

EFFECT OF FLIPPED LEARNING INSTRUCTIONAL STRATEGY ON PRE-SERVICE TEACHERS' ACHIEVEMENT AND ATTITUDE TOWARDS BIOLOGY CONCEPTS IN ANAMBRA STATE, NIGERIA

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Abstract

The study of biology plays a crucial role in scientific and technological advancement of a nation. To achieve this, students must have a strong knowledge of biological concepts and as well develop a positive attitude towards the subject. Therefore, this study investigated the effect of flipped learning instructional strategy on the achievement and attitude towards biology concepts among pre-service teachers at Anambra State, Nigeria. It also examined the moderating effect of gender on the attitude and achievement. The study adopted a pretest, posttest non-randomized control group quasi-experimental research design with a 2×2×2 factorial matrix, with a sample of 150 intact classes (70 males and 80 females). The validated instruments used for data collection were Biology Achievement Test (BAT) and Questionnaire on Students' Attitude to Biology (QSAB). The reliability of the instruments were established using Kuder Richardson 20 and Cronbach Alpha which yielded a reliability coefficient of 0.79 and 0.96 respectively. The treatment material was Flipped Learning Instructional Package (FLIP) which contains biology lesson while the control group were exposed to Conventional Lecture Method (CLM). Data obtained were analysed using mean and standard deviation to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The results revealed that flipped learning Instructional strategy significantly improved students' academic achievement and attitude towards biology. However, gender did not significantly affect pre-service teachers' achievement and attitude towards biology. The study concluded that flipped learning instructional strategy is an effective instructional strategy for teaching biology concepts, particularly at tertiary academic level and other science-related concepts, as it creates room for collaboration, creativity and critical thinking. It was recommended that educators should adopt flipped learning strategy in teaching of biology concepts.

Keywords: *Flipped learning Instructional strategy, Achievement, Attitude and Biology.*

INTRODUCTION

For a country to grow and advance, education is essential. Education is seen as a tool for a country's development and change. Consequently, a country's degree of national growth and advancement is determined by the calibre of its educational system. The nation's level of accomplishment and growth is determined by the delivery of educational services, which is why educators, the government, and other stakeholders in education place a strong emphasis on it for a sustainable development. Technology has raised living standards and had a significant impact on every area of daily life, including the home, workplace, school, and marketplace. Nevertheless, the introduction of technology into STEM education delivery had grossly made teaching and learning processes easier and faster because it fosters independent and adaptive learning skills among students (Okanume, 2024). The impact associated with the introduction of technology into science and technology education (STEM) in bringing about social change, improved engagement, critical thinking and creativity among students cannot be overstated (Gambari & Ajanaku, 2019). In today's digitized age, technology stands out as a potential tool in enhancing or facilitating learning experiences. The integration of technology in education has been the forefront of many research that are carried out across the globe. Consequently, science and technology education is also given significant priority since fosters technological advancement in the society. The importance of science and technology to human existence and national development makes science and technology education a top priority. According to Baba (2017), education in science and technology is essential for every country to progress. It is obvious that one cannot become a scientist without good foundation in biology. Biology is a fundamental aspect of science that can be achieved through theoretical and practical work. Biology was coined from Greek word "bios" (meaning life) and "logos" (meaning study), which implies that biology is the scientific study of life. Achufusi and Ezenduka (2017) defined biology as the scientific study of living organisms which include structure, function, origin, evolution, classification, interrelation and their distribution. Furthermore, biology is a branch of science and prerequisite subject for many other fields of study, including agriculture, pharmacy, botany, medicine, nursing, and biotechnology. According to Sallau and Bello (2019), biology education in both senior secondary and postsecondary educational institutions equips students with important ideas theories and concepts that help them deal with life's obstacles even after they graduate. A basic grasp of every facet of life on earth is derived by studying biology. Nwakonobi (2016), opined that the recent advances recorded in the field of biochemistry, physiology, ecology, genetics and molecular biology have made the subject (biology) a central focus in human activities, including solution to problems of food scarcity, pollution, population explosion, radiation, health hygiene, conservation of natural resources, family life as well as bio-technology and ethics. Due to the benefit of the subject (biology), the Federal Government of Nigeria in her National Policy on Education, made biology a core science subject for senior secondary school (FRN, 2000). Among the cardinal objective are to prepare students acquire adequate laboratory and relevant knowledge in biology. However, in recent years, research have revealed that students are increasingly finding it difficult to pass the subject at both the West Africa Secondary School Certificate Examination (WASSCE) and Senior School Certificate Examination (NECO). As a result, the Chief Examiners of WAEC and NECO have consistently expressed their concerns about the poor performance of candidates in biology, using phrases like "not satisfactory," "downward trend," "decline in pass rate," and "fluctuating performance," in their reports. This is consistent with the fourteen years of statistical analysis of students' performance in the SSCE biology from 2010 to 2023, which revealed a "decline in pass rate" of students (Piwuna and Mangut, 2023; Okanume, 2024). Furthermore, at 200 level of biology education,

