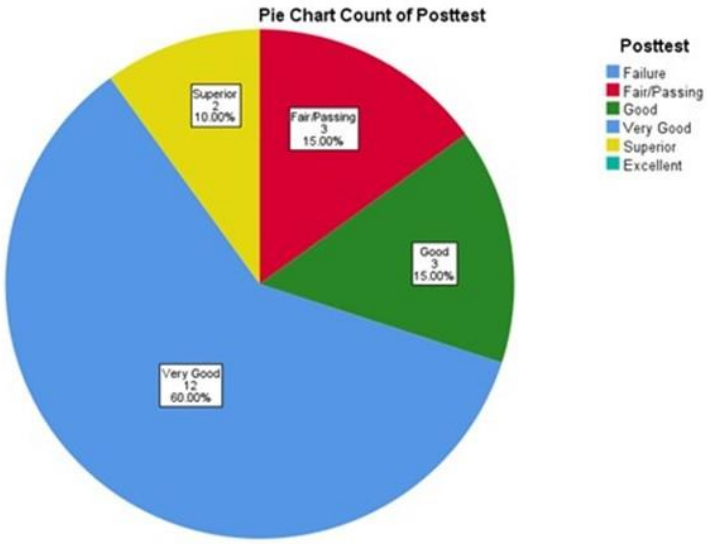
Pretest Score	Numerical Equivalent	Percentage Equivalent	Description	Frequency	Percentage
20	1.0	95	Excellent	2	10
18 – 19	1.1 – 1.5	90 – 94	Superior	1	5
15 – 17	1.6 – 2.0	85 – 89	Very Good	1	5
13 – 14	2.1 – 2.5	80 – 84	Good	3	15
10 – 12	2.6 – 3.0	75 – 79	Fair/Passing	5	25
0 – 9	5.0	65 – 74	Failure	8	40
			Total	20	100%

According to Table 1, the majority of respondents, 5 or 25%, received a score of 10 to 12, with a proportion equivalent of 75 to 79 percent described as Fair/Passing. The remaining 3 percent, or 25%, received a score of 13 to 14, with a percentage equivalent of 80 to 84 percent rated as Good. Furthermore, 2 percent or 10% received a score of 20 with a

percentage equal of 95% characterized as Excellent. However, 1 or 5% of those who received a score of 18 to 19 and 15 to 17 with a percentage equal of 90 to 94 and 85 to 89 were rated as Superior and Very Good, respectively. Furthermore, 8 or 40% of respondents had a score of 0 to 9.

Students' Academic Performance After the Intervention

Table 2 shows the students' post-intervention academic performance in terms of pretest score, numerical equivalent, percentage equivalent, description, frequency, and percentage.



According to Table 2, the majority of respondents, 3 or 15%, received a score of 10 to 12, with a proportion equivalent of 75 to 79 percent defined as Fair/Passing. The remaining 5 percent, or 25%, received a score of 13 to 14, with a percentage equivalent of 80 to 84 percent rated as Good. However, no respondent received a score of 20 and 0 with a percentage equivalent of 0% for Excellent and Failure. Furthermore, 10 percent or 50% of those who received a score of 15 to 17 with a percentage equivalent of 85 to 89 were rated as Very Good. Furthermore, 2 or 10% of respondents received a score of 18 to 19, with an equivalent number of 90 to 94 percent described.

Table 2. *Students' Academic Performance After the Intervention in the Experimental Group*

Pretest Score	Numerical Equivalent	Percentage Equivalent	Description	Frequency	Percentage
20	1.0	95	Excellent	0	0
18 – 19	1.1 – 1.5	90 – 94	Superior	2	10
15 – 17	1.6 – 2.0	85 – 89	Very Good	10	50
13 – 14	2.1 – 2.5	80 – 84	Good	5	25
10 – 12	2.6 – 3.0	75 – 79	Fair/Passing	3	15
0 – 9	5.0	65 – 74	Failure	0	0
			Total	20	100%

Table 2 reveals that the majority of respondents, 3 or 15%, received a score of 10 to 12, with a percentage equivalent of 75 to 79 percent defined as Fair/Passing. Then, 5 percent or 25% received a score of 13 to 14, with a percentage equivalent of 80 to 84 percent rated as Good. However, no respondent received a score of 20 and 0 with a percentage equivalent of 0% defined as Excellent and Failure. Furthermore, 10 or 50% of those who had a score of 15

to 17 with a percentage equal of 85 to 89 were described as Very Good. Furthermore, 2 or 10% of the respondents received a score of 18 to 19, with an equivalent percentage of 90 to 94 percent described. Overall, the results revealed a large jump of 40% among those who failed the pretest passing the posttest, with 0% failing. In addition, a 10% improvement in the pretest regarded very good and superior increased to 60% in the posttest. Clearly, the flipped classroom improved student performance.

Students' Attitude Towards Using Flipped Classroom

Table 3 contains data on students' attitudes about flipped classrooms. The questionnaire includes 10-point Likert scale questions on the significance of instructional videos in better understanding the concepts and principles in Calculus; the accessibility of instructional videos; instructional videos make students highly productive in class; active in interaction; open communication with other students and instructor; the role of the instructor in assisting students to finish the activity, which is motivating because videos can be replayed and encourages students to finish the activity.

