EFFECT OF FLIPPED LEARNING ON NIGERIA CERTIFICATE IN EDUCATION (NCE) MATHEMATICS STUDENTS' INTEREST AND ACHIEVEMENT IN TRIGONOMETRY IN KANO STATE, NIGERIA

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Abstract

This study sought to determine the effects of flipped learning strategy on NCE Mathematics students' interest and achievement in trigonometry. The study employed a quasi-experimental 2 x 2 factorial research design. The sample of the study consisted of 60 students, who had a personal computer and Internet access at home. They were randomly assigned into an experimental group of 32 students (22 males, 10 female) and control group of 28 students (20 males, 8 female) The instruments used for data collection during the pre-test and post-test consisted of a trigonometry achievement test (TAT) and trigonometry interest scale (TIS). The TAT was validated by specialists in mathematics education and measurement and evaluation using table of specifications constructed for the multiple choice test items. The multiple choice test had average difficulty and discrimination indices of 0.43 and 0.55 respectively. The reliabilities of the multiple choice test items and trigonometry interest scale were established using the coefficient of internal consistency based on Cronbach Alpha ($\alpha\alpha$).The reliability coefficients for the TAT and TIS were 0.68 and 0.75 respectively. The data collected from the pre-test and post-test were subjected to statistical analysis using the Statistical Package for Social Sciences (SPSS). The research questions were answered using descriptive statistics while the hypotheses for the study were tested using t-test statistics and the Analysis of Covariance (ANCOVA) with pre-test scores as covariates at 0.05 level of significance. The findings from the study showed that: flipped learning strategy was more effective than the lecture method in improving students' academic achievement and interest in trigonometry. The result also shows that there was no significant difference between the achievement of male and female students from the experimental group in trigonometry and that there was no significant interaction effects of treatment and gender on students' achievement in trigonometry. It was recommended among others that Curriculum planners and educational policy makers should consider a review of the curriculum to incorporate flipped classroom strategy into the Nigeria Certificate in Education Mathematics Curriculum

Key words: Flipped learning, Interest, Achievement, trigonometry & Instructional strategy

Introduction

Today, students in higher education especially, spend their time using technology as much as they have never had. The increasing use of smart devices and the internet have accelerated the integration of multi-media tools in educational environments. In line with technology and science, changing needs of learners, differentiation in instructional designs and growing opportunities form a basis for new teaching approaches to putting into practice. As a result of individualization, it is inevitable for students to realize their own learning responsibilities, and the efficient use of time outside the classroom becomes compulsory. The use of technology is beneficial for efficient use of both in-class and out-of-class time. Flipped classroom, a combination of technology and student-centered learning, emerges as a method of increasing classroom and out-of-class productivity.

Flipped learning is defined as a pedagogical approach that direct instruction moves out of the class via technology and internet (e.g. videos, podcasts, online blogs or available online materials.) while in-class time includes practice and collaborative activities which promote active learning (Abeysekera & Dawson, 2015, Bishop & Vergler, 2013). The flipped learning method offers passive teaching material outside the school, creating extra time for active learning in the classroom (Sarawagi, 2017; Tyler & Abdrakhmanova, 2016). In the process of flipped learning, students read textbook chapters and other materials before class, and then the class time used for problem-solving, execute in-class exercises and seek additional support from their teachers (; Cao & Grabchak, 2019). Jala (2016) has it that flipped classroom model is based on the idea that conventional teaching is inverted because what is normally done in class is flipped or switched with that which is normally done by the students out of class. Here, instead of the students listening

to a lecture in class and then going home to work on a set of assigned problems, they read course literature and assimilate lecture material at home and engage in teacher-guided problem-solving, analysis and discussion in class

The flipped learning model demonstrate several advantages including improve students' learning (Li, Gao, Liu, & Sun, 2018), prompted the student's self-efficacy (Hwang & Lai, 2017, Kurt,2017), enhanced learning experience and improved academic performance (Choi, Kim, Bang, Park, 2016) Flipped learning can motivate students to learn more effectively, develop critical thinking skills, facilitate collaborative learning, and handle different learning styles(Ibrahim & Emmrullah, 2019; Fetaji, & Ebibi, 2019).

