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# EFFECT OF FLIPPED CLASSROOM INSTRUCTIONAL MODEL ON STUDENTS' ACHIEVEMENT IN BIOLOGY AMONG SECONDARY SCHOOLS IN BAYELSA STATE

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## Abstract

*This study examined the effect of the flipped classroom instructional model on students' achievement in biology concepts among secondary schools in Bayelsa State. The "quasi-experimental non-equivalent, non-randomised, pre-test, posttest control design was adopted." One hundred and fifty-nine SSS 2 students from four purposively selected public schools in Bayelsa West Senatorial District were assigned to the experimental group (n = 83) and control group (n = 76). The study lasted for six weeks. This study used three instruments: two instructional guides and the "Biology Achievement Test (BAT)." The BAT had a reliability of 0.75 using Kuder Richardson Formula 21 (KR – 21). Data was analysed using mean and standard deviation for the two research questions and Analysis of Covariance (ANCOVA) for the two null hypotheses. The findings revealed that the students taught the biology concept using the flipped instructional model outperformed their counterparts taught the same concept using the modified lecture method, and there was no significant gender difference in achievement. It was recommended that the flipped classroom strategy be adopted for teaching biology.*

**Keywords:** Achievement, Biology, Flipped Instructional Model, Gender, Modified Lecture Method.

## Introduction

Biology is one of the most popular and influential fields of study today. It is concerned with studying life and all phenomena that characterise it. It deals with all variables related to living organisms, including their physical and chemical structure, function, evolution, and life processes (Umar et al., 2018; Abdulsalam et al., 2020). Biology also studies the existing interactions and relationships between living things and the non-living units of the world and how they affect and might influence each other (Owolabi et al., 2019; Ramon & Bello, 2019). It is quite a broad field, as evidenced by its numerous sub-fields, which all influence the quality and understanding of life. The biological field is essential to man and every other living organism. It is a significant factor contributing to the quality of man's life today and is vital for continued sustainability. It is also rooted in the framework of various essential fields that affect life, like medicine, agriculture, etc. (Annan et al., 2019; Joda, 2019).

Based on the importance of the subject, and it is a pre-requisite for further studies in several major science fields, good performance of students in the subject is essential and should be prioritised. However, the major consensus from available data indicates a poor achievement rate in the subjects, even though the students deemed it among the easier sciences to learn. Adewale et al. (2016) state that most students cannot get the credit pass in biology needed to proceed to tertiary institutions in biology-related fields. This underachievement trend can be seen in the studies by Bichi et al. (2019), Adekunle and Femi-Adeoye (2016), and Olutola et al. (2016) amongst others, who all explored how well the students achieved in the biology subject in Senior Secondary School Certificate Examinations (SSCE).

The achievement rate in the subject has led to several studies. Over time, various variables and reasons have been cited as contributing to the underachievement in the subject, quite prominent among which is the Instructional style used to teach biology. Biology classes are typically carried out using the conventional or modified form of the lecture method, an approach to teaching that places the teacher at the helm of the whole instructional process, which is in direct contradiction to the principles of active learning, which is widely accepted as the modern framework for effective teaching (Hafeez, 2021; Minghong et al., 2019). The learners are typically expected to passively absorb learning data from the teacher, with little to no provision for their involvement. Its passive nature and various other limitations, ranging from the promotion of rote learning and memorisation to not being particularly engaging and capable of holding students' interest among others, make it a contributory factor for underachievement, especially in science-based fields like biology (Saira & Hafeez, 2021; Okoye & Onwuachu, 2018). Though the modified versions of the lecture method commonly used have made steps to make the process more student-centred through activities like brief question-and-answer sessions, the core framework is still the same. Thus, there is a need to explore innovations in instructional design to enhance the learning outcomes of biology. One recommended innovative instructional strategy is the flipped classroom.

The flipped classroom is an innovative instructional model that reverses the structure of the typical classroom. In this model, the students are first exposed to the instructional content outside the classroom through pre-recorded lectures or materials (Sengkey et al., 2019). This allows class time to be focused solely on more practical and active learning activities, including discussions, problem-solving, collaborative activities, etc. The pre-class learning introduces the learning contents to the students, and class time supports the reinforcement of the materials learned outside the classroom.

