

Flipping the Mathematics Classroom to Enhance Senior Secondary Students Interest

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Abstract

The study focused on effect of flipping a mathematics classroom on the interest of senior secondary school II students. Two pedagogical methods were used namely Flipped Classroom Strategy (FCS) and Teacher-Centered Method (TCM). The study adopted the two group pre-test post-test quasi-experimental design. The sample size for this study was one hundred and four (104) students; fifty three (53) in the control group and fifty one (51) students in the experimental group. To collect data for the research, the authors designed and developed a Mathematics Interest Scale (MIS) which was validated by mathematics teachers and experts in the field of measurement and evaluation. To test the internal consistency of the MIS, the Cronbach Alpha technique was used and a reliability coefficient of 0.708 was obtained. The results from the pre-interest and post-interest mean scores revealed that FCS enhanced students' interest in mathematics. However, the effect was not statistically significant. There also existed a difference in students' interest in mathematics for the two groups (FCS & TCM) in favour of those taught with the FCS, but this was also not statistically significant.

Keywords - *Flipped classroom, Teacher centered method (TCM), Flipped classroom strategy (FCS), Mathematics, Students interest*

I. INTRODUCTION

Mathematics, according to [1], is described as a subject that affects all aspects of human life at different degrees. According to [2], mathematics is used throughout our daily lives. The importance of mathematics in day-to-day activities cannot be over emphasized. Mathematics is a very important subject that affects various aspect of the decision making process. All fields of endeavour need mathematics for actualization. Such fields as engineering, medicine, aviation, construction, agriculture just to mention few, cannot be achieved without proper understanding of mathematics. Mathematics is one of the compulsory disciplines in the Nigerian educational system.

Reference [3] stressed that mathematics stimulates self-reliance and gives the learners the opportunity to think and solve their problems with ease. For example, looking at geometry as a topic, it stimulates logical reasoning in individuals and gives them the ability to measure distances and materials. By so doing, students learn the habit of analytical thinking which would enable them to establish a link between known and anticipated reality. Besides, mathematics disciplines the mind and elevates individuals to a point where they should be able to live without being cheated, robbed or abused [4]. Mathematics generally deals with accuracy in calculation and exactness in problem solving. Consequently, learners are exposed to discovering their abilities in analyzing and interpreting situations in their daily life encounter-in a logical and orderly manner.

Reference [5] stated that whoever earns and spends uses mathematics. In the quest to discover ways of enhancing the teaching and learning of Mathematics, there is need to foster innovative teaching strategy and improve students' interest in Mathematics. For secondary school students to develop authentic foundation in the knowledge of Mathematics, there is need for practical, hands-and minds-on activities in Mathematical lessons. Definitely, active participation of students in the learning process has the potential to build students' interest and academic achievement in mathematics as a subject.

There are various methods of teaching which include among others; lecture method, demonstration method, project method, discovery/inquiry method, field trips and discussion method. These different methods of teaching are rooted in the Blended learning framework. Blended learning is a form of learning system that combines online learning with face-to-face learning. Basically, there are four models under this framework; Rotation model, Flex model, Self-Blend model and Enriched-Virtual model. The flipped classroom is under the Rotation model. Therefore, flipped classroom is a form of blended learning.

II. LITERATURE REVIEW

Flipped classroom is a pedagogical method of teaching where home works are done at school and school works done at home [6]. Similarly, flipped classroom is a method in which students assess instructional video prepared by the instructor prior to the classroom sessions and use class time to participate in meaningful learning activities, instructor guided problem solving and discussions ([7],[8]). Flipped classroom is an educational approach in which learners view pre-recorded lectures using technological devices at home, library environment or any place where the materials for instruction are made accessible ([9], [10], [11]). The students are expected to come to the following class after they have viewed the prepared instructional materials to have an interactive class discussion with their peers and teacher based on the viewed lecture/material.