some general biological ideas may be difficult for pre-service teachers (teacher trainees) to understand because they are abstract or complicated. Among these concepts were "Molecular Biology, Invertebrate Zoology, and Genetics." Since these ideas are included in the senior high school curriculum, pre-service teachers should be familiar with them. Pre-service teachers can effectively teach these ideas during their senior secondary school teaching practice activities if they have a good comprehension of them. However, a recent analysis that examined statistical data on students' performance in a General biology course (BIO 101) over a six-year period in a college of education, from 2017 to 2022, revealed a decline in the pass rate (Okanume, 2024). However, the persistent drop of pre-service teachers' performance in biology, particularly in BIO 101, may be attributed to the negative attitudes that students have developed as a result of the inappropriate teaching methods that the majority of biology lecturers use when teaching complex biological concepts (Nja, Orim, Neji, Ukwentang and Ideba, 2022). These methods fail to effectively engage students and aid in their understanding of basic concepts and principles (Etobro & Fabinu, 2017; Jean, Tienne and Floriene, 2021). According to Chinonso and Emenike (2019), a lack of comprehension of biological ideas, which is mostly a consequence of inefficient teaching methods may frustrate students and result in a bad attitude and poor performance in the subject. Recent studies have shown that a teacher-centered approach to teaching may be a factor in students' poor achievement and persistently negative feelings toward biology. Nevertheless, Poor teaching methodology and inadequate laboratory equipment in biology can hinder students' understanding (Darling-Hammond, 2017) and application of biological concepts, leading to frustration and negative attitudes. Teachers often rely on charts, diagrams, and improvisation, limiting practical exercises (Ajemba et al., 2021; Ndayambaje et al., 2021). Another significant factor that may impact students' attitudes and biology performance may be inherent on certain gender (male or female sex) perceptions. According to Tambaya and Matazu (2016), gender is a factor that has contributed to the stereotype that biology is a topic better studied by female students than by male ones. Because biology is perceived by male students as a feminine topic best suited for women, they have formed a negative attitude towards the subject (Ekineh & Adolphus, 2019). Furthermore, Jung, Ann and Park (2018) asserted that in biology classes, female exhibits greater interest and demonstrate heightened engagement in digital environments relative to males. However, Makarova & Aeschlimann (2019) opined that implementing an active teaching strategies that are appropriate for the subject matter and customized to the unique characteristics and learning styles of the students is necessary to address the low performance of pre-service teachers in biology and the negative attitudes of students towards the subject. In quest to solve the problem of poor achievement of pre-service teachers in biology, Nalevska and Kuzmanovska (2020) asserted that students' academic achievement can be increased if the teaching method is adjusted to the students' learning styles and abilities. However to improve on learning, Chan and Zhan (2019) and Mai, Yusuf and Saleh,(2023) asserted that the use of active teaching pedagogies such as flipped learning instructional strategy that are capable of enhancing students' full participation, creativity and teamwork should be adopted which could help the students take responsibility for their own learning. Recent literature has highlighted the importance of active teaching pedagogies in fostering student engagement, creativity, and collaboration. Researchers have developed innovations like Brain-based teaching (Saleh and Subramaniam, 2018); Blended Learning Approach (Okoye, Nwagu and Abraham-Ibe, 2018; Ndirika, 2018), and Gamification and Game-Based Learning (Gambari, 2019; Udeani & Akhigbe, 2020), to improve STEM education performance. However, there is limited attention on incorporating of an active instructional pedagogy: (Flipped instructional strategy), particularly in General biology. In the context of education, Flipped learning strategy is an instructional