The flipped classroom structure has been associated with a series of benefits, including the emphasis on active learning and student engagement. The strategy moves what is typically

passive receiving of information outside the class, making the class time an active and interactive experience centred around students' activities (Alexander, 2018). This can aid in developing better understanding, increased retention of learning materials and even critical thinking skills.

The flipped classroom also supports personalised learning and offers students a great deal of flexibility, particularly during pre-class activities (Djumabaeva & Zharkynbekova, 2023). Students are able to move through the pre-recorded lectures or readings at the initial stage at their own pace, without the pressures of time and keeping up with others as present in the typical classroom. They can pause and rewind videos or reread parts of the material as much time as needed to grasp the concepts. This personalised learning structure affords the students greater control over their learning process and is more accommodating of the needs of the students and differences in learning preferences. Now free from the task of directly transmitting knowledge to passive students, teachers are better able to offer individualised support and feedback in the interactive classroom (Goedhart et al., 2019). Thus, the flipped classroom addresses several of the limitations of the lecture method and can potentially enhance students' learning process in subjects like biology.

Students' achievement in subjects like biology can be further affected and influenced by some variables present in the form of learners' characteristics and outcomes of experiences. One such variable is the gender of the students, which can affect students' learning outcomes and lead to variations in academic achievement. Gender differences in education are complex and possibly influenced by biology, cultural norms, societal expectations, and personal experiences. For instance, some studies have reported natural differences between genders in their spatial ability (Esipenko et al., 2018; Yoon & Mann, 2017), and verbal skill (Aucejo & James, 2021; Izzaty & Setiawati, 2019), which can impact students' aptitude and success in specific subjects. Societal expectations and cultural norms, such as gender stereotypes, can also contribute to these differences in academic achievement (Gonzalez et al., 2019; Nnamani & Oyibe, 2016). These stereotypes can create a ripple effect, with each gender receiving more attention and success in subjects considered more appropriate for their gender. This can lead to less interest in subjects deemed inappropriate for their gender, affecting academic achievement. In a society where one gender is considered superior, the other may have low expectations and less importance for specific subjects. Thus, this study determined the effects of the flipped classroom strategy on students' achievement in biology and the moderating effects of gender.

### **Statement of the Problem**

Biology is one of the most critical fields in the world due to the various functions derived from an understanding of man and other living organisms in nature. Despite this, available data indicates an underachievement rate in the subject. Studies have linked the achievement issue to varying factors and reasons, but one variable that has continually been brought to light is issues related to strategies used to teach biology. Plain or modified forms of the lecture method are predominantly utilised for biology instruction, and as such, it can be linked to poor learning outcomes in biology. This issue can thus be resolved through the introduction of better instructional approaches. One recommended approach is the use of the flipped classroom strategy. However, most studies on the flipped classroom strategy were conducted in non-biology subject areas and vastly different geographical settings from that of this study. Furthermore, being a newer instructional model, the amount of research that has been done exploring this model in practical settings is limited compared to other, more established models. Therefore, this study assessed the effects of the flipped classroom model

on students' biology achievement in secondary schools. The study also determines the moderating effects of gender on achievement.

### **Research Questions**

1. What is the mean achievement score of students taught biology with flipped classroom instructional models and those taught with the modified lecture method?
2. What is the mean achievement score of male and female students taught biology with the flipped classroom instructional model and those taught with the modified lecture method?

### **Null Hypotheses**

1. There is no statistically significant difference in the mean achievement score of students taught biology with flipped classroom instructional models and those taught with the modified lecture method.
2. There is no statistically significant difference in the mean achievement score of male and female students taught biology with the flipped classroom instructional model and those taught with the modified lecture method.

### **Methodology**

A "pre-test posttest control group quasi-experimental design" was used for this study. The study population comprised 2,829 senior secondary two (SS 2) students from the Bayelsa West Senatorial District, as reported by the Bayelsa State Post-Primary Schools Board in 2020. A total of 159 students were selected from four mixed-gender schools in the district using a four-stage sampling process. The sampling process involved selecting two municipalities based on the presence of roads in the local government areas, with at least ten public secondary schools with access to roads in each district.

The schools were then selected based on three criteria: they must be public institutions, have proper information and communication technology facilities, and their biology educators must consent to participate in the study. A complete class was selected from each school, and two schools were chosen randomly as the Experimental and Control groups.

