

EFFECT OF FLIPPED EDUCATION ON STUDENTS' ACADEMIC ACHIEVEMENT IN BIOLOGY

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Abstract

The study investigated the Effect of Flipped Education (FE) on Senior Secondary Two (SS II) Students' Achievement in Biology. The study adopted a quasi experiment of the pre-test post-test non-equivalent control group design. The population was 856 SS II students in all the 61 public secondary schools in Onueke education zone of Ebonyi state. The sample of the study comprised of 155 SS II students of the intact classes of four randomly sampled schools from two Local Government Areas in the zone. Two schools were assigned to experimental group and two schools were assigned to control group. The experimental group was taught biology using FE while the control group was taught using conventional method. Three research questions and three null hypotheses guided the study. A Biology Achievement Test (BAT) was the instrument used for data collection. The data were analysed using mean, standard deviation and analysis of co-variance (ANCOVA). Research questions were answered using mean and standard deviation while hypotheses were tested using ANCOVA at 0.05 level of significance. Results of the study revealed that: FE significantly enhanced students' mean achievement in biology more than the conventional method. It further revealed that FE has no differential impact on both male and female students' achievement in biology. In addition, the results revealed that the interaction between gender and teaching method on students' mean achievement scores in biology is not statistically significant. The study therefore concluded that FE is superior to conventional method in enhancing students' achievement in biology. Based on the above findings, it was recommended among others that biology teachers should prioritize the use of FE as it has been proved empirically, to have a significant positive effect on students' academic achievement in biology.

Key words: Biology, Secondary School Students, Flipped Education, Academic Achievement

Introduction

As a science subject that is much concerned with the study of the living components of the environment, biology is generally defined as a branch of science that deals with the study of living things. (Ukpai 2022). Biology encompasses diverse fields including botany, zoology, conservation, ecology, evolution, genetics, physiology, medicine, microbiology, molecular biology etc. Biology has a great position in the secondary school curriculum due to its significance as a life science. It plays important role in various aspects of public and personal life including areas like health, teaching, climate change, medicine, agriculture, industry, and attitudinal change. Biology also helps in developing students' critical thinking and problem-solving skills, environmental conservation, food security, career opportunities, informed decision-making and prepares secondary school students for future career in those fields mentioned above and more. Biology being a foundational subject to the various areas of human endeavour as mentioned above, if taught properly especially in secondary schools, will contribute significantly to human well-being, sustainability and societal progress by providing a deeper understanding of the natural world (Ukpai 2022).

Many secondary school students prefer biology to physical science subjects like chemistry and physics and that makes it popular in schools Ukpai asserted. But in spite of its popularity, there is high rate of students' poor performance in secondary school biology especially in external examinations (Ukpai & Nwotolo, 2022 Ray & Shon 2024). The West African Examination Council (WAEC) chief examiner's report further substantiated this students' poor achievement in biology. Recent WAEC chief examiner's reports of 2022-2024 showed that students performed badly in biology (WAEC Chief Examiner's Report, 2022-2024). This increasing poor achievement of students in science subjects including biology has been a thing of concern in Nigeria and in Ebonyi State in particular. The statistics shows that

students' performance in biology in Ebonyi State has been below average for years (WAEC Chief Examiner's Report, 2022-2024). According to the report, students' performance over the past four years (2020-2024) has been below average.

However, some factors could be responsible for the students' poor achievement in biology. According to studies the following factors inhibit students' achievement and retention in biology namely: over loaded biology syllabus (Rahman, Yunus, & Hashim, 2019), lack of adequate laboratory activities (Adonu et al, 2021, use of ineffective instructional approach (Suleiman and Akilu (2023)), nature of the curriculum (Ugwuanyi, Okeke & Njeze, 2020) among others. Among all these causes of decline in students' achievement in biology examinations, ineffective instructional approaches teachers use in teaching biology in schools have been described as one of the major factors leading to students poor achievement in biology examinations (Ukpai 2022). In line with this, (Adonu, et al (2021), asserted that the use of poor instructional approaches can lead to poor achievement in biology. Adonu stressed that teaching strategies like activity-based (active) strategy enhance students' ability to retain and recall information easily while passive strategies do not. Activity-based teaching strategy is student-centred strategy that allows full students participation in class or teaching and learning process. One of such activity-based strategies could be the flipped classroom instructional strategy.

Flipped education is one of the growing technology-integrated teaching strategies that are used as alternative method to the traditional learning environments (Rahman, Yunus, & Hashim, 2019). It is a type of blended learning which is half online and half in class learning and involves any employment of technology to influence learning in the classroom, so a teacher can have more time to interact with students instead of lecturing (Ahmed, 2016).