strategy that reverses traditional classroom models by delivering content online or offline, often using pre-recorded videos or text. Students watch videos, read from text, and conduct research at home, prepared for active learning experiences like discussion, peer teaching, presentations, and group-based problem-solving under teacher guidance. The core objective is to shift instruction to learner-centered, with teacher-led instruction strategy taking a backseat and active learning taking the forefront. Moreover, by assessing instructional materials or resources outside of the traditional classroom setting, students acquire greater autonomy in determining their learning pace and enjoy the convenience of self-directed learning (Seggie & Oguzi, 2021). In addition, Hassan (2020) affirmed that flipped classroom enhances students' level of engagement, foster the development of critical thinking skills and facilitate the attainment of a profound understanding of the subject matter because of the pre-recorded video lesson content which they have watched at home in their own learning pace before the class time, their need for competence, autonomy and relatedness were satisfied. Nevertheless, since biology as a course offered by the pre-service teachers is broad and diversified, The teaching of biology should be blended with the incorporation of intervention; the Flipped instructional strategy which would provide the learners the opportunity to acquire knowledge about a concept prior to the scheduled class time, and comes to the class fully prepared for collaboration, questioning and group-base problem solving. Learners thereby becomes active participants in the classroom. However, the effectiveness of reverse learning heavily relies on the ability of these videos and other educational materials to captivate students' attention. When the video content is too large and also if these resources used for the video, fail to be sufficiently engaging, reverse learning may not yield desirable outcomes (Turan & Akdag-Cimen, 2020). Additionally, the workload involved in flipped learning must be carefully managed. If the workload surpasses that of traditional classroom setting, the effectiveness of flipped instructional strategy may be compromised. Shujan, (2022) emphasized that teacher needs to trust that students complete their task independently. However, certain students may encounter difficulties in term of self-motivation and discipline when it comes to learning content at their own pace. Some may struggle to complete activities, such as assigned reading, before next class, and less motivated students may not adequately prepare for the class. Nevertheless, insufficient preparation prior to class can hinder their active participation within the flipped classroom, as only those who have prepared adequately will actively engaged in group discussions and pose questions (Aaron, 2017). Researchers have advocated for the adoption of novel instructional approaches in biology education to raise students' achievement and attitude in the subject. Several empirical investigations on these approaches have been carried out. However, flipped learning which involves students actively participating in activities, communicating with others, collaborating, and experiencing a stress-free classroom has been supported by studies. It has been discovered that this strategy raises achievement, particularly in biology. In a flipped classroom, the main elements of flipped instructional strategy, according to Yilmaz and Baydas' (2017) research, are shifting the delivery of knowledge outside of the classroom and using class time for more advanced activities often through the use of pre-recorded video and face-to-face learning. Students participate in learning by downloading, watching and studying the pre-recorded video of lesson content at home using their digital devices; gain knowledge and understanding by themselves and come to class the next class meeting to engage in face-to-face learning with their peers using active learning activities such as discussion, presentations and group-based problem-solving under the guidance of the teacher. The teacher's role during learning is facilitating and mentoring the students. However, they discovered in their research that the flipped instructional strategy not only greatly increased students' attitude and achievement but also encouraged

participation and motivation. Park and Chae (2018) compared flipped classrooms with traditional classrooms, highlighting the active participation of students in flipped learning environments. They found that students in flipped learning environments achieved higher grades than those in traditional learning environments. Riedl, Yeung, and Burke (2021) also examined the effectiveness of flipped instructional strategy in a general biology course at a Community college Rwanda district. After 15 weeks, 800 students participated in 33 sections of the course, and after 15 weeks, the results showed that students who were taught with flipped instructional strategy outperformed students in the control group on common exam questions. The study concluded that using a flipped instructional strategy improved students' achievement and attitude in a general biology course at a community college Rwanda and also gender has no influence on achievement of students. This was also in support of the findings of Godpower-Echie & Ihenko (2017) asserted that gender has no significant effect on the achievement of students when an active instructional pedagogy is involved. Additionally, to support this claim, Dorji and Dorji (2022) affirmed that flipped learning instructional strategy significantly affect the attitude of students in biology. Empirically, it is clear from a critical evaluation of incorporation of flipped instructional strategy in the classroom that there are few studies looking at how flipped instruction affects biology concepts. It is important to acknowledge that, despite the body of prior research, there is a relatively small number of studies that examine gender as a mediator between pre-service teachers' attitudes and achievement in a flipped classroom. Therefore, the main objective of this study is to provide insight into how flipped instruction may affect pre-service teachers' attitude and academic achievement regarding to biology concepts. Additionally, it examined the moderating effect of gender on pre-service teachers' attitudes and performance in general biology.

