



Original Article

IMPACT OF FLIPPED CLASSROOM INSTRUCTIONAL MODEL ON STUDENTS' ACHIEVEMENT AND RETENTION OF MAMMALIAN SKELETAL SYSTEM IN MINNA, NIGER STATE, NIGERIA

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ABSTRACT

This study investigated the impact of flipped classroom instructional model on students' achievement and retention of mammalian skeletal system in Minna, Niger State, Nigeria. The quasi-experimental non-equivalent, non-randomized, pre-post-test control group design comprised of an experimental group (n = 83) with group learning treatment and a Control group (n = 76) was given conventional teaching for a duration of 4-week. Four research questions and four hypotheses were raised and tested at 0.05 level of significance. Biology Achievement Test (BAT) and Field Trial Validation Questionnaire (FTVQ) with reliability coefficient of 0.70 and 0.84 respectively, were used for data collection. The ANCOVA was employed to determine the main effects of flipped classroom instructional model on group achievement, retention and gender. The results showed a significant effect on students' achievement, retention but no significant effect of gender on the concept of Mammalian skeletal system's achievement. The findings revealed that the students taught the concept of Mammalian skeletal system using flipped classroom instructional model out-performed their counterpart taught the same concept using conventional lecture method both in achievement and retention; and both the male and female students in the experimental group improved their achievement and retention in which no significant difference was observed after the treatment. Flipped classroom instructional model had significant effects on students' achievement and retention. Gender differences with respect to the effects of flipped classroom instructional model on achievement and retention was not significant. Therefore, biology teachers should be encouraged and trained in the use of flipped classroom instructional model to improve students' achievement and retention in Nigeria.

Keywords: Flipped Classroom, Mammalian Skeletal System, Gender, Achievement, Retention

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INTRODUCTION

In Nigeria, Biology occupies a central position among all science subjects. It is a core subject for, Agricultural science, Nursing, Medical science Pharmacy, Synthetic industry, Textile science, Chemical technology. Research evidences have proved that Biology contributes to the quality of life and nation building in all aspects of human endeavour (Abimbola, 2013). Therefore, for any meaningful development to take place, every nation must embark on knowledge and skills of science and technology (including Biological Sciences) for rapid and sustainable social, economic, political and technological advancement.

In spite of the importance of Biology education to nation building, students' achievement in biology at Senior Secondary School level is not encouraging. Previous results of Senior School Certificate Examination (SSCE) conducted by National Examinations Council (NECO) (NECO, 2013) reveals that Biology students always perform poorly. From the analysis of the 2013/2014 NECO results, the candidates' results in the science subjects such as Biology, Chemistry and Physics were generally poor. The percentage of students that obtained Credit pass in Biology fluctuated from 45.77% to 22.47% for the past 5 years (2009-2014) in Nigeria (NECO, 2014).

At secondary school level in Nigeria, students' failure in Biology is due to lack of laboratory, unprofessional and inexperienced biology personnel, high population in the classes which affects class control, poor mode of instructional delivery, among others (Akanbi and Kolawole, 2014). Some researchers have attributed the students' poor

performance in Biology was due to the abstract concepts of internally situated organs and systems which ordinarily could not be easily accessed. Such complex and internal structures include nervous system, excretory system, respiratory system, blood circulatory system, digestive system, tissue and supporting systems in animals among others (Singer, 2015). Teachers' teaching strategies plays a significant role towards improve teaching and learning process. Student-centred approach supported by educational media could enhance effective teaching and learning. Among the new educational media for teaching and learning is flipped classroom instructional practice.

Flipped classroom instructional practice, is a new model for effective teaching. Leo and Puzio (2016) referred to it as the process by which students gain first hand exposure to learning content outside the class, usually via reading or lecture videos, and then use class time to do the harder work of assimilating that knowledge through problem solving, discussion, or debates. Flipped classroom is a form of blended learning in which learners learn content online by listening to audio lectures or the watching the video lectures, mostly at their various home, and assignment is done together in the class with teachers and students discussing and solving questions. Students can work together on a task, exchange their opinion, experiences, views, discuss and negotiate strategies, actions and results through flipped classroom (Ichinose and Clinkenbeard, 2016; Zhonggen and Guifang, 2016). These actions can provide students with opportunity to help, discuss, review teach, influence each other and thereby enhance a motivational situation for developing a

learning community. In flipped classroom, teacher's role is of a mentor or facilitator of the learning process. The achievements of individual member within the group are shared among the group members.