Concerning academic achievement, the flipped learning approach and traditional learning approach have been subject to many types of research. Based on the post-test scores, while

some research suggests there is a meaningful difference in favour of flipped learning (Aljaser 2017; Sickle, 2016; Sun & Wu, 2016; Webb & Doman, 2016; Salimi Zhonggen & Wang, 2017; Ibenegbu & Ugwu, 2022; Ezeudu &Gbendu, 2021). some others say that there is no significant difference between flipped and traditional approach (Cashin, 2016, Crawford, 2017; Dixon, 2017; Fraga & Harmon, 2017; Sharpe, 2016). In other words, all these studies suggest that there is no consensus on whether the flipped learning approach is significantly effective or not over the traditional approach.

In this study, the academic achievement and interest of the students were studied as a dependent variable and the effects of the application of the flipped classroom on the students were tried to be determined in comparison with the traditional method. The flipped classroom is used to individualize learning out of class and reinforce and support classroom practices. It is expected that this study will provide information on the applicability of the flipped classroom in mathematics classes.

The purpose of this study therefore is to examine the effect of the flipped classroom on interest and achievement of NCE mathematics students in trigonometry. The study also sought to determine the extent to which the use of flipped learning affects the interest and achievement of male and female students in trigonometry.

Statement of Problem

The study examines the effect of flipped learning on NCE mathematics students' interest and achievement in trigonometry. Regarding the experience of the researcher in the field of teaching the course, it is noted that high education mathematics classrooms often deserve the commonly held notion of a boring, inflexible learning environment where the teacher lectures and the students frequently practice problems towards mastering the required skills. The main challenges teachers face is that:

i)   the practicing time is not enough to master the skills.

ii)   students encounter difficulties in effectively utilizing procedural abstraction techniques to solve problems,

iii)   the topic requires conceptual deep understanding, quantitative technical background, mental imagination skills which need several exercises to understand with limited classroom period allocated to execute the curricula, which is inadequate to cover it.

So it was notable for the researcher that there is a need to conduct a research study that would contribute to raising the achievement level of the students in the trigonometry course. It was also notable that the course content was large, and the number of sessions (one sessions a week) makes teachers unable to give students enough time of follow-up, and also made students have a negative attitude towards the course.

Therefore, there was an urgent need to develop the educational process by using the modern concepts in instructional technology. The researcher therefore suggests using the flipped instructional strategy that would help the teacher raise the academic achievement of their students, overcome the problem of the session time, limit the students' negative attitude towards the course, and also makes him keep up with technology. This is one of the best strategies that make the teachers use class time in enriching students with discussions and activities, because the student watches the lesson as a video before the class, and, therefore, would be more interactive during lessons, and it also takes into account the individual differences between learners and makes learning more enjoyable.

Objectives of the Study

The major objective of this study is to determine the effect of flipped learning on Nigeria Certificate in Education Mathematics students' interest and achievement in trigonometry.

Specifically, the study sought to:

Analyze the effect of flipped learning on students' achievement in trigonometry.

Find out the effect of flipped learning on the achievement of male and female students' in trigonometry.

Find out the interaction effect of gender on method as measured by trigonometry achievement test (TAT).

Determine the effect of flipped learning on students' interest rating in trigonometry.

Compare the effect of flipped learning on the interest rating of male and female students' trigonometry.

Research Questions

The following research questions would be formulated to guide the study.

a) What is the effect of flipped learning on students' post-test trigonometry achievement test?

b) What is the effect of flipped learning on the achievement scores of male and female students' in trigonometry?

c) What is the interaction effect of gender on method as measured by trigonometry achievement test (TAT)?

d) What is the effect of flipped learning on the students' post-test mean interest rating in trigonometry?

e) What is the effect of flipped learning on the level of interest of male and female students' in trigonometry?