Thus, there is an opportunity to provide more personal feedback and assistance to students, and in addition to receive feedback from their peers about the activities that they are

performing and what they don't yet understand. It is also a medium of delivering and receiving information between teachers and students (Clark, Kaw & Braga 2022). The young students prefer to do everything online these days, including learning and socializing. Studies have shown that students are learning a lot through the social media (Shazali, Shamsudin, & Yunus, 2019; Suleman & Akilu 2023).

Flipped education was propounded and introduced by chemistry teachers, Bergmann and Sams in 2007, because their students could not come to class due to training and tournaments. Instead of repeating the same lesson for absent students, they decided to record their lectures and put it online so that the absent students could be able to watch/read it later and learn (Zaki & Yunus, 2015). The flipped classroom instruction is a new pedagogical model where the instructor shares predetermined digital resources with students through a platform outside the classroom, and related content is also taught through this outside platform asynchronously (Toto & Nguyen, 2019). Inside the classroom, active, collaborative, and interactive problem-solving activities and consolidation practices are carried out (Vitta, Al-Hoore & Ali 2020). Thus, learners are more active in the class, internalizing the contents through a wide range of classroom tasks. Flipped classroom is a method of teaching and learning in which students watch a video lesson or recorded lectures outside class while participating in hands-on activities in class. It combines face-to-face learning in the classroom with group discussion and learning outside the class with video lessons and online collaboration. The lower cognitive work is done at home without the teacher while the higher cognitive work is done in class with the teacher. The teacher's role here changes from being a communicant into a coach and facilitator, motivating, guiding, and providing input on student's activities (Vitta, Al-Hoore & Ali 2020). By using flipped classroom instruction, the teacher can prepare lesson videos, and students can watch them outside the class. Thus, Singh and Arya (2020) asserted that flipped education is an educational technique which consists of two significant

components namely: the use of computer technologies such as video lectures/notes (at home) and the involvement of interactive learning activities (in class). Singh and Arya stressed that teachers should consider using flipped instruction in teaching and learning as it has tremendous benefits which include:

It involves all forms of learning (oral, visual, listening, hands-on, problem solving etc.), uses a more application-based strategy for students (hands-on and problem solving activities), offers greater accessibility, especially for students that face difficulties in travelling to the physical classroom, emphasizes greater communication essentially referring to: student-student and student-teacher interactions, uses a student-centred teaching model to ensure that the course is primarily aimed at contributing to the student's overall success in obtaining a proper, effective education. It avoids the overarching idea of "cramming" for exams and forgetting the information later, it encourages students to understand the underlying rationale behind the information being provided to them, among others. Meanwhile, studies have shown that flipped education enhances students' achievement in engineering, medicine and few other disciplines (Adonu et al (2021), Chebotibi & Angeti (2022), Dorji & Dorji (2022), Asad, Chur & Moreno (2022), Anyaneme & Nwokolo (2022), sulieman & Akilu (2023). It's efficacy in enhancing students' achievement in biology in Ebonyi state has not been determined empirically.

Purpose of the Study

The study aimed at investigating the effect of flipped education on students' academic achievement and retention in biology. Specifically, the study was to:

1. Investigate the effect of flipped education on students' achievement in biology.
2. Investigate the effect of flipped education on achievement of male and female students in biology.

- Investigate interaction effect of gender and instructional method on students’ achievement in biology.

Research Questions

The study was guided by three research questions as follows:

- What is the effect of flipped education on students’ mean achievement in biology?
- What is the effect of flipped education on the mean achievement of male and female students in biology?
- What is the interaction effect of gender and instructional method on students’ mean achievement in biology?

Hypotheses

The following hypotheses were tested to provide answers to the above research questions at an alpha level of 0.05:

HO₁: There is no significant difference in the mean achievement scores of students taught biology using flipped education and those taught biology using conventional method.

HO₂: There is no significant difference in the mean achievement scores of male and female students taught biology using flipped education.

HO₃: There is no significant interaction between gender and instructional method on students’ mean achievement scores in Biology.

Research Method

The study adopted a quasi-experimental design specifically, pre-test post-test non-equivalent control group design. Symbolically, the research design is represented thus:

E	O ₁	X	O ₂	O ₃
C	O ₁	Y	O ₂	O ₃

Where:

E = Experimental group

C = Control group

O₁ = Pre-test Achievement

O₂ = Post-test Achievement

O₃ = Retention test

The study involved the use of intact classes to ensure that the regular class period was not altered. A pre-test was employed to determine initial group equivalence and control for selection bias.