Studies on effectiveness of Flipped classroom on students' achievement are yet to be concluded. For Instance, Balaban *et al.* (2016) reported that the flipped classroom instructional format enhances learners' achievement than traditional method when taught the principles of economics course. In another study, Zhonggen and Guifang (2016) discovered that the flipped classroom employed in teaching Business English writing improved students' performance than the traditional approach. Similarly, Leo and Puzio (2016) reported that flipped classroom promotes students' achievement. Furthermore, studies showed that students preferred watching video lectures on their own and applying more active approaches to learning. Likewise, Ichinose and Clinkenbeard (2016) found that students exposed to flipped classroom instructional format consistently performed better throughout the course than those students in the traditional course. In another study, Ahmad (2016) concluded that the flipped classroom had a significant effect on the listening comprehension of Egyptian English as Foreign Language (EFL) students. However, Foldnes (2016) examined the effect of flipped classroom instructional strategy and conventional lecture method and found that students' examination scores did not differ between the lecture classes and the flipped classroom. For students to succeed using Flipped Classroom Model, they should have high retentive memory.

Fakayode (2012) defined retention as individual ability to hold information or store learned material for future use. The prevalent problem in secondary schools is poor retention among secondary school students offering science subjects including Biology. Concepts learned tend to fade with time when not put to use, or not properly retained, hence, lead to forgetting and loss of knowledge. This was supported in a study conducted by Barata *et al.* (2016) in their study on evaluation of the impact of national educational policy to reduce retention and increase achievement in compulsory education and found that Programa Mais Sucesso Escolar (PMSE) had mixed effects on educational achievement but significantly reduced retention. Similarly, Jukic and Ljerka (2014) reported that students had a very low retention of concepts when taught differential and integral calculus. However, the works of Ikpe (2011) and Ukwürü (2012) concluded that computer-based instruction facilitated students' learning in integrated science and chemistry. The question is, could students' retention be influenced by gender?

Gender is a contemporary issue in education and has attracted the attention of many researchers. Findings on effects of gender on students' achievement are inconclusive. For instance, Etim *et al.* (2016) reported the performance of female students was higher than that of male counterparts in English Language, Mathematics and Biology. Similarly, Alexander and Maeda (2015) reported that females outperformed their male counterparts in sciences, but no gender difference in mathematics was observed. Also, Hossain and Tarmizi (2012) reported that the performance of male and female were highly improved in mathematics

achievement, however, the performance of female students higher than that of male students after the treatment. However, Gambari *et al.* (2016) reported that gender did not influence students' performance in individualized and cooperative learning but the males performed better than female in competitive instructional strategy. In addition, Salah (2016) found no significant difference in terms of achievements between female and male students. Similarly, Yaki and Babagana, (2016) reported that Technology Instructional Package employed for teaching Biology was gender friendly. Also, Onwuebguna (2009) reported the performance of male and female students exposed to computer-assisted instruction and found no significant difference between the groups.

Flipped classroom is an innovative teaching strategy; few researchers have worked on effects of flipped classroom on students' achievement, retention and gender within and outside Nigeria. Therefore, this study investigates the impact of flipped classroom instructional model on students' achievement and retention of Mammalian skeletal system in Minna, Niger State, Nigeria.

Research Questions

The following research questions were raised to guide the study:

- (i) What is the impact of flipped classroom instructional model on students' achievement in the concept of mammalian skeletal system?
- (ii) What is the influence of gender on the achievement of students taught the concept mammalian skeletal system using flipped classroom instructional model?

- (iii) What is the difference between the mean retention scores of students taught the concept of Mammalian skeletal system using flipped classroom instructional model and conventional method?
- (iv) What is the difference between the mean retention scores of male and female students taught Biology using flipped classroom instructional model?

Research Hypotheses

The following null research hypotheses were formulated and tested at 0.05 level of significance.

H₀₁: There is no significant difference in the achievement scores of students taught the concept of mammalian skeletal system using flipped classroom instructional model and those taught using conventional method.

