International Journal of u- and e- Service, Science and Technology
Vol. 12, No. 4 (2019), pp.37-46
http://dx.doi.org/10.33832/ijunesst.2019.12.4.04

EFFECTIVENESS OF FLIPPED CLASSROOM INSTRUCTIONAL TECHNOLOGY MODEL IN ENHANCING STUDENTS' ACHIEVEMENT IN PHYSICS

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***Abstract*— The achievement of physics students in recent years has been on the decline. This is for the fact that secondary school students perceived physics as an abstract subject due to the method of instruction adopted by the teachers. Thus, this study determined the effectiveness of flipped classroom instructional technology model in enhancing students' achievement physics. Pre-test post-test control group design was adopted for the study. The sample size of the study comprised 64 students. The instrument for data collection was Physics Achievement Test (PAT) which is 20-item multiple-choice questions. An internal consistency reliability index of 0.87 was obtained for PAT using Kuder-Richardson 20 (KR-20) formula. All groups were pretested before the experiment and post-tested after the experiment. Mean was used in answering the research questions while repeated-measures 2-way Analysis of variance (ANOVA) was used to test all the null hypotheses. The result showed that flipped classroom instructional technology was effective in enhancing the achievement of physics students at both post-test and follow-up measurements. Also, there was a significant interaction effect of time and group on the achievement of students in physics.**

***Keywords*— Achievement, Flipped Classroom Instructional Technology, Physics**

1. INTRODUCTION

Today, the use of technology has led to ease of task performance and the use of information in our everyday lives. Modern-day technology has been vastly used by many, particularly youths[1]. According to some authors [2,3], children of the twenty-first century occupy the seats and desks in our high school classrooms today and live in a world of instant gratification with technology integrated into every aspect of their daily lives. These group of students no longer need to pull out a dictionary to lookup an unknown word to find the answer to a puzzling question but simply use their iPhone to find the answer. Today's high school students can hold multiple conversations at the

Received: September 15, 2019
Reviewed: November 18, 2019
Accepted: December 3, 2019

ISSN: 2207-9718 IJUNESST

same time via text message, and academically they may have access to speech-to-text technology that allows them to write an entire paper without ever holding a pen or touching a keyboard[4]. Furthermore, there is an available application that students may use to complete their academic homework simply by taking a picture of the posed problem[3].

Studies have shown that teaching and learning in most senior secondary schools are saddled with limited instructional materials or tools particularly interactive whiteboard [5] and power-point[6]; lack of laboratory demonstration[7,8]; and limited flipped classroom[9]. However, flipped classroom is an instructional material, responds to the needs of modern learning and provides an effective model of reinvention since students prefer classroom experience that encourages and help them develop knowledge of subject matter. This is because a flipped classroom provides an avenue for a topic to be viewed at home before the normal activity based on the same topic.

The flipped classroom design implies that the teacher supplies the course content to the students through videos and other learning materials to be absorbed at their own time before they enter the classroom [10]. The flipped classroom provides students with video lectures that can be accessed from home and paired with collaborative, student-centred activities during class time to aid mastery of concepts and skills [11-13]. The flipped classroom design assigns video lectures for homework to replace the instructional lectures that traditionally take place during class time. The role of the teacher during class time is to provide students with the opportunity to practice and explore new concepts and skills through student-centred activities that focus on skill application and productive collaboration [11-13]. The instructor may also upload these materials online to be easily accessible to the student anyway and at any time [14]. This means that a flipped classroom promotes the democratization of learning as the autonomy of students is enhanced where the instructor becomes the guide. However, the students are encouraged to put down questions to ask once they come to class and not just to watch or read the instructional content [15]. Once the students come into the classroom, an opportunity is given to them to voice out their opinion and share knowledge based on the instructional content through cooperative and collaborative activities [16].