The target population of the study comprised of 856 senior secondary class two (SS 2) biology students in all the sixty nine (61) public Senior Secondary Schools in Onueke Education Zone of Ebonyi State. This population is made up of male and female students in co-education secondary schools.

The sample of the study comprised of one hundred and fifty five (155) SS11 students from four schools out of 69 public schools in the zone. Simple random sampling technique was used for this study. The four schools were co-educational schools. The instrument used for data collection was Biology Achievement Test (BAT). The Biology Achievement Test (BAT) comprised of a 30 multiple choice objective test items developed by the researcher from the content that was covered in the study. The instrument covered three main topics drawn from SS 2 first term scheme of work which are: botanical classification of plants, agricultural classification of plants, and classification of plants based on their life cycle.

Experimental procedure

The regular biology teachers were used throughout the study. Normal class period was used with the permission of the principals of all the schools. Two schools were used for experimental group and were taught biology using Flipped Education (FE), and the other two schools were used for control group and were taught biology using conventional Method (CM). Three lesson packages were used which were the same in terms of content to be taught, objectives and method of evaluation. Method of instruction and instructional activities were the only differences between them. For the flipped classroom group, the students were given CD-ROM/flash drive/voice note containing pictures/lectures/video lessons (or note) on the biology topics a day before the class, to listen to/watch and read at home. And during class time, the students were engaged in in-class activities (like doing assignments, answering questions, drawing, comparing organisms, peer discussion etc). While the conventional chalk and talk method proceeded normally with the teacher doing most of the teaching activities in the class and students were passive listeners. Teachers administered pre-test and post-test before and after instructions respectively. Test items for the post-test were reshuffled to give it a different look.

Presentation of Results

Results are presented according to the research questions and the hypotheses. Research question 1 sought information on the effect of flipped education on students' mean achievement scores in biology. Data for answering research question 1 is presented in table 1 below.

Table 1: *Mean Biology Achievement scores of students taught Biology with flipped classroom instructional strategy and those taught with the conventional method.*

Groups	N	Mean	SD
Experimental Group (Taught with Flipped Classroom Strategy)	91	21.5495	2.32505
Control Group (Taught with Conventional Method)	64	13.5313	3.06526

The result in table 1, show that the mean achievement scores of students for the experimental group is 21.54 and the mean achievement scores for control group is 13.53. The two mean scores from the table indicates that the students in the experimental group achieved better academically than the students in the control group.

Research question 2 sought information on the effect of flipped education on the mean achievement of male and female students in biology.

For this research question both pre-test and post-test data obtained with the Biology Achievement Test for only the experimental group was used to answer the research question.

Data for answering this research question is presented in table 2 below:

Table 2: *Mean Biology scores of male and female students taught Biology using flipped classroom instructional strategy.*

Gender Categories	N	Mean	SD
Male Students	32	21.0000	2.55267
Female Students	59	21.8475	2.15609

The result as presented in table 2, show that the mean achievement scores of male students which is 21.0000 is less than that of the female students which is 21.8475. This shows that

flipped education had a slight variation effect on the achievement of male and female students in Biology in the favour of female students.

Research Question 3 sought information on the interaction effect of gender and instructional approach on students’ mean achievement in biology. The scores of males and females that were subjected to the flipped education and those subjected to the conventional method were used to assess the interaction. Data for answering this research question is presented in table 3 below:

Table 3: *Summary of interaction of gender and teaching method on students’ mean achievement scores in biology.*

Gender Groups	Experimental Group	Adjusted Mean for Control
Male	21.0000	13.0435
Female	21.8475	13.8049

Table 3 reveals that both male (21.0000) and female (21.8475) students in the experimental group scored higher than those of male (13.0435) and female (13.8049) students in the control group. This shows that at all levels of gender; the experimental group is superior to the control group. This implies that there is no interaction between method and gender on students’ achievement in biology.

The first hypothesis states that-There is no significant difference in the mean achievement scores of students taught Biology with flipped classroom instructional strategy and those taught Biology with conventional strategy.

Hypothesis 3states that-There is no significant interaction between gender and instructional strategy on students’ mean Achievement in Biology.