Hypotheses

The following null hypotheses would be formulated and tested at 0.05 level of significance.

1. There is no significant main effect of treatment (flipped learning & Conventional) on NCE students' achievement in trigonometry.

2. There is no significant main effect of gender on NCE students' achievement in trigonometry.

3. There is no significant interaction effect of treatment and gender on NCE students' achievement in trigonometry.

4. There is no significant main effect of treatment (flipped learning & Conventional) on NCE students' interest in trigonometry.

5. There is no significant main effect of gender on NCE Mathematics students' interest in trigonometry.

Methodology

Design

This study uses a quasi-experimental pretest-posttest design to study the effect of flipped learning on NCE mathematics students' interest and achievement in trigonometry and compare with the traditional method in term of students' scores on trigonometry achievement test (TAT) that was created by the researchers and trigonometry interest scale (TIS) of the experimental group (EG). Students were randomly assigned into two equal groups, where control group (CG) was taught using a traditional method while the EG was taught using the FL model. The TAT implemented on both groups at a pretest and posttest points, while the TIS implemented on the EG. The diagrammatic representation of the design is shown in figure 1.

Fig.1.   **Pre-test, Post-test Nonequivalent Control group Research Design.**

G1	O_1	X	O_2	Experimental group	**…………………..**
G_2	O_3		O_4	Control group	
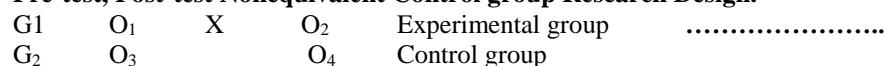
Where, O represents observation of the measurements

X, represents treatment for the experimental group and the blank space between O_3 and

O_4 indicates that there is no treatment for the control group.

O_1 and O_3 represents pre-test

Participants

The population of the study consists of all NCE one Mathematics students', who registered in the Mathematics Discipline Trigonometry (MAT112) at Federal college of education (Technical), Bichi, Kano in the first semester of (2021/2022) academic session. In this study, purposive sampling technique, one of the non-random sampling techniques, was used. The sample of the study consisted of 60 students, who had a personal computer and Internet access at home. They were randomly assigned into an experimental group of 32 students (22 male, 10 female) and control group of 28 students (20 male, 8 female) . The pilot sample consisted of 20 students (13 males, 7 female) that were randomly selected from the population and outside of the study sample.

Instruments

Two instruments were used for the study. They are: the trigonometry Achievement test (TAT) which was used for the pre-test and the post-test and the Trigonometry Interest scale (TIS) which was also used for the pre-test and post- test.

The TAT instrument and TIS instruments were developed by the researcher. The question items in TAT is 40 multiple-choice items having four alternative options A, B, C, D. TAT was administered to the student to ascertain their level of mastery of instruction at the end of the course. Every correct answer was assigned a 2.5 (100%) point while the incorrect options will have no point 0 The trigonometry interest scale consists 25 items questionnaire that was used to get the students' feelings towards mathematics generally and trigonometry in particular. It consisted of two sections. Section A seeks for general information about respondents such as Name, Age, Gender and number in the class while section B was based on their interest in trigonometry. Each of the items is a modified 4-point likert type rating scale. The options are: Strongly agree (SA), Agree(A), Disagree(D), Strongly disagree(SD) rated ,4,3,2 and 1 for positive statements and 1,2,3,4 for all negative statements.

Validity and reliability of the Instruments.
The instruments for data collection: TAT and the lesson plans were subjected to face and content validation by research experts in Mathematics Education and Measurement and Evaluation. The experts scrutinized the instruments in terms of relevance, general format, suitability, structure and adequate timing. The independent corrections, observations and comments made by these experts were incorporated into the final form of the instruments. A table of specification was developed and was used in constructing the items in TAT to ensure content validity.