Different studies have been conducted in foreign countries to determine whether or not a flipped classroom enhances students' academic success in physics education. Some of these studies [17-19] indicated that there is an improvement on achievement scores of students exposed to a flipped classroom. In Nigeria, there is a high rate of poor academic achievement of students in public examinations. Students' poor academic achievement has become the concerns of parents, teachers, school administrators, and government [20, 21]. Their worries are becoming more intense as they realize that students' performance in school may connect with their performance in real life [21]. Earlier research in Nigeria traced students' poor academic achievement to teachers' specific factors, school-related problems [22] and home front [20]. Despite such efforts by the researchers, students' academic achievement in Nigeria has not improved to expectations [23]. Thus, this study sought to determine the effectiveness of flipped classroom instructional technology in the enhancement of physics academic success using Nigerian students. The researchers hypothesized that there is no significant effect of flipped classroom instructional technology on the achievement of students in physics at both post-test and follow-up measures.

2. METHODS

2.1. ETHICAL CONSIDERATIONS

Research Ethics Committee of the Faculty of Education, University of Nigeria approved this study. The researchers strictly followed the ethical standard specifications

of the American Psychological Association. Students who participated in this study provided informed assent.

2.2. DESIGN OF THE STUDY

Pre-test-post-test control group design was adopted by the researchers for the study.

2.3. PARTICIPANTS

A total of 64 secondary school physics students in Anambra State Nigeria were used as participants. Besides, the accuracy of the sample size was determined using *G-Power*, version 3.1 which gave 0.84. The demographic statistics of the participants are presented in Tables I.