Table 4 will be used to test for both hypothesis 1 and 3 using the Analysis of Co-variance at an alpha level of 0.05. Summary of result for these two null hypotheses are presented in table 4 below:

Table 4: *Analysis of Co-Variance (ANCOVA) for Overall Biology Students' Achievement scores by Teaching Methods and by Gender with Interaction Effect.*

Source	Type III				
	Sum of squares	DF	Mean squares	F-Value	Sig.
Corrected Model	2764.257 ^a	4	691.064	142.017	.000
Intercept	2699.412	1	2699.412	554.742	.000
Pretest	325.112	1	325.112	66.812	.000
Methods	2257.257	1	2257.257	463.877	.000
Gender	3.791	1	3.791	.779	.379
Methods * Gender	1.044	1	1.044	.215	.644
Error	729.911	150	4.866		
Total	55055.000	155			
Corrected Total	3494.168	154			

Results in table 4 indicate that for hypothesis 1, the calculated F-ratio (F-cal) is 463.877 with (.000 Sig.) is significant at alpha level of 0.05. This implies that there exist a significant difference in the mean achievement scores of students taught biology using flipped education and those taught with conventional method. The null hypothesis is therefore rejected and the

researcher concludes that there is significant difference in the mean achievement scores of students taught biology using flipped education and those taught with conventional method in favour of those taught using flipped education.

Results in table 4 also show that for hypothesis 3, the calculated ratio is (.215) with (.644 Sig.) is not significant at alpha level of 0.05. Based on the decision rule, the null hypothesis is not rejected (upheld). The researcher therefore concludes that there is no significant interaction between gender and instructional method on students' achievement in biology.

Hypothesis 2 states that-There is no significant difference in the mean achievement scores of male and female biology students taught biology with flipped method.

Scores of male and female students in the experimental group only were used to test this hypothesis. Summary of result is shown in Table 5 below.

Table 5: *Analysis of Co-Variance (ANCOVA) for Students Overall Biology Achievement Scores by Teaching Method and Gender.*

Source	Type III				
	Sum of squares	DF	Mean squares	F-Value	Sig.
Corrected Model	186.890	2	93.445	27.444	.000
Intercept	3221.146	1	3221.146	946.013	.000
Pretest	171.990	1	171.990	50.511	.000
Gender	6.080	3	6.080	1.786	.000
Error	299.637	88	3.405		

Total	42745.000	91
Corrected Total	486.527	90

Results in table 5 revealed that for hypothesis 2, there is a significant difference in the mean achievement scores of male and female students taught biology using flipped education. This is indicated by the F-calculated value at (1.786) with (.000 Sig.) which is significant at 0.05 level of significance. The null hypothesis is therefore rejected and the researcher concludes that gender (male or female) is a significant factor in students' achievement in biology due to teaching method.

Discussion of the Findings

Results in tables 2, 3 and 4 (used in answering research questions) show that students in the experimental group who were taught biology with flipped education had significantly higher scores than students in control group who were taught with conventional method. In other words, the difference between the adjusted mean achievements scores of the experimental group and the control group was significant in favour of the experimental group. This implies that flipped classroom education has a more favourable effect on the students' achievement in biology. This finding is in agreement with the works of Adonu et al (2021), and Badmus (2021), who respectively stated that the flipped education which enables students to have knowledge of the lesson before class makes learning more effective, concrete, simple and significantly more meaningful and consequently facilitates students' achievement in the subject.

The result also indicates that gender is a significant factor in students' achievement in biology due to teaching methods. The result also shows that the scores of the female students

are slightly higher than that of the males in the experimental group. This finding agrees to a large extent with the work of Chebotibi and Angeti (2022) which revealed that there can be gender difference in the achievement of students in biology. This study to a large extent, agrees with the work of Suleiman and Akilu (2023) which revealed that male and female students can both do well with flipped education though one may do better than the other. This could be due to the fact that in flipped classroom instruction, all the students may not have all it takes to study well due to challenges like power failure, access to video clips, availability of handsets etc to access the lesson materials before and after classes.

The result as well revealed no interaction between method and gender on students' achievement in biology. The result is in line with the work of Doss (2023), who asserted that there is no significant difference when interaction effect of gender and instructional method was explored, showing that the males and females were affected positively by the method. Similar results were obtained by other researchers (Dorji and Dorji (2022), Asad, Chur & Moreno (2022), Anyaneme and Nwokolo (2022), who all observed that there exists no significant difference when interaction effect of gender and instructional method are explored.

Conclusion

1. Students in experimental group (taught using flipped education) had higher mean achievement scores than those in control group (taught using conventional method). Therefore, flipped education is superior to conventional method.
2. The mean achievement scores of the male students were slightly less than that of female students in experimental group.

3. The mean achievement scores of both male and female students in experimental group are higher than those of male and female students in control group. Therefore, there is no interaction between method and gender on students' achievement in biology.

Recommendations

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

1. Ministries of education (Federal and State) in conjunction with education institutions in the country should organize seminars and workshops to keep biology teachers abreast with the application of flipped education for instructional delivery.
2. Teachers should endeavour to make teaching more learner-centred by adopting flipped education which encourages activity-based learning and team work among students as this will promote students' achievement in science subjects including biology.

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