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EFFECTS OF FLIPPED CLASSROOM STRATEGY ON SENIOR SECONDARY SCHOOL STUDENTS' RETENTION IN BIOLOGY IN JOS SOUTH, PLATEAU STATE, NIGERIA

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ABSTRACT

The study investigated the effects of flipped classroom strategy on senior secondary school students' retention in Biology in Jos South, Plateau State, Nigeria*. The study was guided by two objectives; two research questions and two hypotheses. The study adopted a quasi-experimental design, specifically the pre-test post-test non-equivalent control- group design. The population of the study consisted of all 979 SS II students (423 males and 556 females) who were offering Biology in the 18 co-educational public senior secondary schools in Jos South LGA, Plateau State in the 2025/2026 academic session. A sample of 53 students (20 males and 33 females) was drawn from two intact classes from two schools selected from the 18 co-educational public senior secondary schools in Jos South Using simple random sampling technique participated in the study. Data were collected using Biology Retention Test (BRT). It consisted of 50 multiple choice questions with options A-D adapted from West Africa Senior School Certificate Examination and JAMB past question papers. The maximum marks obtainable were 100, while the minimum obtainable marks were 0. Three experts validated the instrument. The reliability of the BAT was established using Kuder-Richardson 20 (K-R20) method which yielded a reliability coefficient of 0.93. The research questions were answered using descriptive statistics of mean and standard deviation, while the hypotheses were tested using ANCOVA at 0.05 level of significance. The findings showed that a statistically significant difference exists between the retention mean scores of the students in the experimental and control groups. The students in the experimental group had a higher retention mean scores than the students in control group. The findings further revealed that no significant difference exists between the retention mean scores of male and female students in Biology in the experimental group. The male and female students in the experimental group had similar retention mean scores. Hence, the use of Flipped classroom Strategy in teaching Biology does improved students' retention in the subject irrespective of gender. It was recommended among others that Biology teachers should employ more technology-driven teaching strategies in the teaching and learning of topics that are abstract and complex. It was recommended that the Federal and state governments, school authorities should provide the basic information technology tools such as computers, storage devices and projectors required by Biology and other Science teachers for preparing and teaching their lessons using Flipped classroom Strategy.*

Key words: Biology, Flipped classroom, Retention, Gender

INTRODUCTION

Education is an essential process in human development. It is a process of acquiring knowledge, skills, values and habits through teaching and training. Nuru (2023) defined education as the organized and systematic activity that constructs and organizes knowledge in the form of testable explanations and predictions about the universe. The importance of education to national growth and development cannot be overemphasized, as it serves as the foundation for equipping individuals with requisite knowledge, skills and attitudes for solving societal challenges. Science education which is an integral part of the Nigerian curriculum serves as a tool for expanding knowledge and provoking critical thinking for addressing pressing national issues, such as ecological

sustainability, health care and technological advancement. The nature of science education is rapidly evolving in the 21st century and technology has become a critical tool for transforming teaching and learning processes. Science has contributed in no small measure to the development of Nigeria and the modern world at large (Piwuna, 2023). The core science subjects in the secondary school level are Biology, Chemistry and Physics. Nevertheless, this research focuses on Biology.

Biology is one of the natural science subjects that focus on living and non-living organisms. In Nigeria, Biology occupies a central position among all science subjects. Research evidences such as Sharma and Singh (2020) have proven that Biology help to develop keen understanding of one's own physical and biological existence and learns the ways to manage a healthy and worthy life. Learning of Biology facilitates individuals' development of positive attitude towards environmental protection, family life, poverty eradication, management and preservation of natural resources. Hence the need for meaningful teaching and learning of Biology so as to foster better interest, achievement and retention in the subject. Recognizing the importance of Biology to national development. The Nigerian government and other stakeholders have made considerable efforts to improve the teaching and learning of Biology in the secondary school level. These efforts include: the revisions of Nigerian senior secondary school curriculum, teacher training programs, provision of laboratory and ICT facilities and provision of instructional materials among others to improve the teaching and learning of Biology.