To ensure the reliability, the test was administered in a different school setting with different participants. The reliabilities of the multiple choice test items and trigonometry interest scale were established using the coefficient of internal consistency based on Cronbach Alpha ($\alpha\alpha$)

The reliability coefficients for the TAT and TIS were 0.68 and 0.75 respectively. The difficulty and discrimination indices of the multiple choice questions were also computed. While mean of item difficulty index was 0,43; mean of item discriminating index was 0,55.. These values indicate that this test measures validly and reliably academic achievement of students.

The Experimental Procedure
Prior to the experimental study, trigonometry interest scale and pre-test were administered in the group. Also, Google Classroom and Google applications (Drive, YouTube, Google Search, Google Calendar, Google+, Google Docs) were introduced and explained in detail by the Mathematics teacher. The students received a 6-hour training in total about these applications. Then, the teacher opened a Google Classroom and the participants in the experimental group joined in the classroom. Flipped learning videos were shared with the students by means of Google Classroom. The videos prepared by the teacher were shared on Google Classroom to have the students come to the class prepared. In the course of the study, the students were informed via text messages and emails when the teacher shared something on Google Classroom, which helped ensure that the students would watch the videos before coming to the classroom. The students were also asked to keep diaries to reflect on flipped classroom practices. At the end of the process, the students were given the post-test and trigonometry interest Scale.

Data Analysis
The scores from the pretest and posttest were subjected to statistical analysis using the Statistical Package for Social Sciences (SPSS). The research questions were analyzed using descriptive statistics of mean and standard deviation (SD) while hypotheses (1-3) were tested at 0.05 level of significance using ANCOVA. ANCOVA was considered to be appropriate for analyzing the difference between the initial effects of the treatment on the dependent variable, Again, since the research involved pre-test and post-test of intact classes, the statistical technique that was adopted for analyzing the hypotheses enabled the researcher to adjust initial group difference. Hypotheses (4 and 5) were tested using the independent sample t-test statistic in order to determine if there was a statistically significant difference in the mean interest rating scores of students. Effect size (Eta-Squared) was used to determine how important any observed differences are.

Results
The results of the study are presented in the tables below

Research Question one
What is the effect of flipped learning on students' post-test trigonometry achievement test?

Table 1. **Mean and Standard Deviation (SD) achievement scores of students in Experimental and Control groups**

Group	Type of test	N	Mean	S.D	Mean gain
Flipped classroom	PRE-TAT		2.58	0.35	
	POST-TAT	32	3.34	0.32	0.76
Lecture method	PRE-TAT		2.05	0.31	
	POST-TAT	28	2.54	0.42	0.49

The results in Table 1 shows that the pre-test mean achievement scores of students in the flipped classroom group and those in the lecture group were 2.58 and 2.05 with standard deviations of 0.35 and 0.32 respectively. This indicates that both groups were relatively at the same achievement level before treatment. However, the posttest mean achievement scores for the flipped classroom and lecture groups were 3.34 and 2.54 with standard deviations of 0.31 and 0.42 respectively. The higher mean achievement gain score of 0.76 for the flipped classroom group over that of the lecture group (0.49) indicate that flipped classroom strategy was more effective in enhancing students' achievement towards trigonometry.

Research Question two
What is the effect of flipped learning on the achievement scores of male and female students' in trigonometry?