The study used three instruments: "Instructional Guide on Flipped Classroom Instructional Model (IGFCIM), Instructional Guide on Modified Lecture Method (IGMLM), and Biology Achievement Test (BAT)." Biological science and science education experts and professional SS2 biology teachers validated these instruments. The BAT had a reliability of 0.70 using Kuder-Richardson Formula 21 (KR – 21).

During the first two weeks of data collection, the researcher trained the teachers to use the instructional guides. The pre-test was administered during the third week by the researcher and teachers. The control and experimental groups were taught using the IGMLM and IGFCIM during the third to fifth week. The BAT was re-administered to the students immediately after treatment to get their achievement scores.

The research questions were analysed using "mean and standard deviation", while "Analysis of Covariance (ANCOVA)" inferential statistics were utilised to test the hypotheses at a 0.05 level of significance.

## Results

**Research Question One:** “What is the mean achievement score of students taught biology with flipped classroom instructional models and those taught with the modified lecture method?”

**Table 1:** *Summary Of Mean And Standard Deviation Of Pre-test And Posttest Scores On The Effect Of Instructional Strategies On Students' Achievement In Biology*

Instructional Strategies	N	Pre-test scores		Posttest Scores		Mean gain
		M	SD	M	SD	
Flipped Classroom	83	46.51	10.38	66.48	12.45	19.97
Modified Lecture	76	39.09	12.55	56.32	9.39	17.23
Total	156	42.96	12.02	61.62	12.18	18.66

The result presented in Table 1 shows that the posttest mean score of students taught with the Flipped Classroom (66.48) is greater than that of students taught with the Modified Lecture Method (56.32). The result further indicates that the mean gain score of students taught with Flipped Classroom (19.97) is greater than that of students taught the Modified Lecture Method (17.23). This implies that students taught using the Flipped Classroom Instructional Model achieved better than their counterparts taught using the Modified Lecture Method.

**Research Question Two:** “What is the mean achievement score of male and female students taught biology with the flipped classroom instructional model and those taught with the modified lecture method?”

**Table 2:** Summary of Mean and Standard Deviation of Pre-test and Posttest Scores on the Effect of Instructional Strategies on Male and Female Students' Achievement in Biology.

Instructional Strategy	Gender	N	Pre-test		Posttest		Mean gain
			M	SD	M	SD	
Flipped Classroom	Male	50	48.24	10.49	67.82	12.32	19.58
	Female	33	43.88	9.78	64.45	12.55	20.57
	Total	83	46.51	10.38	66.48	12.45	19.97
Modified method Lecture	Male	39	39.44	12.08	57.23	9.01	17.79
	Female	37	38.73	13.17	55.35	9.81	16.62
	Total	76	39.09	12.55	56.32	9.39	17.23
Total	Male	89	44.38	11.99	63.18	12.15	18.80
	Female	70	41.16	11.90	59.64	12.01	18.48
	Total	159	42.96	12.02	61.62	12.18	18.66

The data presented in Table 2 reveals that the posttest mean score of male students taught with Flipped Classroom (67.82) was greater than their female counterparts (64.45). Also, the posttest mean score of male students taught with the Modified Lecture Method (66.48) is greater than that of their female counterparts (57.23). Overall, the posttest mean score of male students taught with Flipped Classroom and Modified Lecture Method is (63.18) greater than that of their female counterparts (59.64). The table further indicates that the mean gain score of male students taught with both Instructional strategies (18.80) was greater than those of their female colleagues (18.48). This implies that male students' achievement was greater than their female colleagues when taught with both Instructional strategies.

**Null Hypothesis One:** "There is no statistically significant difference in the mean achievement score of students taught biology with flipped classroom instructional model and those taught with the modified lecture method."

**Table 3:** One-way Analysis of Covariance (ANCOVA) of Posttest Scores of Students' Achievement in Biology when Taught with Flipped Classroom and Modified Lecture Method Instructional Strategies.