At this juncture, they must have worked on all the difficult concepts with regards to the content already viewed. The teacher would require the students to have completed the assigned works, prepare for discussions and explanations of the concepts they have studied in preparation for the next lesson. In effect, what the students have normally done at home is now becoming what they do in class. The conventional class works and assigned works at home are flipped. The above definitions indicate the fact that flipped classroom is a novel teaching strategy in Nigerian educational system which emphasizes student- centeredness as against teacher-centered approach to teaching and learning.

Some authors ([12], [13]) have written justifying why flipping classrooms are very necessary. To them, flipped classroom increases students' engagement in class activities. It allows personal guidance of the students and makes the environment for learning to be very flexible so that students can meet their academic needs. Nevertheless, there are possible challenges that can hinder its implementation and effectiveness. Some of them could be infrastructural challenges meaning that some classrooms might not be designed for group work, class size management; and many families have not integrated the needed technologies for their children's pre-assignment works.

However, literature abounds concerning the fact that flipped classroom has the potential to arouse students' interest in Mathematics ([14], [15], [16]). To this end, The Macquorie Dictionary, 1987 as cited in [17] defined Interest as the feeling of one whose attention or curiosity is particularly engaged by something.[17] further stated that interest is a state where learners become so absorbed in the learning task that they lose all sense of time. Therefore, students' interest in mathematics would imply steady attendance to classes, curiosity as to what will be done next, active involvement in home assigned works and participating actively in interactive sessions in the flipped classrooms. [18] stressed that the instructional strategy employed in teaching any subject could have positive or negative effect on students' interest.

Reference [19] opined that the teaching method used by a teacher is very crucial to students' academic achievement and it can greatly affect the way a student views a particular subject. The way a teacher teaches would encourage or discourage the students from studying the subject. According to [20], a mathematics teacher who is dedicated to his teaching should be able to lift his/her students to a level where they begin to appreciate mathematics as a subject. If students are able to appreciate the beauty and application of mathematics, their attitude towards the subject would change positively. Thus the learning of mathematics involves both the teacher and the students. That is the reason why this research is anchored on Vygotsky's Social Cultural Theory to explain the connections between the flipped classroom approach and students' interest in senior secondary school mathematics.

This theory recommended that when students learned through social interactions, in groups, or in collaboration with the teacher as a facilitator, they retained the self-discovered knowledge and information comprehended based on the teacher's assistance, thereby enjoying the learning of Mathematics [21]. Reference [22] opined that students acquired knowledge through social interactions and through their culture to experience meaningful learning. When Vygotsky's social cultural theory was carried out in the mathematics classroom (via facilitation, collaboration, multiple representation, technology, etc.), students retained mathematical information longer and grasped the concepts easily regardless of the level of difficulty; in turn, students mathematics achievement was maximized [23]. The major theme of the social cultural theory structure is that social interactions play an important part in cognitive development. For mathematics teaching to successfully take place, students' interests in mathematics must be well thought-out. Lessons should be well planned so that students effectively interact within the classroom and construct their own understanding ([9], [13]). Ideas from Vygotsky's social cultural theory are apparent within the flipped classroom and evidently work well within the flipped classroom approach.

A. Statement of Problem

The authors have observed that teacher centered approach has dominated the teaching of mathematics in Nigerian educational system especially in Rivers State. This method according to researchers is one of the major factors impeding the teaching of Mathematics [20]. Therefore, there is need to employ an innovative teaching approach which may have the capability of spurring the interest of students and enhance the academic

achievement of senior secondary school mathematics students. This study therefore, seeks to find out the extent to which the flipped classroom strategy (FCS) can enhance senior secondary school students' interest in mathematics.

B. Aim and Objectives of the Study

The aim of this study is to investigate the effects of the Flipped Classroom Strategy (FCS) on senior secondary school students' interest in Mathematics. Specifically, the study intended to:

- I. Investigate the effect of Flipped Classroom Strategy (FCS) on students' interest in mathematics.
- II. Determine whether students taught with the Flipped Classroom Strategy differ in their interest in mathematics from those taught with the Teacher Centered Method (TCM).