H₀₂: There is no significant difference in the achievement scores of male and female student's taught the concept of mammalian Skeletal System using flipped classroom instructional model.

H₀₃: There is no significant difference in retention scores of students taught the concept of mammalian skeletal system using flipped classroom instructional model and those taught with conventional method.

H₀₄: There is no significant difference in the retention of male and female students taught the concept of mammalian skeletal system using flipped instructional model.

MATERIALS AND METHODS

Research Design

This study adopted quasi-experimental design which involves pre-test, post-test and control group design (Frankel and Wallen, 2003). The design involves two level independent variables (Flipped

classroom instructional model and Conventional method of teaching). Three level of dependent variables (achievement & retention) and two

level of moderating variables of gender (male & female). The design layout is as shown in Table 1.

Table 1: Research Design Layout

Group	Pretest	Treatment	Posttest	Retention Test
Experiment	O ₁	X ₁	O ₂	O ₃
Control	O ₄	X ₀	O ₅	O ₆

Keys:

O₁, O₄ = Pretest administered on Experimental and Control Groups

O₂, O₅ = Posttest administered on Experimental and Control Groups

O₃, O₆ = Retention administered on Experimental and Control Groups

X₁ = Flipped Classroom

X₀ = Conventional Lecture Method

Sample and Sampling Techniques

The population of this study was made up of all Senior Secondary School Biology students in Minna. The target population was the twenty-three (23) public senior secondary schools class one (SSI) students with population of 6,710 for 2014/2015 academic session in Minna Niger State. The choice of SSI is based on the fact that the concept (Mammalian Skeletal System) is contained in their syllabus and scheme of work.

The sample was made up of 159 students drawn from four co-educational schools in Minna Metropolis, Niger State. These schools are Bosso Secondary School, Minna, Day Secondary School, Tunga, Minna, Government Day Secondary School, Minna, and UBE Tundun Fulani, Minna. Based on the nature of this research four stages sampling techniques were used. Firstly, A purposive sampling technique was employed to select four schools that are well equipped with Information and Communication Technology (ICT) facilities and with similar characteristics.

Two schools were randomly assigned to the experimental group and the other two to Control group. Simple random sampling technique was used to select one arm of the class from each school that were sampled for the experimental group. Students were not randomized therefore Intact class was used.

Research Instruments

Three research instruments were used for this study. They are; Flipped Instructional Model (FIM), Biology Achievement Test (BAT)

Flipped Instructional Model (FIM)

FIM is the treatment used for teaching and learning of mammalian skeletal system. It was developed by the researchers with the assistance of a studio programmer using a Sony SD 1000 Camera, an attached Boom Microphone, a Camera Stand and an editing software named Corel Video Studio Pro X3. The FIM contains a video of the researcher using the model of a mammalian skeleton to explain the Biology concept of mammalian skeletal system. This include discussion of the location of bones in the body, the number of each vertebrae and total

number of bones in the body of mammals, functions and characteristics of each bone in the body. The concept was sub-divided into eight lesson plan, in-line with the senior secondary school one (SSSI) curriculum and scheme of work. The script was produced, and recorded in the studio and edited by TV production experts.

Biology Achievement Test (BAT)

The Biology Achievement Test consisted of 35 objective items developed by the researcher, from Essential Biology for Senior Secondary by Michael M.C. (2008), and Comprehensive Biology by Nweze (2004). The test items were drawn based on the national curriculum for senior secondary school SSI Biology concept of Mammalian skeletal system that were taught. Each item has four options (A-D) that contained only one correct answer and three distracters. The (BAT) was used to obtain data on students' achievement and retention after the treatments.

Validation of the Research Instruments

(a) Validation of FIM

The validation of FIM was done in three stages (i) expert validation (ii) content validation and (iii) field trial validation.

(i) Expert validation

Experts validation was conducted by Educational Technology and Biology experts from the Department of Science Education and Biological Sciences in Federal University of Technology Minna, who determined the appropriateness of the package in terms of clarity, and simplicity of the package, colour used, spellings, text, voicing, as well as the font size used, technical quality, pacing and use of emphasis

on key concept were noticed by the expert which were later used to amend the instrument. The package was a video compact disc VCD plate and was introduced to the whole contents.