Source of Variation	Type Sum Squares	III of Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	14034.676	2	7017.338	116.648	.000	.599
Intercept	10579.266	1	10579.266	175.857	.000	.530
Pre-test Scores	9934.462	1	9934.462	165.139	.000	.514
Instructional Strategies	905.315	1	905.315	15.049	.000*	.088
Error	9384.682	156	60.158			
Total	627198.000	159				
Corrected Total	23419.358	158				

*R Squared = .599 (Adjusted R Squared = .594) \*= Significant at  $p < 0.05$  alpha level*

The result in Table 3 shows that the main effect was significant on students' achievement in Biology ( $F_{1,156} = 60.158$ ;  $p < 0.05$ ; partial eta squared = 0.088), which gives an effect size of 8.8 percent. Therefore, the null hypothesis was rejected, which states that "there is no statistically significant difference in the mean achievement score of students taught biology with flipped classroom instructional models and those taught with the modified lecture method".

**Null Hypothesis Two:** "There is no statistically significant difference in the mean achievement scores of male and female students taught biology with the flipped classroom instructional model and those taught with the modified lecture method."

**Table 4:** *2 x 2 Factorial Analysis of Covariance (ANCOVA) of Posttest Scores of Male and Female Students' Achievements in Biology when Taught with Flipped Classroom Model and Modified Lecture Method.*

Source of Variation	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	14073.748	4	3518.437	57.978	.000	.601
Intercept	10532.513	1	10532.513	173.558	.000	.530
Pre-test Scores	9681.307	1	9681.307	159.532	.000	.509
Instructional Strategies	896.420	1	896.420	14.771	.000	.088
Gender	29.097	1	29.097	.479	.490	.003
2Way-interactions Instructional Strategies * Gender	10.454	1	10.454	.172	.172	.001
Error	9345.610	154	60.686			
Total	627198.000	159				
Corrected Total	23419.358	158				

*R Squared = .601 (Adjusted R Squared = .591) \*= Significant at  $p < 0.05$  alpha level*

The result in Table 4 shows that the main effect was insignificant on male and female students' achievement in Biology ( $F_{1,154} = 60.686$ ;  $p < 0.05$ ; partial eta squared = 0.001), giving an effect size of 0.1 percent. Therefore, the null hypothesis, which states that "there is no statistically significant difference in the mean achievement scores of male and female students taught biology with flipped classroom instructional model and those taught with the modified lecture method", was accepted.

### Discussion of Findings

The study's finding shows a statistically significant difference in the mean achievement score of students taught biology with flipped classroom instructional models and those taught with the modified lecture method in favour of those taught with the flipped classroom.

This finding agrees with Adonu et al. (2021), who examined the impact of using the flipped classroom style and PowerPoint presentations to teach biology at primary schools and reported that both the flipped classroom and the PowerPoint educational strategy greatly improved biology students' performance, with the flipped classroom being even more successful than the PowerPoint instructional technique.

The finding also agrees with Abolarinwa (2020), who examined the impact of three different types of flipped classroom collaborative learning methodologies on students' performance and learning outcomes in physics and reported that all three types of flipped classroom collaboration tactics significantly improved students' performance in physics classes. The study also agrees with that of Jdaitawi (2019), who evaluated the impact of the flipped



classroom paradigm on students' achievement at tertiary institutions and showed that the students in the flipped classroom had a significant advantage in learning. The finding also coincides with Fard et al. (2021), who assessed the impact of using a flipped-classroom approach to teaching language and vocabulary to university students and reported that using a flipped classroom paradigm significantly improved students' vocabulary acquisition.

This study's findings showed no statistically significant difference in the mean achievement scores of male and female students taught biology with the flipped classroom instructional model and those taught with the modified lecture method.

This finding agrees with Abolarinwa (2020) and Minaz et al. (2018), who reported that gender did not significantly impacts on students' achievement in a study on the flipped classroom. The finding disagrees with that of Doyle and Nilsson (2019), who assessed whether there exist variations based on gender on students' learning gains and perceptions in a flipped classroom model and reported that female students responded better to the flipped classroom model with increased engagement and performance than their male colleagues.

### **Conclusion**

Based on the study's findings, the flipped classroom is effective for teaching biology and better than the modified lecture method. Gender also does not affect students' achievement in biology when taught with the flipped classroom model instructional strategy.

### **Recommendations**

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

1. Teachers should adopt innovative instructional strategies like the flipped classroom model to teach biology students.
2. Government and other educational bodies should provide adequate in-service training to keep teachers abreast of the various innovations for teaching biology and equip them with the skills and knowledge needed to bring such innovations (like the flipped classroom model) into the classroom practice.
3. Curriculum developers should recommend the use of flipped classroom model for proper implementation of biology curriculum.

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