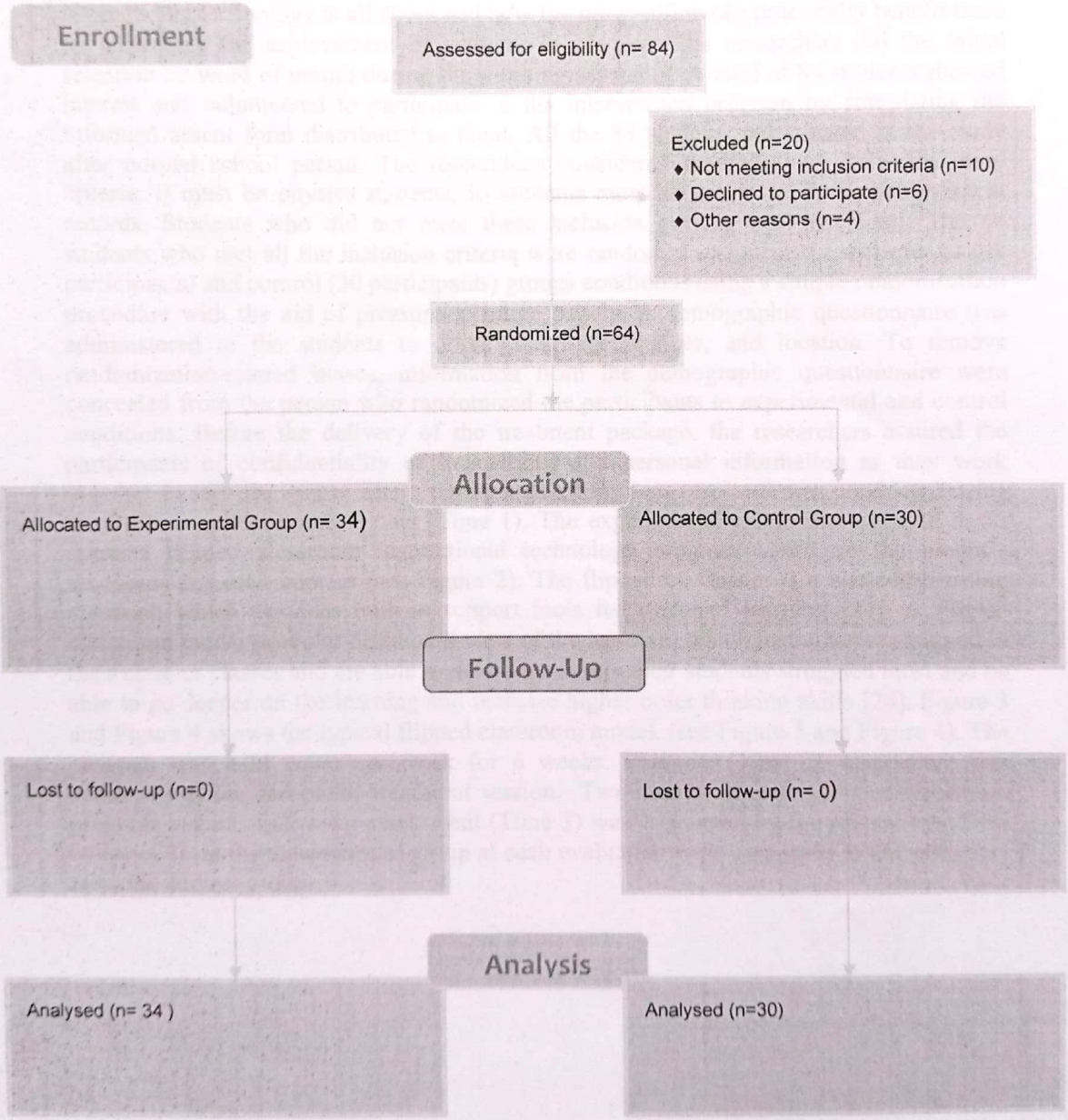

Fig. 1 Flow Diagram for Participants' Allocation

2.4. INSTRUMENT FOR DATA COLLECTION

The instrument for data collection was the Physics Achievement Test (PAT). PAT consist of 20-items multiple-choice questions of response options, B, C and D. PAT was developed by the researcher using test-blue print or table of specification to ensure proper content coverage. PAT was face-validated by three test development experts. Content validity of PAT was determined using a table of specification. An internal consistency reliability index of the instrument was 0.87 using Kuder-Richardson 20 (KR-20) formula.

2.5. PROCEDURE

The researchers visited the principals of each of the schools in Anambra state, Nigeria to notify and obtain permission to carry out the research in their schools. At the course of the visits, the researchers explained to the school authorities what flipped classroom instructional technology is all about and how the intervention can potentially benefit them by enhancing the achievement of students in physics. The researchers did the initial selection by word of mouth during the morning assembly. A total of 84 students showed interest and volunteered to participate in the intervention program by completing the informed assent form distributed to them. All the 84 students participated in the study after normal school period. The researchers considered the following as inclusionary criteria: i) must be physics students; ii) students must have low academic achievement records. Students who did not meet these inclusion criteria were excluded. The 64 students who met all the inclusion criteria were randomly assigned to experimental (34 participants) and control (30 participants) groups conditions using a simple randomization procedure with the aid of pressure-sensitive papers. A demographic questionnaire was administered to the students to obtain their age, gender, and location. To remove randomization-related biases, information from the demographic questionnaire were concealed from the person who randomized the participants to experimental and control conditions. Before the delivery of the treatment package, the researchers assured the participants of confidentiality of interactions and personal information as they work together in self-disclosure. The pre-treatment assessment (pre-test) was conducted using the PAT to collect baseline data (Time 1). The experimental group was exposed to 50 minutes flipped classroom instructional technology program based on the bloom's taxonomy for each contact (see Figure 2). The flipped classroom is a blended learning approach which provides built-in support tools for students' learning [24]. A flipped classroom model provides dashboard view of the lesson(s) which instructor(s) assigned to their class or classes and are able to determine where their students struggled most and be able to go deeper on the learning and increase higher order thinking skills [24]. Figure 3 and Figure 4 shows the typical flipped classroom model. (see Figure 3 and Figure 4). The program was held twice per week for 6 weeks. Post-test (Time 2) assessment was conducted at the end of the treatment session. Two months after the flipped classroom program, regular follow-up assessment (Time 3) was conducted by the researchers. Data collected from the experimental group at each evaluation were compared to that collected from the control group.