(ii) Content validation

The contents of Biology and BAT was validated by subject specialist. One Senior Lecturer each from the Departments from Science Education and Biological Sciences, Federal University of Technology, Minna and one Biology teacher from Ahmadu Bahago Secondary School in Minna examined and assessed the content and test items and determined its face and content validity. According to validation report, the number of items were increased to fifty and were properly structured.

Field Trial Validation

The model FIM was trial tested on ten Biology students from two secondary schools (Zarumai Model Schools and Limawa Model Schools) which are part of the population, but not among the sampled schools. The field trial validation was conducted on sampled students that were exposed to mammalian skeletal system using the FIM for 40 minute duration. They were instructed to watch the video at home and come back the following day and discuss, perform some tasks and brainstormed on what they have watched. Later, they were asked to respond to the Field Trial Validation Questionnaire.

(b) Validation of Biology Achievement Test (BAT)

Face and content validity of BAT was conducted by subject specialists. One Biology teacher from Limawa Model schools, one lecturer each from

Biological Sciences Department and Science Education Department of Federal University of Technology, Minna. Their useful and constructive suggestions were used to modify some items in the objective questions.

Reliability of the Instrument

Reliability coefficient of the Biology Achievement Test and Field Trial Validation Questionnaire determined after been administered on SSI students from Limawa Model School, Minna which were not among the sampled schools but within the target population for the study. One intact class of 32 students was used for the trial testing. The reliability of the Biology Achievement Test (BAT) was also determined using Kuder Richardson Formula ($K-R_{21}$) which gave rise to 0.70 while 0.84 was obtained for Field Trial Validation Questionnaire using Cronbach Alpha.

Method of Data Collection

After obtaining permission to use the selected schools, the researchers trained the subject teachers who served as research assistants on the use of FIM. At the beginning, pre-test was administered to both experimental and control groups while the treatment was administered on experimental group using FIM. The FIM was uploaded to website and also burn on (CD) Compact Disc for students who will not have access to the internet. The CD was released on weekly basis. Students were instructed to watch the video at home before the class session. For benefit of doubts, they were also given time frame of 40 minutes to watch the video in the

class before the class session. During the Biology class, students were given some tasks to perform based on the video clip watched. In addition, they were allowed to go home with the FIM at the end of each week for more comprehension and mastery of the concept. Meanwhile, students in the control group were taught the same concept using the conventional lecture method. After four weeks of treatment, BAT was administered to both experimental and control group to determine the achievement of the concepts learnt while using FIM. Two weeks waiting period was observed and BAT was reshuffled and re-administered as retention test. The pre-test, post-test and retention test were marked according to marking scheme and the results generated were subjected to data analysis.

The data obtained from the pre-test and post-test were compiled and analysed using descriptive statistics of mean and standard deviation to answer the research questions, while inferential statistics of ANCOVA was used to test the hypotheses at 0.05 alpha level of significance. The results on the research questions and hypotheses are presented in the tables.

RESULTS

Research Question 1: What is the impact of flipped classroom instructional model on students' achievement in the concept of mammalian skeletal system?

To answer the research question 1, mean and standard deviation were analysed as shown in Table 1.

Table 1: Mean achievement scores and standard deviation of students in experimental and control groups

Group	N	Pretest		Posttest		Mean Gain
		Mean	S.D	Mean	SD	
Experimental	83	37.37	13.07	59.64	15.44	22.27
Control	76	33.07	10.63	44.88	17.02	11.81

Table 1 showed the mean and standard deviation of the pretest and posttest scores of the experimental and control groups. The results revealed that, the mean and standard deviation of the pretest and posttest scores of the experimental group are 37.37; 13.07 and 59.64; 15.44 respectively. This gives a mean gain of 22.27 in favour of the posttest. Similarly, the mean and standard deviation of the pretest and posttest scores of the control groups are 33.07; 10.63 and 44.88; 17.02 respectively. This gives a mean gain of 11.81 in favour of posttest. This indicated that, the experimental group upon which the research instrument

was used achieved higher than the control group exposed to conventional method of teaching. The result therefore reveals that, the treatment instrument employed produced higher mean scores for experimental group than control method.

Research Question 2: What is the influence of gender on the achievement of students taught the concept mammalian skeletal system using flipped classroom instructional model?