Table 3. Students' Attitude Towards Using Flipped Classroom

	Mean	SD	Level
1. Instructional videos help me better to comprehend concept and principle in Calculus.	4.6000	0.68056	High
2. The instructional videos are accessible for me to learn during pandemic.	4.4000	0.82078	High
3. The instructional videos enable me to be highly productive in class.	4.5500	0.68633	High
4. Flipped classroom encourages more active interaction in online class.	4.7000	0.65695	High
5. It opens interaction between me and my instructor.	4.8000	0.52315	High
6. To submit on line my class requirement, the instructor helps me by responding to query in the messenger.	4.6500	0.58714	High
7. The flipped classroom approach is motivating and a fun way to learn.	4.4500	0.75915	High
8. To better understand the topic, I watch the video many times.	4.5500	0.82558	High
9. It encourages collaborative learning.	4.6000	0.75394	High
10. The College should utilize the Flipped Classroom Approach in teaching Calculus.	4.6500	0.67082	High
Total	4.595	0.81170	High

Table 3 shows that the mean of students' attitudes toward flipped classrooms is 4.595, with a standard deviation (SD) of 0.81170, indicating "High". All of the items received a "High" rating. The item pertaining to the usage of instructional videos to better learn Calculus topics and principles received the highest mean score of 0.82558 and was categorized as "High." Evidently, as a new generation of learners, they are thought to value flipped classroom learning.

Significance Difference Between Pretest and Posttest Results of the Respondents Utilizing Flipped Classroom.

Table 4 reveals the result of significant difference between pretest scores, posttest scores, mean, standard deviation, t-value, P-value, decision, and interpretation.

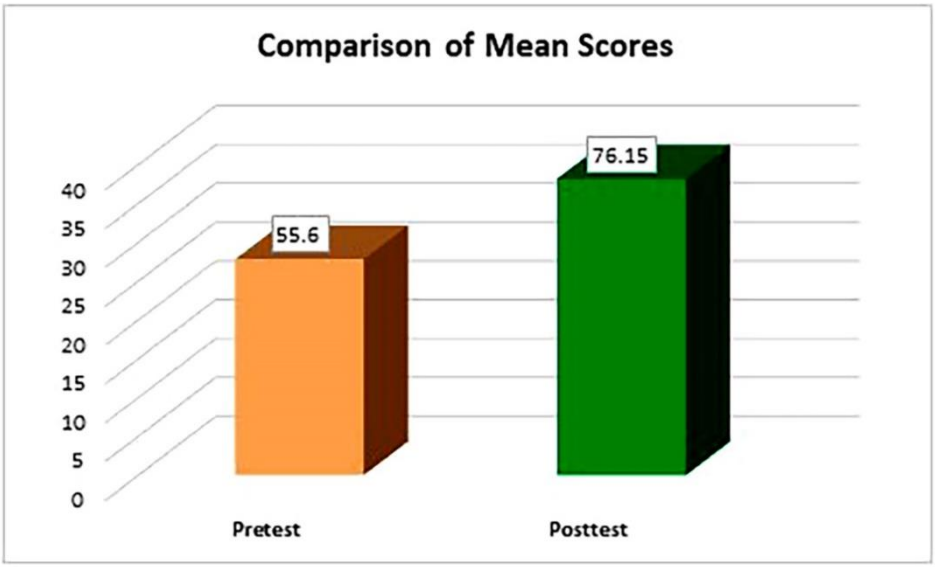


Table 4. t-Test Result of the significance difference of the Pretest and Posttest Scores of the Experimental Group

Pair	N	Mean	SD	df	Difference	t-value	P-Value
Pretest Experimental	20	55.6	24.64	19	-9.66111	-3.95	0
Posttest Experimental		76.15	12.40				

Note: If the P-value is less than or equal to α = 5%, Reject Ho

The experimental group's "t" value between the pretest and posttest is -3.95 with 19 degrees of freedom. Because the experimental group's mean posttest score (76.15) is greater than the experimental group's mean pretest score (55.60). As a result of the null hypothesis being rejected in favor of the research hypothesis, the P-value is less than 0.05. Similarly, the finding indicates that there is a significant difference in the experimental group's pretest and posttest scores. It may be concluded that using the flipped classroom to teach mathematics, notably calculus, has improved students' achievement. Furthermore, because the result is significant, this study concludes that it applies to the entire population.

Conclusion

The conclusions of this study were derived from an experiment in which the flipped classroom was used as an intervention. According to the findings of the study, flipped classrooms have a considerable positive impact on students' academic achievement in Calculus. The researcher created and verified Calculus video courses, quizzes, and questionnaires to see how they affected first-year electrical and mechanical engineering students. Moreover, the mean of the posttest scores was higher compared to the pretest after the said intervention conducted. Correspondingly, the null hypothesis was rejected in favor of the research hypothesis. Obviously, it revealed that there is a significant difference between the pretest and the posttest scores of the experimental group. Consequently, results discovered that flipped classroom is an operational approach in improving the students' academic performance in Calculus.

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Recommendations

According to the study's findings, it is highly recommended that flipped classroom be taught to other difficult Calculus courses. Educationalists may even institutionalize the usage of flipped classrooms, and other pedagogies geared toward 21st century education may be provided. Successive researchers of the flipped classroom approach may use a larger sample size to achieve decisive results while limiting errors. Video lessons, for example, can be adjusted to make them more appealing to pupils. Researchers may also devise, implement, and assess outcomes of flipped classroom integration in mathematics and other topics.

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