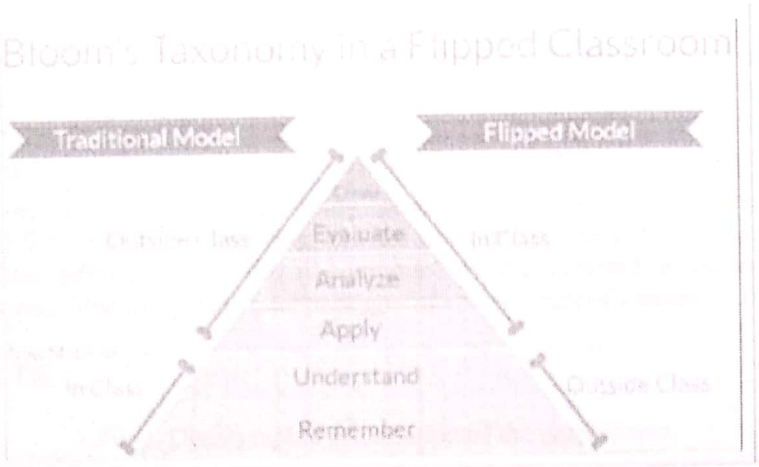

Fig. 2 Flipped Classroom model and the Bloom's Taxonomy [24]

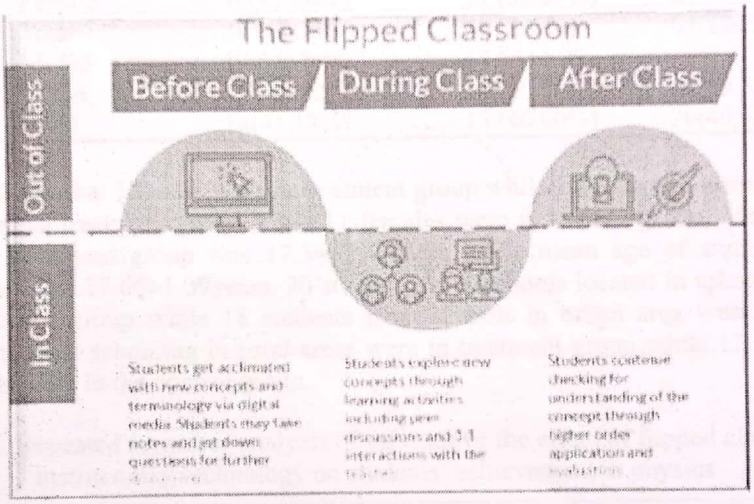

Fig. 3 Flipped Classroom Instructional Technology Model (see 24)

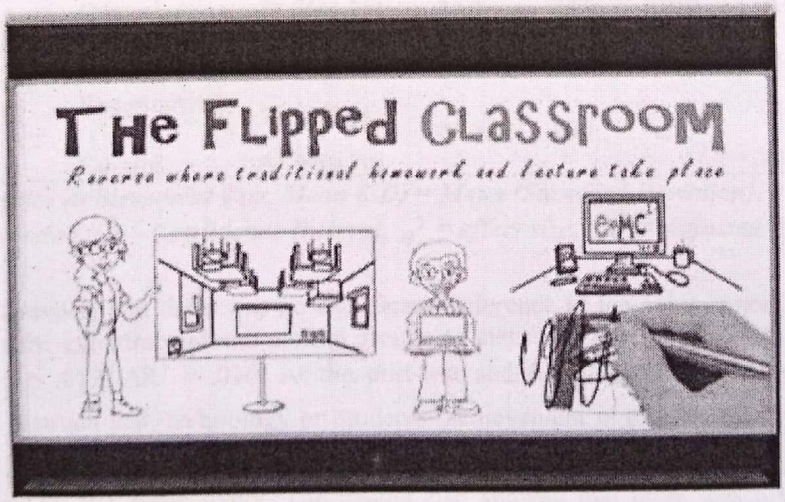

Fig. 4 Flipped Classroom (*see* [25])