To answer the research question 2, mean and standard deviation were analysed as shown in Table 2.

Table 2: Mean achievement of male and female students taught the concept of mammalian skeletal system using flipped classroom instructional model

Group	Pretest			Posttest		Mean Gain
	N	Mean	SD	Mean	SD	
Male	89	34.76	12.27	81.29	4.70	45.53
Female	70	36.01	11.99	65.36	4.85	31.35

Table 2 showed the mean and standard deviation of the male and female students taught the concept of skeletal system using flipped classroom instructional model. The male students' pretest and posttest scores are 34.76; 12.27 and 81.29; 4.70 respectively. This gives a mean gain of 45.53 in favour of the posttest. Similarly, the female students obtained scores of 36.01; 11.99 and 65.36; 4.85 at pretest and posttest, respectively. This produces a mean gain of 31.35 in favour of the posttest. This results indicated that, both groups benefited from the treatment but the

male students benefited more from the treatment than their female counterpart with mean difference of 14.18.

Research Question Three: What is the difference between the mean retention scores of students taught the concept of Mammalian skeletal system using flipped classroom instructional model and conventional method?

To answer the research question 6, mean and standard deviation were analysed as shown in 3

Table 3: Mean retention scores and standard deviation of students in experimental and control groups

Group	N	Posttest		Retention Test		
		Mean	SD	Mean	SD	Mean Loss
Experimental	83	59.64	15.44	49.69	14.32	9.95
Control	76	44.88	17.02	39.46	14.60	5.42

Table 3 showed the mean retention and standard deviation of the posttest and post-retention test scores of the experimental and control groups. The results revealed that, the mean and standard deviation of the posttest and retention test scores of the experimental group are 59.64; 15.44 and 49.69; 14.32, respectively. This produced a mean loss of 9.95 in favour of the posttest. Similarly, the mean and standard deviation of the posttest and retention test of the control group are 44.88; 17.02 and 39.46; 14.60, respectively. This gives a mean loss of 5.42 in favour of the posttest. This implies, the

experimental group upon which the research instrument was used achieved higher than the control group upon which conventional method was used. The results, therefore, revealed that the treatment did not increase the retention of students in experimental group.

Research Question Four: What is the difference between the mean retention scores of male and female students taught Biology using flipped classroom instructional model?

To answer the research question 4, mean and standard deviation were analysed as shown in Table 5.

Table 5: Mean and standard deviation of retention scores of male and female students in experimental groups

Groups	N	Posttest		Retention Test		
		Mean	SD	Mean	SD	Mean Oss
Male	89	50.94	18.32	46.06	15.11	4.88
Female	70	54.67	16.96	43.20	15.50	11.47

Table 5 showed the mean retention scores and standard deviation of the male and female students taught the concept of mammalian skeletal system using flipped classroom instructional model. The result reveals that, the mean and standard deviation of the male students' posttest and retention scores are 50.94; 18.32 and 46.06; 15.11, respectively. This produce a mean loss of 4.88 in favour of the posttest. Similarly, the mean and standard deviation of the female students' posttest and retention scores are 54.67; 16.96 and 43.20; 15.50 respectively. This gives a mean loss of 11.47 in favour

of the post-posttest. This implies that, both group benefited from the treatment but female benefited from treatment than their male counterpart.

Testing of Hypotheses

Hypothesis One: There is no significant difference in the mean achievement scores of students taught the concept of mammalian skeletal system in using flipped classroom instructional model and those taught using conventional method.

Table 6: ANCOVA results of students in experimental and control groups taught the concept of Mammalia skeletal system using flipped classroom instructional model

Source	Sum of Squares	df	Mean Square	F	p-value
Corrected Model	8879.78	2	4439.89	16.87	.000
Intercept	38471.41	1	38471.41	146.198	.000
Pretest (Covariate)	240.27	1	240.27	.91	.01
Treatment (Main Effect)	7868.56	1	7868.56	29.90*	.000
Error	41050.82	156	263.15		
Total	489593.00	159			
Corrected Total	49930.60	158			

*: Significant at 0.05 alpha level

Table 6 showed the ANCOVA results of achievement scores of groups taught the concept of Mammalia skeletal system in biology with flipped classroom instructional model and conventional teaching method. The ANCOVA result ($F = 1, 156$) = 29.90, $p = 0.000$ for the main effect (Treatment) is significant at 0.05 alpha level. The treatment using flipped classroom instructional model and conventional method produced a significant difference on students'

achievement. This is an indication that there was a significant difference between experimental and control groups hence, the research hypothesis one was rejected.