C. Research Questions

The following research questions guided the study:

- I. What is the effect of flipped classroom strategy on students' interest in mathematics?
- II. To what extent do students taught with the flipped classroom strategy differ in their interest in mathematics from those taught with the TCM as measured by their post-test mean scores?

D. Hypotheses

- I. H_{01} The flipped classroom strategy had no significant effect on students' interest in mathematics.
- II. H_{02} There is no significant difference in the interest of students taught using FCS and those taught using TCM with respect to mathematics.

III. METHODS AND MATERIALS

The study focused on the interest of senior secondary school II students in two schools in Rivers State, Nigeria. Flipped Classroom Strategy (FCS) and Teacher-Centered Method (TCM) were the pedagogical methods used in the classroom to evaluate how they relate to the enhancement of students' interest when classrooms are flipped. The design of this study is the two group pre-test post-test quasi-experimental design. Intact classes were used to determine the effects of the two teaching strategies on students' interest in mathematics. One instrument for data collection was developed and used. The authors designed and developed a Mathematics Interest Scale (MIS) which was validated by mathematics teachers and experts in the field of measurement and evaluation. The internal consistency of the MIS was determined with the use of Cronbach Alpha technique. The authors administered the final MIS to 20 SS11 Mathematics students who were not involved in the study. The reliability analysis produced a Cronbach's alpha coefficient of 0.708.

The MIS consisted of 28-items to ascertain the interest of the students in mathematics. It was a 4-point modified Likert-type response scale ranging from Strongly Agreed to Strongly Disagreed. The Mathematics Interest Scale (MIS) development was based largely on the affective domain of Benjamin Blooms Taxonomy of Educational Objectives [24]. The MIS comprised inputs from those educational objectives that were concerned with ones' emotional state, feelings, degree of acceptance or rejection of some materials taught and the modes of personal or social adjustment. The MIS involved questions that probe students' curiosity, values, interest, appreciations and attitudes. Also, there were inputs from flipped classroom strategies and the social learning theories. Furthermore, there were inputs from research literatures that stressed the relevance of mathematics in Nigeria specifically and globally in general.

The sample size for this study was one hundred and four (104) students; fifty three (53) students (34 boys and 19 girls) in the control group and fifty one (51) students (34 boys and 17 girls) in the experimental group. The two co-educational senior secondary school students were selected using purposive sampling technique because they possessed the specific characteristics to be studied. The criteria that were used for adequate representation of male and female students were:

1. A school that was co-educational to offer opportunity to assess students' interest and achievement in mathematics based on gender.
2. A school that has ICT facilities needed for flipped classroom
3. Administrative consent
4. Qualified mathematics teachers
5. Individual student consent.

The experimental group was taught using the Flipped Classroom Strategy (FCS). Selected mathematics topics were built into the flipped classroom lesson plan using the flipping principles. There were also contributions from the recommended SS II Mathematics books; Essential Mathematics 2 for Senior Secondary Schools by Oluwasanmi (2013). These were imbedded into the instructional package which was burnt into the CDs for students to view at home in preparation for the next class. The instructional packages in the CDs reflected learning principles such as; active involvement of students; problem-solving, collaborative learning,

student-to- student interactions, students’ ownership of the lesson, student-teacher interactions and relating the lessons to real-world experiences. The control group were taught the same topics using the Teacher Centered Method (TCM). The instructional package for this group was based on the traditional teaching strategies where students are usually taught in class and have assignments given to them to be completed at home. The same recommended textbook was used.

Before the introduction of the treatment (that is, Instructional CDs for the Experimental group), both groups were given the pre-test instrument – Mathematics Interest Scale (MIS). Thereafter, treatment commenced and lasted for five weeks of twenty periods. For the experimental group, the traditional classroom was inverted. Thus students were given their instructional packages in CDs. During the next class, students were allowed to interact among themselves, discussed the content and answered questions based on the pre-assignment which they had already done at home. As these processes were going on, students were guided on difficult problems they encountered. During the process, students paused, replayed, and watched lessons repeatedly during the interaction process.