2.6. DATA ANALYSIS

The effectiveness of flipped classroom instructional technology in enhancing the achievement of students in physics was determined using repeated measures 2-way analysis of variance (ANOVA). The effect size of the intervention was reported using Partial Eta squared (η_p^2) and adjusted R^2values. The assumption of the sphericity of the test statistic was tested using the Mauchly test of sphericity which was not significant (Mauchly W=0.764, p=.813), implying that the assumption was not violated. Thus, the variances of the differences between all combinations of the related measures are equal. The analysis was done using statistical package for social sciences version 18.0.

3. RESULTS

Table I. Demographic information of the participants

Variables	Categories	Treatment group	Control Group	Total
Gender	Male	18(52.94%)	19 (63.33%)	37(57.81%)
	Female	16(47.06%)	11 (36.67%)	27(42.19%)
	Total	34 (100%)	30 (100%)	64(100%)
Mean Age	M±SD	17.34±2.43	17.65±1.09	
Location	Urban	20(58.82%)	18 (60.00%)	38(59.38)
	Rural	14(41.18%)	12 (40.00%)	26(40.62)

Table I shows that 18 male were in treatment group while 19 were in control group. 16 females were in treatment group while 11 females were in control group. Mean age for students in treatment group was 17.34±2.43years while mean age of students in the control group was 17.65±1.09years. 20 students from schools located in urban area were in the treatment group while 18 students from schools in urban area were in control group. 14 students schooling in rural areas were in treatment group while 12 students in rural schools were in the control group.

Table II. Repeated measures analysis of variance of the effect of flipped classroom instructional technology on students' achievement in physics

Time	Measures	Group	Mean(SD)	F	p	η_p^2	ΔR^2	95%CI
Pre-test	PAT	Experimental	38.45(2.54)					
		Control	38.76(3.25)	1.05	.743	.012	.016	0.11, 1.89
Post-test	PAT	Experimental	69.50(4.76)					
		Control	40.79(8.76)	61.699	.000	.783	.791	59.87, 70.45
Follow-up	PAT	Experimental	70.21(2.01)	84.328	.000	.799		
		Control	41.44(6.76)				.801	72.87, 95.66

PAT = Physics Achievement Test, Mean (SD) = Mean (Standard Deviation), p = probability value, CI – Confidence Interval, η_p^2 = effect size, ΔR^2 = Adjusted R^2

Table II reveals that there was no significant difference in the achievement scores of students in the experimental and control groups as measured by PAT, $F(1,61) = 1.05$, $p = .743$, $\eta_p^2 = .012$, $\Delta R^2 = .016$. At the post-test and follow-up, the effect of flipped classroom instructional; technology on students' achievement in physics was significant, $F(1,61) = 61.699$, $p = .000$, $\eta^2 = .783$, $\Delta R^2 = .791$; and $F(1,61) = 84.328$, $p = .000$, $\eta_p^2 = .799$, $\Delta R^2 = .801$ respectively. The results also showed that there was a significant interaction effect of time and group on the achievement of students in physics, $F(2,61) =$

15.761, p = .000, η_p^2 = .467, ΔR^2 = .521. Figure 4 shows the graph of the interaction effect of time and group.