STATEMENT OF PROBLEM

Despite these efforts and the well-documented importance of Biology to National growth and development, students have often recorded low and fluctuating achievement in the subject that is unsatisfactory (WAEC Chief Examiners Report, 2022). The WAEC Chief Examiners' reports (2013-2023) also revealed persistent students' unsatisfactory achievement in the West African Senior School Certificate Examination. The WAEC Chief Examiners' reports attributed the unsatisfactory achievement to weaknesses observed in the candidates such as: lack of in-depth knowledge of some basic topics like genetics, nervous systems, ecology and nutrient cycle: candidates lack of knowledge regarding the rubrics in biological drawing, technical terms wrongly spelt by many candidates and inability to explain how energy flows in a freshwater habitat among others. This achievement in Biology could be partly blamed on declining students' interest in learning, poor retention, and Biology teachers' frequent use of lecture method in teaching with little or no augmentation with innovative technology-aided strategies like Flipped classroom Strategy in their teaching.

Although the analysis of West African Examination Council (WAEC) SSCE candidates' results in Biology as compiled by the Educational Resource Centre (ERC) Plateau state and NECO SSCE results from 2015 to 2023 showed minimal fluctuating percentage fail D7-F9 which represent non-credit grades (such as WASSCE: 51.09%, 30.19%, 35.03%, 51.21%, 33.44%, 13.59%, 7.79%, 10.51%, and 9.44% and NECO SSCE: 24.06%, 17.36%, 15.35%, 21.00%, 13.86%, 5.53%, 6.26%, 29.23% and 28.91% respectively), the results showed that many students still failed as could be seen in the tables in appendices A12, A13, A14, and A15. Furthermore, very few candidates fell within the excellent (A1) level pass while majority of the candidates fell within the credit pass level (C4-C6). Credit level performance in relevant subjects is commonly required for admission to study science related courses such as Medicine, Biochemistry, Biology, Microbiology and other science and technology courses in the higher institutions. For students to perform well in Biology in senior secondary schools, teachers must limit the use of teaching strategies that are teacher-centered to student-centered strategies that increase students' engagement and retention in science.

Traditionally, in Nigerian secondary schools, the teaching of subjects like Biology has been teacher-centered, with the instructor delivering lectures while students passively receive information. While this approach is conventional, it may limit the interest, retention, critical thinking and students' engagement in learning. However, education scholars are increasingly advocating for more flexible education deliveries that are student centered, engage students actively and integrate social media in teaching (Norman & Wills, 2020; Tsai, Liao, Chang & Chan, 2020). This quest has

led to the development of several instructional strategies that are learner-centered and technology-driven; one of such strategies is the flipped classroom strategy.

Flipped classroom Strategy (FCS) is a strategy in which students are exposed to instructional content (examples are online resources and lectures, online videos/audio) before class and engage in collaborative learning activities, discussions, and problem-solving exercises during class time. It advocates for an inversion of the typical learning structure. This reversal of the typical teaching method allows students to engage with content at their own pace, creating opportunities for deeper learning during face-to-face class time (Bergmann & Sams, 2024). In this strategy, students are introduced to new content before the class through video lectures, reading assignments, or other online resources while classroom time is then dedicated to collaborative learning activities, discussions, hands-on activities and mind-on experience. The teacher's role transits from the traditional "lecturer" to a facilitator who guides students in applying their knowledge through problem-solving and critical thinking exercises. According to Ezenwabachili and Okoli (2021) flipped classroom strategy intentionally shifts instruction to a learner-centered model in which class time explores topics in greater depth and creates meaningful learning opportunities, while educational technologies such as online videos are used to 'deliver content' outside of the classroom. In a flipped classroom, 'content delivery' may take a variety of forms, this may include lessons video prepared by the teacher to deliver content, online collaborative discussions, creation of WhatsApp groups chat, digital research and text readings may be used. The benefits of Flipped Classroom strategy to students are: it encourages the student to utilize digital content to explore knowledge beyond textbooks, it improves personalized learning and teaching methods and it gives rise to student-centered learning. The researcher intends to try out the use of flipped classroom strategy to find out if it could solve the situation of lack of students' retention in Biology.

Retention is the ability to recall or reproduce learned knowledge after a period of time. It also refers to the post-post test mean achievement scores of students. This also means that for a student to retain; the task has been absorbed and the experiences gotten from such task is continuously held, and also used. Yusuf and Umar (2019) defined retention as the ability of the learner to recall information, ideas or learning activities at a later time which he/she may be asked to mention, write or remember after some times . Therefore, retention is a very important aspect of students' learning or rather an aspect of measuring the cognitive ability of learners.