IV. RESULTS

A. Research Question 1: What is the effect of flipped classroom strategy on students’ interest in mathematics

V. TABLE I

MEAN, STANDARD DEVIATION ON THE EFFECT OF FLIPPED CLASSROOM STRATEGY ON STUDENTS’ INTEREST IN MATHEMATICS

N	Pre-Interest \bar{X}	SD	Post-Interest \bar{X}	SD	Mean Gain
51	83.76	7.15	85.55	8.45	1.79

Table 1 shows that the pre-interest and post-interest mean scores of students in flipped classroom strategy group are 83.76 and 85.55 respectively. The gained mean score of 1.79 shows that the FCS enhanced students’ interest in mathematics.

B. Research question 2: To what extent do students taught with the flipped classroom strategy differ in their interest in mathematics from those taught with the TCM as measured by their post-test mean scores?

TABLE III

STUDENTS’ MEAN AND STANDARD DEVIATION FOR THE DIFFERENCE IN MATHEMATICS INTEREST WHEN TAUGHT USING FCS AND TCM

Group	N	Pre-interest		Post –interest		Post-interest Mean Gain
		Mean	SD	Mean	SD	
FCS	51	83.76	7.15	85.55	8.45	2.66
TCM	53	82.51	7.61	82.89	9.16	

Table 2 shows a post-interest mean score of 85.55, for students’ interest in mathematics for the FCS group and 82.89, for TCM group. The results show a difference of 2.66 in the post-interest mean scores of the two groups in favour of the group taught using FCS.

C. Hypothesis 1: There is no significant effect of the flipped classroom strategy on students’ interest in mathematics.

TABLE IIIII

PAIRED T-TEST ON THE EFFECT OF FLIPPED CLASSROOM STRATEGY ON STUDENTS’ INTEREST IN MATHEMATICS

Test	N	\bar{X}	SD	Mean diff.	Df	t-cal	p-value
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Post-test	85.55	8.45	1.79	50	1.46	0.150
	51					
Pre-test	83.76	7.15				

Table 3 shows that when the (mean difference between the) pre-interest and post-interest mean scores were subjected to paired t-test, a t-value of 1.46 was obtained at df of 50 and a p-value of 0.150. Since the p-value is greater than 0.05, the chosen level of significance, the null hypothesis is therefore retained. This indicates that the effect of flipped classroom strategy was not statistically significant at 0.05 level.

D. Hypothesis 2: There is no significant difference between students taught using flipped classroom strategy and those taught using TCM with respect to their interest in mathematics.

TABLE IV

SUMMARY OF 2-WAY ANCOVA ON THE EFFECTS OF FCS AND TCM ON STUDENTS INTEREST IN MATHEMATICS

Source of variation	Sum of Squares	Df	Mean square	F	P-value	Partial square	Eta square
Pretest MIS	2621.254	1	2621.254	51.613			
Group (T.S)	79.673	1	79.673	1.569	0.213	0.016	
Gender	220.391	1	220.391	4.300	0.040	0.042	
Group (T.S) x Gender	3.783	1	3.783	0.074	0.785	0.001	
Error	5027.923	99	50.787				
Total	8120.154	103					

Table 4 reveals that the F-value obtained for teaching strategies (group) is 1.569 at degree of freedom 1 and 99 and 0.213, level of significance. Thus, there is no significant difference in the mathematics interest of students taught using FCS and those taught using TCM. Therefore, the null hypothesis is retained because the obtained level of significance 0.213 is greater than 0.05, the chosen level of significance.