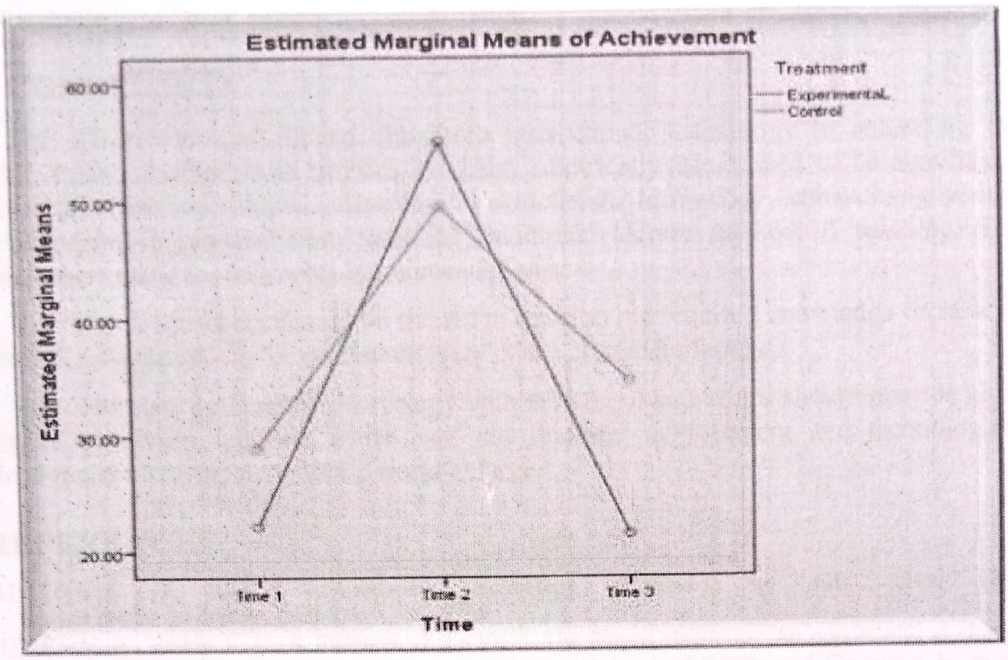

Figure IV. Interaction plot of Time x Group

4. DISCUSSION

The findings of this study showed that students exposed to flipped classroom instructional technology achieved higher than those who were not so exposed. In order words, there is a significant effect of flipped classroom instructional technology on students' achievement in physics at both post-treatment and follow-up measures. The results of this study may not be far from the fact that students exposed to flipped classroom understood the practical aspect of physics concepts more by viewing the video clips than their counterpart who only shared knowledge based on their abstract understanding of physics. In other words, the students exposed to the flipped classroom instructional technology were actively involved in the learning process compared to those who were not exposed thereby developing more interest vis-à-vis achievement. This is in alignment with the finding [26] that there is a significant improvement on semester grades of students when taught using a flipped classroom strategy. Previous research also suggests that the flipped classroom may result in significantly higher academic scores for all students [27] specifically in the science subject [28]. Research suggests that the flipped classroom is an effective intervention for improving homework completion rates among high school students[26]. Research equally found that students' learning activity was improved when using the flipped classroom [29]. Similarly, researchers [30] found that that there was a significant effect of the flipped classroom on students' retention in chemistry and sciences respectively.

This study as the first of its kind in Nigerian context adds to the existing research on the effectiveness of the flipped classroom instructional technology in enhancing the achievement of students in science subjects. Thus, the implementation of the instructional technology package in this research may motivate stakeholders in education to consider alternative (non-traditional lecture method) of teaching science subjects especially physics. The grouping of students during collaborative activities in the treatment phases may limit the generalizability of the findings. Not minding that there were days in which

students worked well with their assigned partners, some other days, personalities clashed leading to students' distraction and lack of focus. However, with the support of the classroom pedagogical professionalism, the researchers were able to organize the participants to enhance successful collaboration.

5. CONCLUSION

The effectiveness of flipped classroom instructional technology in enhancing the achievement of students in physics has been empirically determined to be significant. Thus, the use of flipped classroom instructional technology enhances students' achievement in physics more than the traditional lecture method of teaching. The researchers made the following recommendations;

1. Physics teachers should be trained to develop the required knowledge on how to use a flipped classroom for content delivery of the classroom lessons.

2. The state government in synergy with the school authorities should provide good flipped classroom facilities which will aid students' achievement and technological development to compete with the world at large.

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