Studies have revealed varied findings on the effects of Flipped classroom Strategy on students' retention in Science and Biology in particular. Gabriel, Oluyemi and Gabriel (2024) studied the effects of flipped classroom strategy on retention ability of senior secondary school students' in abstract concepts in biology and found that the effect of Flipped Classroom strategy on retention ability of senior secondary school students' in abstract concepts in Biology was significant. This implies that flipped classroom strategy enhanced students' Retention ability in abstract concepts in Biology. Several other studies have revealed similar findings on the effects of flipped classroom on students' learning retention. For example, Sowunmi, Olagunju and Apata (2024) studied the effects of flipped classroom strategy on achievement and retention of Basic science students' in Lagos State-Nigeria and revealed that there was a significant main effect of treatment on students' achievement and retention in Basic Science. Similarly, Egara and Mosimege (2023) in their study on gender difference in secondary school students' retention of mathematics concepts: a flipped classroom learning approach found that learners who were taught mathematics using flipped classroom approach had higher average retention scores than those who were taught using the traditional method. Retention implies that students' ability to remember have the tendency of improving that students' achievement irrespective of their gender.

Gender is the uniqueness of males and females that are socially constructed. Gender has also remained an important issue which is relevant to the field of education because it has been linked with students' achievement. Gender has been identified as one of the factors influencing students' achievement in science. According to Ajai and Imoko (2020) gender is a social or cultural construct, characteristics, behaviour and roles that distinguish males from females which vary from

place to place and culture to culture. Researchers have revealed divergent findings on the influence of gender on students' retention. For example, Egara and Mosimege (2023) studied gender difference in secondary school students' retention of mathematics concepts: a flipped classroom learning approach and found that a significant gender difference occurred in the mean retention scores of students taught mathematics concepts using flipped classroom approach.

However, Madu and Onoh (2023) researched on the gender disparity on students' achievement, interest and retention in java programming language using the flipped learning instructional strategy. They found that the differences between the retention scores of male and female students taught Java programming language with Flipped Learning Instructional Strategy were not significant. Similarly, Kutigi, Gambari, Tukur, Yusuf, Daramola and Abanikannda (2022) investigated "Gender differentials in the use of flipped classroom instructional models in enhancing achievement and retention in oral-English contents of senior secondary school in Minna, Niger state, Nigeria. The findings of the study revealed that the retention level of male and female students taught Oral-English using Flipped Classroom Strategy was high without discrimination. The belief among researchers varies relative to gender differences and intellectual abilities. That may be the reason Gambari (2016) in Gabriel, Oluyemi and Gabriel (2024) concluded that findings on the effects of gender on students' achievement are inconclusive. However, when the teaching strategy adopted allows both male and female students to freely interact and participate in the learning process, the perceived influence of gender on students' achievement could be minimized.

The aim of the study was to determine the effects of flipped classroom strategy on senior secondary school students' retention in Biology in Jos South, Plateau State, Nigeria. Specifically, the objectives of the study are to:

1. determine the effects of flipped classroom strategy on SS II students' retention in Biology;
2. ascertain the effects of flipped classroom strategy on the male and female SS II students' retention in Biology in the experimental group.

The following research questions guided the study:

1. What are the retention mean scores of SS II students in Biology in the experimental and control groups?
2. What are the retention mean scores of male and female SS II students in Biology in the experimental group?

The following hypotheses guided the study:

1. There is no significant difference between the retention mean scores of SS II students in Biology in the experimental and control group.
2. There is no significant difference in the retention mean scores of male and female SS II students in Biology in the experimental group.

METHODOLOGY

The population of the study consisted of all the 979 senior secondary two students in Jos South Local Government Area of Plateau State, Nigeria, who were offering Biology from the 18 co-educational public secondary schools in 2025/2026 session. Out of the population of 979, 423 students were males, while 556 students were females. The sample size for the study consisted of 53 students from two intact classes. Intact class A served as experimental group with 35 students (11 males, and 24 females), while intact class B was the control group with 18 students (9 males and 9 females). A simple random sampling technique was used to select two schools from the 18 co-educational public senior secondary schools in Jos South Local Government Area that form the population of the study. The simple random sampling was done by using the "hat and draw" method. The list of all the 18 public schools in Jos South Local Government Area was prepared. The name of each school will be written on a piece of paper each and label with a letter ranging from A-R. All the 18 pieces of paper will be placed in a bowl and juggled. Each piece of paper will be picked at random one at a time without replacement. The first school the researcher picked will be designated the experimental group while the second school will be the control group. The two schools picked will