VI. DISCUSSION

A. Flipped Classroom and Students’ Interest in Mathematics

The results from Table 1 showed that the pre-interest mean score of students taught using FCS was 83.76 and the standard deviation was 7.15, while the post-interest mean score was 85.55 and standard deviation 8.45. This shows a gained mean score of 1.79 which means that FCS enhanced students’ interest in mathematics.

However, the effect was not statistically significant at $p=0.05$ level (See Table III). The reasons for this could be that Nigeria is a country where technological facilities are inadequate, where there is irregular power supply, lack of functioning facilities and where students and teachers are still not used to the idea of using technology for academic purposes. In addition, to majority of these students, the use of these technological gadgets for academic purposes could be a novel idea, this could have affected their mind set, resulting in the finding that flipped classroom did not significantly enhance students’ interest in mathematics. The present result is in agreement with some previous research findings. For example, [25] in a study to explore the flipped classroom and its effects on students’ learning in a high school mathematics course, in Penta Carer Centre, Bowling Green State University, found that flipped classroom approach increased students’ interest in mathematics, but the increase was not statistically significant. Similar results were found in related studies by ([26], [27]).

However, findings contradictory with the present study were found by some others ([7], [28], [29]). Reference [7] found that the students taught with flipped classroom strategy were less satisfied with the structure of the learning tasks in the course. Reference [7] claimed that the flipped classroom seemed to work better for certain classroom and courses than others. On their part, [28] found that the students were more interested in the traditional method than the flipped classroom approach because the course does not usually require homework and in addition, very few students agreed to participate in the flipped classroom method.

B. Teaching Strategies and Students' Interest in Mathematics

Table II showed a post- interest mean score of 85.55 and a standard deviation of 8.45 for students' interest in mathematics for students taught using the flipped classroom while those taught using the teacher-centered method had a post-interest mean score of 82.87 and a standard deviation of 9.16. Therefore, there existed a difference of 2.66 in the post-interest mean score of the two teaching strategies in favour of the experimental group (FCS). However, this was not statistically significant (See Table IV). This result means that the flipped classroom strategy enhanced students' interest better than the TCM, though not significantly. This result is not unexpected because these students are in the era of technology and it is possible that their disposition towards the use of video for learning mathematics might have influenced their interest in mathematics, hence the improved interest in mathematics.

In related research, [27] in a research on effects of flipped classroom model on students' performance for advance placement in high school chemistry found that majority of the students preferred the flipped classroom mode of teaching to the traditional mode since they can pause, rewind and review lectures. Similarly, [30] found that students were more interested in the flipped classroom approach and specifically appreciated the benefits of viewing lessons at their own time and pace. However, contrary result was shown by [31] in a study on the Impact of Flipped Classroom Design on students' performance and perceptions in a pharmacotherapy course in Texas. They found that students were not interested in the flipped classroom approach because it increased their workload, and they were not pleased about the interactive nature of the learning method.

VII.CONCLUSION

The use of flipped classroom strategy was found to improve students' interest in mathematics however; the improvement was not statistically significant. There existed a difference in students' interest in mathematics for the two groups (FCS & TCM) in favour of those taught with the FCS, but this was not statistically significant. The results of this study have provided ideas about the potential of an alternative strategy in senior secondary school mathematics. The findings from this study could also persuade teachers to employ alternative strategies combined with technologies in their classrooms to help students with different learning styles, reveal different methods of teaching, give students extra time for collaborations on one-on-one bases with their teachers and create an avenue for students to have momentous discussions with their peers. The advantages of implementing flipped classroom strategy could perhaps enhance teacher effectiveness and consequently, positively affect students' interest and academic achievement in senior secondary school mathematics.

VIII. RECOMMENDATIONS

Based on the results of this research, the following recommendations were made:

1. Schools should be adequately equipped with technological gadgets and infrastructural facilities to facilitate the implementation of ICT integration in the teaching and learning of Mathematics.
2. Rivers State senior secondary schools should consider implementing the flipped classroom strategy in mathematics, as it engages and motivate students' interest.

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