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Effect of Flipped Classroom on Geometry Performance Among Senior Secondary School Students in Zaria, Kaduna State, Nigeria

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Abstract
This study aimed to investigate the effect of flipped classrooms on performance in geometry among Senior Secondary school students in Zaria, Kaduna state. The study employed quasi- quasi-experimental research design. The study was guided by two research questions and two null hypotheses. The targeted population of the study was all SSII students in 20 senior public secondary schools in Zaria. Two schools were randomly selected using a simple random sampling technique from among the public secondary schools in Zaria. A sample size consisting of 157 students; 72 students (42 male and 30 female) were assigned to the experimental group and 85 students (44 male and 41 female) were assigned to the control group. The students' average age was 13 years. The experimental group was taught using a flipped classroom and the Control Group was taught using the Conventional (Lecture) method. The Geometry Performance Test (GPT) which consists of 20 multiple-choice questions was used as an instrument for data collection for the study. GPT was subjected to both face and content validity by 3 experts in mathematics education. The GPT was pilot-rested and a reliability coefficient of 0.82 was obtained using Pearson's Product Moment Correlation coefficient. The research questions were answered using descriptive statistics of mean and standard deviation and the null hypotheses were tested at $\alpha = 0.05$ the level of significance using Analysis of covariance (ANCOVA). The results showed a significant difference in the mean performance score between the experimental group (mean = 67.96, SD = 10.76) and the control group (mean = 36.61, SD = 7.72), F (2, 154) = 473.097, was obtained with a p-value of 0.000. The study also found no significant difference in the mean performance score between male (mean = 68.14, SD = 12.15) and female (mean = 67.70, SD = 8.62) students in the experimental group, F (2, 69) = 0.059, p = 0.982. Based on the findings it was recommended among others that professional bodies such as MAN, STAN, etc. should imbibe Flipped Classroom in the theme of workshops, seminars, and conferences to train mathematics teachers on the use of innovative strategies like the flipped classroom

Keywords: Mathematics, Flipped classroom, Geometry, Performance

Introduction

In Nigeria's educational system, mathematics has always been an integral subject. With a focus on a country's economic and technical growth, mathematics is seen as the foundation for Science, Technology, Mathematics, and Engineering (STME) (Ismail et al., 2019). Generally speaking, being able to solve mathematical problems and overcome physical obstacles is what makes mathematics so important to each person's life and to the survival of the human race. According to the National Council of Teachers of Mathematics (NCTM, 2015), mathematics is a tool that may be used for household and business transactions, scientific breakthroughs, technical advancements, problem-solving, and making decisions in a variety of life scenarios. The subject of mathematics evolved from the study of natural phenomena among which include geometry. Geometry is a branch of mathematics that is associated with other aspects of mathematics such as trigonometry, algebra, calculus, and mensuration are all related to geometry, which is a discipline of mathematics that is utilized by physicists, engineers, architects, and many other professions. Suleiman et al. (2020) define geometry as the study of two- and three-dimensional forms' dimensions, shapes, and positions. Students who study geometry get the ability to analyze and evaluate the world around them as

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well as apply what they learn to other mathematical topics. According to Eshetu et al. (2023), studying geometry is crucial since it is applicable in daily life and can aid students in strengthening their analytical, deductive, and logical thinking abilities.

Despite the importance of mathematics and geometry, students were unable to solve problems in mensuration, geometry, and cyclic quadrilaterals, according to reports and observations from chief examiners of the West African Examination Council (WAEC) in 2017 and 2020. Many studies have found a connection between low performance and teachers' inclination to stick with traditional teaching methods rather than implementing cutting-edge techniques like the flipped classroom, which might spark students' interest in learning. One blended learning strategy that aims to boost student engagement both within and outside of the classroom is the flipped classroom (Nolan et al., 2021). According to Tomas et al. (2019), flipped classrooms are learning programs in which in-person lectures are shifted outside of scheduled class times and substitute traditional lecture time for interactive learning activities. In an attempt to increase student engagement and boost academic performance, the flipped classroom has been widely described as a medium that combines the strengths of face-to-face interaction inside the classroom (such as collaborative study, applied problem-solving, instructor and peer engagement) and internet-driven instruction outside the classroom (such as digital video, self-regulated learning online, discussion) (He et al., 2019).