be the ones to participate in the study.The research instrument used for data collection was the Biology Retention Test (BRT).The BRT consisted of two sections A and B. Section A, focused on the demographic information of the respondents. Section B was the items of the instrument and consisted of 50 multiple choice questions with options A-D. Each of the multiple choice test items consisted of only one correct answer which attracts two marks (100marks). The maximum marks obtainable were 100, while the minimum obtainable marks were 0. The validity of the BAT was ascertained by three experts who established its face, content and construct validity. One of the experts was a lecturer from Biology Education Unit in the Department of Science and Technology of the University of Jos. The second expert was a lecturer from Research, Measurement and Evaluation Unit in the Department of Educational Foundations of the University of Jos, and the third expert was an experienced secondary school Biology teacher from the Public Senior Secondary School in Jos Metropolis, Plateau State. The reliability of the Biology Achievement Test instrument was established using Kuder-Richardson 20 (K-R20) method which yielded a reliability coefficient of 0.93. The descriptive statistics of mean and standard deviation were used to answer the two research questions. While the two hypotheses were tested using ANCOVA at 0.05 level of significance.

RESULTS

Research Question One

What are the retention mean scores of SS II students offering Biology in the experimental and control groups?

Table 1
Means and Standard Deviations of SS II Students' Biology Retention Mean Scores of the Experimental and Control Group

GROUP	N	Posttest Mean	SD	Retention test Mean	SD	Mean Diff.
Experimental	35	69.03	9.93	70.80	9.36	14.80
Control	18	58.44	6.31	56.00	4.95	

Table 1 presents the posttest and retention test of SS II Biology students' achievement mean scores of the experimental and control groups. The table reveals that experimental group yield a posttest mean score of (mean = 69.03, SD = 9.93) and control group had a posttest achievement mean score of (mean = 58.44, SD = 6.31). After two weeks of the experiment, a retention test was administered, the table reveals that experimental group yielded a retention mean score of (mean = 70.80, SD = 9.36) while control group had a retention mean score of (mean = 56.00, SD = 4.95), with a mean difference of 14.80. Retention means score difference of 14.80 existed between the groups in favour of respondents in the experimental group. This implies that the use of flipped classroom strategy in teaching Biology was effective in improving students' retention in the subject.

Hypothesis One

There is no significant difference between the retention mean scores of SS II students in Biology in the experimental and control groups

Table 2
Summary of ANCOVA Result of the Difference in the Retention Mean Scores of the Experimental and Control Group

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4997.678[a]	2	2498.839	197.533	.000
Intercept	79.956	1	79.956	6.321	.015
Posttest scores experimental and control	3950.905	1	3950.905	312.319	.000
Group	77.138	1	77.138	6.098	.017
Error	632.510	50	12.650		
Total	213600.000	53			
Corrected Total	5630.189	52			

a. R Squared =.888 (Adjusted R Squared = .883)

Table 2 reveals the results of ANCOVA, which was conducted to determine if a significant difference exist in the SS II Biology students' retention mean scores of experimental and control groups. The table reveals that F (1, 50) = 6.098, P<0.05. Since the p-value of .017 is less than 0.05 level of significance, the null hypothesis was rejected, indicating that the treatment had significant effects on the retention mean scores of students in Biology. The result further reveals an adjusted R Squared value of .883, which means that 88.3% of the variation in the dependent variable, which is students' retention in Biology, is explained by variation in the treatment while the remaining is due to other factors not included in this study. This means that a statistically significant difference exists between the retention mean scores of the students in the experimental group and students in the control group. The implication of the results is that flipped classroom strategy enhances SSII students' retention in Biology.

Research Question Two
What are the retention mean scores of SS II male and female students in Biology in the experimental group?

Table 3
Means and Standard Deviations of SS II Male and Female students' Biology Retention Mean Scores in the Experimental Group

GROUP	N	Posttest Mean	SD	Retention test Mean	SD	Mean Diff.
Male	11	65.27	9.93	68.00	9.55	4.08
Female	24	70.75	9.65	72.08	9.18	

Table 3 presents the posttest and retention test of SS II male and female Biology students' achievement mean scores of the experimental group. The table reveals that male students yielded a posttest achievement mean score of (mean = 65.27, SD = 9.93) while female students had (mean = 70.75, SD = 9.65). After two weeks of the experiment, a retention test was administered, the table reveals that male students had a retention mean score of (mean = 68.00, SD = 9.55) while female students had a retention mean score of (mean = 72.08, SD = 9.18), with a mean difference of 4.08 in favour of male students. The slight mean difference implies that the male and female students do not differ significantly in their retention. Hence, the flipped classroom strategy had similar effects on the retention of both male and female students in Biology.