Table 2: Mean and standard deviation of achievement scores of male and female students taught with flipped classroom strategy

Gender	Type of test	N	Mean	S.D	Mean gain
Male	PRE-TAT		2.67	0.30	
	POST-TAT	22	3.38	0.38	0.71
Female	PRE-TAT		2.51	0.33	
	POST-TAT	10	3.27	0.32	0.76

Table 2 shows that both male and female students in the experimental group (flipped classroom) had the pretest achievement mean scores of 2.67 and 2.51 with standard deviations of 0.30 and 0.33 respectively. This shows that both male and female students in the treatment group were at the same achievement level before treatment. However, results in the table shows that the posttest achievement mean scores of male and female students in the treatment group were 3.38 and 3.27 with standard deviations of 0.38 and 0.32 respectively. The higher achievement mean gain score of 0.76 for the female group over that of the male group (0.71) indicates that female students had slightly improved achievement towards trigonometry than their male counterparts.

Research question three
What is the effect of flipped learning on the students' post-test mean interest rating in trigonometry?

Table 3: Mean Interest Rating Scores of Students in Experimental and Control Groups

Group	N	Type of test	Mean	S.D	Mean gain
Experimental	32	PRE-TIS	13.8	8.25	
		POST-TIS	28,12	9,75	14.22
Control	28	PRE-TIS	13.9	5.61	
		POST-TIS	20 .53	7.62	7,63

The result in table 3 shows that the mean difference between the Pre-TIS and Post-TIS of students in control and experimental groups were 7.63 and 14.22 respectively. This implies that students taught using flipped learning instructional strategy improved their interest in trigonometry than their counterpart in lecture method.

Research Question four
What is the effect of flipped learning on the level of interest of male and female students' in trigonometry?

Table 4
Mean Interest Rating Scores of PRE-TIS and POST-TIS of male and female Students' in the Experimental Group

Gender	Type of test	N	Mean	S.D	Mean gain
Male.	PRE-TIS	22	8.54	0.38	
	POST-TIS		9.36	0.31	0.70
Female	PRE-TIS		8.42	0.35	
	POST-TIS	10	9. 68	0.32	1.26

Table 4 shows that the PRE-TIS mean scores of the male was 8.54 while that of the female was 8.42. The POST-TIS mean scores of male and female was 9.36 and 9.68 respectively. The mean gain of the female students (1.26) was higher than the male (0.70). This shows that that female students had slightly improved interest towards trigonometry than their male counterparts.

Hypotheses 1. There is no significant main effect of treatment (flipped learning & Conventional) on NCE students' achievement in trigonometry.
Data for testing research hypotheses 1, 2 and 3 are presented in Table 5

Table 5. Summary of ANCOVA for differences in the mean achievement scores of students based on method and gender

Sources of variation	Sum of Squares	Df	Mean Squares	F values	Sig. of F	Partial eta squared (η^2)
Corrected model	15.137[a]	4	3.534	37.951	.000	.668
Intercept	4.600	1	4.600	47.217	.000	.376
Pre-TAT	2.874	1	2.874	31.045	.000	.294
Method	2.347	1	2.347	23.124	.000	.233
Gender	.109	1	.109	1.167	.284	.016
Method* Gender	.076	1	.076	0.695	.507	.009
Error	6.966	55	.094			
Total	717.264	60				
Corrected Total	21.123	59				

Table 5 shows that there is a significant main effect in the mean achievement scores of students' taught trigonometry by flipped classroom strategy and those taught by the lecture method, since $F_{(1, 55)} = 23.124$, p = 0.000 < 0.05 and η^2 = .233. The eta-squared statistic (.233) indicated a substantial effect.

Hypothesis 2. There is no significant main effect of gender on NCE students' achievement in trigonometry as measured by TAT.
The summary of ANCOVA analysis in Table 5 indicate that, an F-ratio of 1.167 and a probability value of 0.284 with a proportional effect size of 0.016 were obtained for the influence of gender on achievement towards trigonometry. Since the associated probability of 0.284 is greater than the 0.05 significant level, hypothesis two was not rejected. Thus, gender has no significant effect on students' mean achievement scores in trigonometry.

Hypothesis 3. There is no significant interaction effect of treatment and gender on NCE students' achievement in trigonometry.