Studies on the effects of flipped classrooms on students' academic performance, including those by Egara and Mosimege (2023), Khaoloek and Chaiyasung (2022), and Ikwuka and Okoye (2021), have shown that these learning environments improve students' academic performance. Bhagat et al. (2016) also found that students exposed to flipped classrooms outperformed those taught using the traditional method. Furthermore, research by Bansal et al. (2020) and Jdaitawi (2020) demonstrated that students' level of engagement increased in comparison to students taught using the traditional method. According to Chen (2016), and Sadhu et al. (2019), among other researchers, obstacles that prevent successful use of ICT resources in flipped classrooms include access to technology, poor ICT skills and competencies, and a lack of assistance outside of the classroom. Likewise, the findings of studies by Smallhorn (2017) and Cambi (2018) indicate that pupils exposed to the flipped classroom method did not perform any better than those exposed to the conventional method. Verifying how flipped classrooms can affect students' performance in geometry is necessary due to the conflicting findings on academic performance. For that reason, the impact of the flipped classroom on geometry students' performance was investigated in this study.

Aim and Objectives of the Study

The aim of the study was to investigate the impact of Flipped Classrooms on academic performance in geometry among senior secondary school students in Zaria. Specifically, the study sought to:

1. Find out the impact of flipped classrooms on students' performance in geometry
2. Determine the effect of the flipped classroom on gender performance in geometry

Research Questions

The following research questions were raised to guide the study.

1. What is the difference in the mean performance scores of students taught geometry using a flipped classroom and those taught using the conventional method?
2. Is there any difference in the mean performance scores of male and female students when taught geometry using a flipped classroom?

Hypotheses

$H0_1$: There is no significant difference in the mean academic performance scores of students taught Geometry using a flipped classroom and those taught using the conventional method

$H0_2$: There is no significant difference in the mean performance scores of male and female students when taught Geometry using a Flipped Classroom

Methodology

This study adopted a quasi-experimental research design involving a pretest and posttest as advocated by Sambo (2010). The target population consisted of all the 6248 senior secondary school two (SS II) students from 20 public secondary schools in Zaria Local Government Area of Kaduna State. A simple random sampling technique was

used to select two schools out of 16 senior secondary schools in Zaria. The two schools were randomly assigned experimental and control groups respectively. Subsequently, two intact classes were selected through balloting one from each school. A sample size of 157 students was obtained for the study which comprised 72 students for the experimental group and 85 students for the control group. This sample was considered viable for the study as advocated for the study by the central limit theorem recommendation of a minimum of 30 subjects as a sufficient sample size for the study. A Geometry Performance Test (GPT) made of 20-item multiple choice questions was used as an instrument for data collection. Which required students to choose the correct answer from option lettered A-D. Each correct answer in the test was assigned 5 marks. The instrument, GPT and lesson plan used for gathering data were subjected to face and content validity by experts in the field of Measurement and Evaluation and experts in the field of Mathematics education for adequate criticism and correction before it was administered to the sample. The instrument was pilot-tested using 40 students in school that was part of the population but not part of the sample. The result obtained from the pilot test was used to establish the reliability coefficient using a test-retest method and a reliability coefficient of 0.82 was found using Pearson's Product moment correlation coefficient (PPMCC). A pre-test was administered before the treatment to both the experimental and control groups. Thereafter, a post-test was administered to both groups after treatment of six weeks.

Results

Data collected for the study were analyzed via Statistical Package for Social Sciences (SPSS). Descriptive statistics of mean and standard deviation were used to answer the research questions, while inferential statistics of analysis of covariance were used to test the null hypotheses at a 0.05 level of significance.

Research Question One: What is the difference in the mean performance score between students taught geometry using a Flipped Classroom and those taught using the Conventional Method?

Table 1: Descriptive statistics of mean academic performance of students taught Geometry using Flipped Classroom and those taught using the Conventional Method

		Pre-test		Post-test		
Group	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain**
Experimental	72	27.61	6.67	67.96	10.76	40.35
Control	85	27.21	7.28	36.61	7.72	9.40
Mean Diff.				31.35		

Table 1 shows the difference in the mean between the experimental and the control group at pre-test as 0.40in favour of the experimental group. In the post-test, the table revealed the difference as 31.35 in favour of the experimental group. This indicates that the experimental group's performance was better than the control group.

$H0_1$: There is no significant difference between the mean performance scores of students taught Geometry using a Flipped Classroom and those taught using a Conventional Method

Table 2: Summary Analysis of Covariance showing the difference in the performance of students who were taught Geometry using a Flipped classroom and those taught using a Conventional Method.