Hypothesis Two: There are no significant differences in the mean achievement scores of male and female students taught the concept of Mammalian Skeleton Using Flipped Classroom Instructional Model.

Table 7: ANCOVA results of male and female students taught using the concept of Mammalian skeletal system using flipped classroom instructional model

Source	Sum of Squares	df	Mean Square	F	p-value
Corrected Model	741.690	2	370.845	2.388	.10
Intercept	17266.2866	1	17266.2865	111.195	.00
Pretest (Covariate)	469.469	1	469.469	3.023	.02
Gender (Main Effect)	236.077	1	236.0775	1.520*	.22
Error	24223.612	80	155.2795		
Total	244796.500	83			
Corrected Total	24965.302	82			

*: Significant at 0.05 alpha level

Table 7 showed the ANCOVA results of achievement scores of male and female students taught the concept of Mammalia skeletal system in biology with flipped classroom instructional model. The ANCOVA result ($F = 1, 80$) = 1.520, $p = 0.02$ for the main effect (Gender) is significant at 0.05 alpha level. The treatment using flipped

classroom instructional model produced a significant difference on male and female students' achievement. This is an indication that there was a significance difference between experimental and control groups. Hence, the research hypothesis two was therefore rejected.

Hypothesis Three: There is no significant difference in retention scores of students Taught the concept of mammalian skeletal system using

Flipped classroom instructional model and those taught with conventional method.

Table 8: Analysis of covariance of retention scores of students taught Mammalia skeletal system using flipped classroom instructional model

Source	Sum of Squares	df	Mean Square	F	p-value
Corrected Model	4150.085 ^a	2	2075.042	9.853	.000
Intercept	27781.915	1	27781.915	131.918	.000
Posttest (Covariate)	1.262	1	1.262	.006	.012
Treatment (Main Effect)	3485.906	1	3485.906	16.552*	.000
Error	32853.475	156	210.599		
Total	356105.000	159			
Corrected Total	37003.560	158			

*: Significant at 0.05 alpha level

Table 8 showed the ANCOVA results of retention scores of groups taught the concept of Mammalian skeletal system in biology with flipped classroom instructional model and conventional teaching method. The ANCOVA result ($F = 1, 156) = 16.552, p = 0.000$ for the main effect (Treatment) is significant at 0.05 alpha level. The treatment using flipped classroom instructional model and conventional method produced a significant difference on students' retention. This is an indication that

there was a significant difference between experimental and control groups hence, the research hypothesis six was thereby rejected.

Hypothesis Four: There is no significant difference in the retention scores of male and female students taught the concept of mammalian skeletal system using flipped classroom instructional model and those taught with conventional method.

Table 9: ANCOVA results of retention scores of male and female students taught the concept of Mammalian skeletal system using flipped classroom instructional model

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1091.952	2	545.976	2.372	.097
Intercept	23006.052	1	23006.052	99.938	.000
Pretest (covariate)	772.312	1	772.312	3.355	.031
Gender (Main Effect)	427.774	1	427.774	1.858 ^{ns}	.175
Error	35911.608	80	230.203		
Total	356105.000	83			
Corrected Total	37003.560	82			

Not Significant at 0.05 alpha level

Table 9 showed the ANCOVA results of retention scores of male and female students taught the concept of Mammalia skeletal system in biology with flipped classroom instructional model. The ANCOVA results ($F = 1, 80$) = 1.858, $p = 0.175$ for the main effect (Gender) is not significant at 0.05 alpha level. The treatment using flipped classroom instructional model on male and female students produced no significant difference on students' retention. This is an indication that there was no significance difference between male and female students in retention test. Hence, the research hypothesis seven was thereby not rejected.