In testing for hypothesis 3, Table 5 equally shows that gender did not interact significantly with method to influence students' achievement, since $F_{(1,55)} = 0.695$ P = 0.507 >0.05 and η^2 = .0 09.
Thus hypothesis 3 which states that there is no significant interaction effect of treatment and gender on students' achievement in geometry was also upheld.

Hypothesis 4. There is no significant main effect of treatment (flipped learning & Conventional) on NCE students' interest in trigonometry.

Data for testing the research hypothesis 4 is presented in table 6

Table 6. t- test comparison of the post-test mean interest scores of students' in the experimental and control group

Group	N	Mean	SD	Df	t-value	P-value	η2
Experimental	32	28.12	9.75	58	2,34	0.001	0.09
Control	28	20,53	7.62				

Table 6 indicates that there is significant difference between the experimental group students' interest gain scores (M=28.12; SD=9.75) and the control group students' interest gain scores (M=20.53; SD=7.62) in favor of experimental group (t(58)=2,34; p<0,05). **η2** of this difference was calculated as 0,09. This value indicates that flipped classroom has medium effect on interest towards trigonometry compared to lecture method.

Hypothesis 5. There is no significant main effect of gender on NCE Mathematics students' interest in trigonometry.
Data for testing the research hypothesis 4 is presented in table 7

Table 7. t- test comparison of the mean interest scores of students in the experimental group based on gender

Gender	N	Mean	SD	Df	t-value	P-value	η2
Male	22	9.36	0.31	30	2.04	0.102	0.035
Female	10	9.68	1.32				

Table 7 also shows that there was no significant main effect of gender on students' interest in trigonometry since, $t_{(30)}$ = 2.04, P = 0.102 >0.05 and η^2 = 0.035 . This means that male students did not achieve significantly better than their female counterpart in trigonometry. Thus, hypothesis 5 which states that there is no significant main effect of gender on NCE students'
Interest in trigonometry was therefore upheld.

Discussion of the Results
The results of the study are discussed based on the research questions answered and the hypotheses tested.

Effect of Instructional Strategy on Students' Achievement towards Trigonometry
The study revealed that, students taught trigonometry with flipped classroom strategy obtained higher achievement mean scores than those of their counterparts taught the same topics with conventional lecture method. The finding showed a significant difference in the mean achievement scores of students taught Trigonometry with flipped classroom strategy and those taught with conventional lecture method, specifically, in favour of the flipped classroom strategy. This is attributable to the individualized learning experiences through the use of online Trigonometry instructional videos and the classroom activities that were provided in the flipped classroom group.
This finding is similar to the findings of the study about the positive impact of flipped learning on students' success (Aydın, 2016; Sickle, 2016; Sun & Wu, 2016; Salimi, Zhonggen & Wang, 2016; Ibenegbu & Ugwu, 2022; Ezeudu &Gbendu, 2021 ; Choi, Kim, Bang, Park, Lee, & Kim, 2017 ; Duygu & Ali , 2018) which justified according to the different benefits of the FL model such as the flexibility in time and place, support the student-centered approach, differentiate the learning experience, self-paced study, the diversity of resources, enjoyable environment, self-assessment, giving the students more time to study and prepare their own questions when they enter the class to start applying what they studied out of the classroom.

Effect of Gender on Students' Achievement in Trigonometry
The results showed that female students had slightly improved mean-gain achievement scores than their male counterparts in Trigonometry though the difference was not significant. Specifically, the finding showed no significant gender-influence on students' mean achievement scores in Trigonometry. This could be attributed to the equal learning opportunities that were provided to both male and female students in the flipped learning group. This finding was consistent with the finding by Charles- Ogan (2014) who indicated in his study that there were equivalent numbers of

male and female students with mathematics disability. This result also fall in line with the positions of (Ibenegbu & Ugwu, 2022; Ezeudu & Gbendu, 2021) who debunked the idea of gender differentiation in ability. This is contrary to Marcus and Joakim (2016) who insisted that boys use group work more than girls do. Boys feel that they have an influence over the content and are more involved during the lesson than girls and therefore, should perform more than females but the reverse was the case.