Source	**SS**	**df**	**MS**	**F-value**	**Sig.**
Corrected Model	39315.151[a]	2	19657.576	247.088	.000
Intercept	16978.062	1	16978.062	213.407	.000
Pre-test	983.483	1	983.483	12.362	.001
Treatment	37638.183	1	37638.183	473.097	.000
Error	12251.792	154	79.557		
Total	459618.000	157			
Corrected Total	51566.943	156			

As revealed in Table 2, the F (2, 154) = 473.097, was obtained with a p-value of 0.000. This implies that there was a significant effect of the flipped classroom on the post-test academic performance of the students. This indicates that

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the use of flipped classrooms accounted for the statistically significant difference in the post-test performance scores of the students. There the null hypothesis one was rejected.

Research Question two: Is there any difference in the mean performance scores of male and female students when geometry using the flipped classroom

Table 3: Descriptive statistics of mean academic performance of Male and Female students taught Geometry using Flipped Classroom

		Pre-test		Post-test		
Gender	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain**
Male	42	28.36	6.71	68.14	12.15	39.78
Female	30	27.23	6.70	67.70	8.62	40.47
Mean Diff.				0.44		

Table 3 revealed the difference in the mean between male and female students at pre-test as 1.13 in favour of the male students. In the post-test, the table revealed the difference as 0.44 in favour of the male students.

$H0_2$: there is no significant difference in the mean performance scores of male and female students when taught Geometry using a Flipped Classroom

Table 4: Summary Analysis of Covariance showing the difference in the performance of Male and Female students taught Geometry using Flipped Classroom

Source	**SS**	**df**	**MS**	**F**	**Sig.**
Corrected Model	372.434[a]	2	186.217	1.639	.202
Intercept	13139.493	1	13139.493	115.634	.000
Pre-test	369.002	1	369.002	3.247	.076
Gender	0.059	1	.059	.001	.982
Error	7840.441	69	113.630		
Total	340733.000	72			
Corrected Total	8212.875	71			

The result in Table 4 shows that there is no significant difference between the male and female students when taught Geometry using Flipped Classroom. The calculated F (2, 69) = 0.059, p = 0.982. This implies that there is no significant difference in the mean performance of male and female students taught geometry using a flipped classroom. Therefore, the null hypothesis which states that there is no significant difference between the mean performance scores of male and female students when taught Geometry using Flipped Classroom was retained.

Discussion

According to the first hypothesis's findings, students who received their geometry instruction in a flipped classroom outperformed those who received conventional instruction. The beneficial effect of the flipped classroom on student performance is supported by earlier research conducted by Atta and Bonyah (2023) as well as Khaoloek and Chaiyasung (2022). Students may express and display their abilities and skills in a new learning environment that values cooperation over competition, which makes it easier for them to respond and perform successfully. As opposed to lower-level abilities like memorization and repetition, this aids students in understanding more fully, remembering information, and using critical thinking skills. By encouraging students to participate in learning activities, flipped classroom instruction increases the amount of time that students and teachers spend interacting in the classroom. Drawing from the research of Atwa and Sulyeh (2020) and Boubih et al. (2020), teachers can assist and reach every student in the classroom. These findings are consistent with earlier research by Wilson (2020), who discovered that flipped classrooms enhance student performance by helping students remember information over time.

The results of the current study also showed that both male and female students who received instruction in flipped classrooms increased their performance in geometry; however, after the intervention, male students' performance was only slightly higher than that of female students. Notwithstanding the findings reveal that there was no

significant interaction effect of flipped classroom instruction on gender performance. Therefore, gender is not a significant predictor of male and female students' performance in flipped classrooms. These findings support Eze's (2023) findings who reported that male students did better than their female counterparts when exposed to flipped classrooms, although no significant difference was observed in their performance. Egara and Mosimege (2023) and Ikwuka and Okoye (2021) also agreed that gender is not a significant factor in flipped classrooms, implying that flipped classrooms are gender-friendly. The results of this study, however, are not consistent with those of Chiquito et al.'s (2019) investigation, which found that female students outperformed their male counterparts when exposed to flipped classrooms.

Conclusion

Students' performance in geometry has improved as a result of flipped classrooms. As a result, the study came to the conclusion that flipped classrooms could improve students' performance in geometry and mathematics in general. The study discovered that there was no discernible difference in the average performance scores of male and female students who were taught geometry in flipped classrooms. The study points to the possibility that implementing flipped classrooms could enhance geometry and mathematics performance for both male and female students.

Recommendations

The following recommendations were made in light of the findings:

1. Professional organizations like MAN, STAN, and others should incorporate Flipped Classroom into their workshops, seminars, and conferences to educate math teachers on cutting-edge tactics like flipped classrooms, as it has been shown to enhance student performance.
2. It is recommended that math professors incorporate engaging and interactive exercises into their lessons to entice and inspire students to understand mathematics.

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