DISCUSSION

This study revealed that students taught the concept of Mammalian skeletal system using flipped instructional model performed better than those taught using conventional lecture method. This finding was supported by that of Balabanet al. (2016), Zhonggen and Guifang (2016), Ahmad (2016), Leo and Puzio (2016) and Ichinose and Clinkenbeard (2016) who reported that the flipped classroom instructional increases student performance than their counterparts in traditional method. However, the finding contradicts the results obtained by Foldnes (2016) who found that students' examination scores did not differ between the lecture classes and the flipped classroom.

This study revealed that male and female students taught the concept of Mammalian Skeletal system using flipped classroom instructional model performed equally better. This finding is in support of findings of Gambari *et al.* (2016) who reported that gender had no influence on students' performance

in cooperative and individualized learning but males performed better than females in competitive instructional strategy. It also agrees with the result of Salah (2016) which revealed no significant difference in the achievements between female and male students. It also supports the finding of Yaki and Babagana (2016) which showed that Technology Instructional Package employed for teaching Biology was gender friendly. However, the finding of this study disagrees with that of Alexander, and Maeda (2015) who reported that females outscored males in science, but there was no significant gender difference in mathematics. It is not in agreement with that of Hossain and Tarmizi (2012) which reported that both the male and female students in the experimental group improved their mathematics achievement in which the performance of female students were significantly better than that of male students after the treatment.

Significant difference was observed in the retention of students taught Mammalian skeletal system using flipped classroom instructional model and those taught using conventional lecture method in favour of flipped classroom group. This conforms to the earlier finding of Ikpe (2011) and Ukwuru (2012) which all support the fact that CBI enhances students' retention in subjects than the conventional method. However, it disagrees with that of Barata *et al.* (2016) which revealed that Programa Mais Sucesso Escolar (PMSE) significantly reduced retention, but had mixed effects on educational achievement. It also disagrees with the results of Jukic and Ljerka (2014) which showed that students had a very low retention of concepts, even after hints.

This study also found no significant difference between the retention scores of male and female students taught skeletal system using flipped classroom instructional model and those taught using conventional lecture method. This finding agrees with the result of Yaki and Babagana (2016) which showed that Technology Instructional Package employed for teaching Biology was gender friendly. It also agrees with that of Onwuegbuna (2009) who found that there was no significant difference in the achievement of male and female students when computer assisted instruction was used. However, it does not support that of Etim *et al.* (2016) who reported that female students performed significantly higher than male students in English Language, Mathematics and Biology. It also did not agree with that of Salah (2016) who found did not find any significant difference in terms of achievements between female and male students.

The superiority of Flipped Classroom Instructional Model over conventional method of teaching stemmed from the fact that it is a student-centred approach where students were given opportunity to watch the video of the lecture prior to the classroom session as compared to conventional method which is teacher-centred approach. In addition, Flipped Classroom as an activity-based learning enables the students to actively engaged in some tasks facilitated by the lecturers as compare to traditional method where students are passive learners. All these could be responsible for the findings of this study. The results of this study has confirmed the Dikici and Yavuzer (2006)'s conclusion that the manner in which students participate actively using variety of instructional materials enhanced effective learning. The implication of this study is an indication that performance of students in Biology

at Senior Secondary School in Nigeria would be better improved if students are exposed to Flipped Classroom Instructional Model.

CONCLUSION

Based on the findings of this study, students taught mammalian skeletal system using flipped classroom instructional model performed better than those taught the same concepts using conventional method. Therefore, using flipped instructional model enhances achievement and retention of secondary school Biology students. Male and female Biology students performed equally better when exposed to flipped classroom instructional model and conventional method. However, flipped classroom instructional model is gender friendly since both male and female students performed equally better.

RECOMMENDATIONS

Based on the findings and conclusions of this study, the followed recommendations are made:

- (i) Flipped classroom instructional model should be adopted by Biology teachers in teaching and learning process at senior secondary schools' level in Nigeria. This could be achieved by training Biology teachers on effective use Flipped classroom instructional model in the classroom environment.
- (ii) Flipped classroom instructional model enhances students' retention, therefore, Biology teachers, policy makers, textbook writers and other stakeholders should emphasise on the use of flipped classroom instructional model to enable students excel in national examinations.

(iii) Flipped classroom instructional model could bridge the gap between male and female academic disparity in Biology. Therefore, Flipped classroom instructional model used in this study should be used to encourage the male and female students in studying Biology.

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