Interaction Effect of Instructional Strategy and Gender on Achievement
The interaction effect of approach and gender was not significant. Female students performed better than male students irrespective of the instructional approach. However, the differences in the mean scores were not significant. This may be a result of the nature of the approach.
The students were comfortable with the instructional approach irrespective of gender. This result is consistent with the findings of (Ibenegbu & Ugwu, 2022) who reported that gender did not have any significant interaction effect on the achievement scores of students taught government using flipped learning instructional strategy. Since method by gender interaction was not significant, it follows that the difference in the mean achievement of male and female students was not due to method of instruction. Thus flipped learning instructional strategy which has been found to enhance achievement in mathematics can be conveniently used by mathematics teachers in both male and female schools.

Effect of Instructional Strategy on Students' Interest towards Trigonometry
This study revealed that flipped learning contributed positively to the students' interest towards mathematics. The results are similar to the results of the studies conducted by Abeysekera & Dawson (2015), Wael, Aseel & Nayel (2020) showing that flipped learning promoted positive attitudes towards mathematics class and increased motivation due to due to increasing of social interaction, collaboration, the positive relationship, teamwork skills and share different perspectives with peers.as well as the increase of communication, collaboration, with the teacher.

Effect of Gender on Students' interest towards Trigonometry
The results showed that female students had slightly improved mean-gain interest scores than their male counterparts in trigonometry though the difference was not significant. Specifically, the finding showed no significant gender-difference on students' mean interest scores in Trigonometry. This could be attributed to the equal learning opportunities that were provided to both male and female students in the flipped learning group. The finding is in agreement with the study conducted by (Ozyurt & Ozyurt ,2017; Karadag,. & Keskin, 2017) which shows that the majority of students express positive interest towards flipped learning.

Conclusion
From the findings and discussion, it was established that, flipped classroom strategy was more effective in enhancing students' achievement in Trigonometry concepts. There was no significant gender effect on students' mean interest scores in Trigonometry concepts when taught with flipped classroom strategy. It has been established that instructional strategy and gender do not exert any significant interaction effect on students' achievement. Thus, the treatment variable (Flipped classroom) was accountable for the significant improvement in the achievement of students in this study. Considering the results of the study and the related literature, flipped learning is found quite effective and efficient in increasing academic success of students in mathematics and promoting positive interests towards mathematics. This might imply that applying new teaching methods in teaching-learning processes may help improve positive interest towards lessons and in having more efficient and effective lessons. It might also be stated that flipped learning is an appropriate and good method to apply in mathematics classes and an effective variable in increasing positive students' interest.

Recommendations
Based on the findings of the study, the following recommendations were made:
1. The Nigerian Colleges of Education lecturers should adopt the use of flipped learning approach in teaching and learning of Mathematics. It should also be used as a medium of instruction at all levels of the Nigerian educational system as part of their teaching methods.
2. Curriculum planners and educational policy makers should consider a review
3. of the curriculum to incorporate flipped classroom strategy into the Nigeria Certificate in Education Mathematics Curriculum. This could significantly improve students' interest and achievement in Mathematics concepts

4. Federal and State Governments in collaboration with Ministries of Education should organize and sponsor regular training workshops and conferences to train lecturers on how to promote Mathematics instruction through the use of innovative flipped classroom strategy.
5. In order to equip pre-service teachers with necessary skills to use flipped learning efficiently in their teaching, prior to their teaching career, their exposure to and active participation in flipped learning must be ensured by providing them with flipped learning practices
6. The Federal and State governments through the Ministry of Education should provide ICT facilities and resources adequately to implement flipped learning strategy in all colleges of Education in Nigeria

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