Hypothesis Two
There is no significant difference between the retention mean scores of male and female SS II students in Biology in the experimental group.

Table 4
Summary of ANCOVA Result of the Difference in Retention Mean Scores of Male and Female students in the Experimental Group

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3824.723[a]	2	1912.361	168.933	.000
Intercept	39.323	1	39.323	3.474	.072
Posttest Scores Male and Female	3771.085	1	3771.085	333.127	.000
Group	20.612	1	20.612	1.821	.187
Error	362.248	32	11.320		
Total	155856.000	35			
Corrected Total	4186.971	34			

R Squared =.913 (Adjusted R Squared = .908)

Table 4 reveals the results of ANCOVA, which was conducted to determine if a significant difference exist in the Biology retention mean scores of male and female students in the experimental group. The table reveals that F (1, 32) =1.821, P>0.05. Since the P-value of .187 is greater than 0.05 level of significance, the null hypothesis was retained. It was concluded that no significant difference existed between the retention mean scores of male and female students in the experimental group; hence the students did not differ significantly in their retention based on gender. The result further shows an adjusted R Squared value of .908, which means that 90.8% of the variation in the dependent variable, which is students' retention is explained by variation in gender while the remaining is due to treatment and other factors not included in this study. This implies that the flipped classroom strategy is gender friendly in influencing students' retention in Biology.

DISCUSION

Research question one shows that students in the experimental group had higher retention mean scores in Biology after treatment than those in the control group who were not given the treatment. This implies that the use of flipped classroom strategy enhanced the experimental groups' retention in Biology more than the control group. Furthermore, hypothesis one revealed that there was a statistically significant difference in the retention mean scores of experimental and control groups in Biology. This shows that flipped classroom strategy can help improve students' retention in Biology. Hence, there is significant difference between retention mean scores of SS2 students in the experimental and control groups.

The result of the finding is in line with Gabriel, Oluyemi and Gabriel (2024) who found that the effect of Flipped Classroom strategy on retention ability of senior secondary school students in abstract concepts in Biology was significant. It is also in agreement with the findings by Sowunmi, Olagunju and Apata (2024); Isa and Bukar (2023); Madu and Onoh (2023), who all reported that Flipped classroom Strategy significantly, improved the students' achievement and retention more than Lecture Method.

Research question two revealed that female students had slightly higher retention mean scores in Biology after treatment than their male counterpart. This implies that the use of flipped classroom strategy enhanced the female students' retention in Biology more than the male students. While hypothesis two which state that there is no significant difference between the retention mean scores of male and female SS II students in Biology in the experimental group was retained, indicating that there was no significant difference in the retention mean scores of male and female SS two students in Biology.

The result of the finding is in line with Madu and Onoh (2023) who found that the differences between the retention scores of male and female students taught Java programming language with Flipped Learning Instructional Strategy were not significant. Similarly, Kutigi, Gambari, Tukur, Yusuf, Daramola and Abanikannda (2022) revealed that the retention level of male and female students taught Oral-English using Flipped Classroom Strategy was high without discrimination. However, the finding contradicts that of Egara and Mosimege (2023) who found that a significant gender difference occurred in the mean retention scores of students taught mathematics concepts using flipped classroom approach.

CONCLUSION

The students taught using Flipped Classroom Strategy (FCS) had higher retention mean scores than the students taught using lecture method. Thus, the study concluded that the treatment (FCS) had significant positive effects on students' retention in Biology in Jos South Local Government Area, Plateau State, Nigeria. The study further concluded that the significant positive effect of Flipped Classroom Strategy (FCS) on students' retention in Biology in the experimental group is not

based on gender. The use of Flipped Classroom Strategy (FCS) in teaching Biology does improved students' retention in the subject irrespective of gender.

RECOMMENDATION

Based on the findings of the study, the following recommendations were made:

1. Since the use of Flipped Classroom Strategy (FCS) in teaching has been found to enhance students' retention in Biology, Biology teachers should employ it more in the teaching of the subject especially for topics that are abstract and complex.
2. Biology teachers' capacity in the preparation and effective use of FCS in teaching concepts needs should be built.
3. Biology and Science teachers in general should be provided with the information technology tools such as computers, storage devices and projectors which they need for preparing and teaching their lessons using Flipped Classroom Strategy.

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