This study is based on Vygotsky's constructivist learning theory which was adopted to explain the importance of social interaction and cultural context in the development of cognitive processes, stressing that learning could take place in shorter time and with less stress, with the assistance of someone who knows better. The theory suggests two major zones of cognitive development of a learner. The Zone of Proximal Development (ZPD) and the More Knowledgeable Other (MKO), which have implications for educational strategies like flipped learning. The principle of the more knowledgeable other (MKO) is a person or source with a higher level of knowledge or skill than the learner and the expertise of such person should be sought for the learner to be able to develop the level of capability they need to complete a given task. In a traditional classroom, the teacher often serves as the MKO. Apparently, this more knowledgeable other may not only be the teacher, it could be other learners, classroom assistant, or anything which is programmed with more knowledge in a particular concept to be learn, or task to be undertaken. In flipped classroom, online resources like learning content video, printed text, images or interactive platforms can also act as MKOs. These resources guide the students through challenging content, providing support as they progress through their zone of proximal development (ZPD). The second principle which is the zone of proximal development for cognitive development of a learner. Vygotsky, (1978), explained the zone of proximal development of a learner as the gap between the learner's actual developmental level (what a learner can do independently) and their potential development level (what they can achieve without assistance). Scaffolding in the context of Vygotsky's zone of proximal development, refers to the support provided by a more knowledgeable person (MKO), typically a teacher or peer, to help a learner bridge the gap between their current level of understanding and their potential development level. Scaffolding is employed in this study to assist learners in mastering areas they have not yet fully grasped. When learners watch pre-recorded videos or read learning

materials before attending class, the teacher, acting as a more knowledgeable other, offers support or assistance during class activities that serve as stimuli for their learning.

Statement of Problems

The study of biology plays a vital role in a nation's scientific and technological advancement. To achieve this, it is crucial for students to have a strong grasp of biology concepts and develop a positive attitude towards the subject. However, there has been a noticeable setback in the academic performance of pre-service teachers in general biology course due to the negative attitudes students' have developed towards the course. This has resulted to poor academic performance in both internal and external examinations. Gender differences have also influenced the effectiveness of instructional strategies employed by researchers to enhance students' attitude and academic performance in biology. This is because some students may lack full motivation and engagement in such pedagogical approaches. Several studies have shown that different active learning strategies such as gamification approach, use of blended learning approach, use of video- assisted learning and others have been applied to enhance students' active participation, attitude, interest, motivation in biology classroom towards a positive learning outcome. Despite all, the problem still persist. The reason for this scenario may not be connected to the method of teaching teachers adopted during instructional delivery. Teaching and learning opportunities can be improved through appropriate application of a more flexible, active and hands-on activities. This study therefore, aims to explore the effect of flipped instructional strategy on the achievement and attitude towards biology concepts among pre-service teachers in Anambra State, Nigeria. It also seeks to examine the moderating effect of gender on students' attitudes and achievement in biology.

Research Questions

The following research questions were answered in the study;

1. What are the pretest and posttest mean achievement scores of pre-service teachers taught with flipped learning instructional strategy and those taught with conventional lecture instructional strategy?
2. What are the pretest and posttest mean achievement scores of male and female pre-service teachers taught with flipped learning instructional strategy and those taught with conventional instructional strategy?
3. What are the attitude scores of pre-service teachers before and after the intervention?

Hypotheses

The following null hypotheses are formulated to guide the study;

Ho1: There is no significant main effect of treatment on the achievement scores of the pre-service teachers exposed to the intervention and those taught using conventional lecture instructional strategy.

Ho2: There is no significant main effect of treatment on the mean achievement scores of pre-service teachers taught with the intervention and those taught using conventional lecture method based on gender.

Ho3: There is no significant main effect of treatment on the attitudes of pre-service teachers after the intervention.

Ho4 There is no significant main effect of gender on the attitude of pre-service teachers towards biology.

Ho5: There is no significant interaction effects of treatment and gender on pre-service teachers': (i) achievement in (ii) attitudes towards biology.

Method

The study adopted a pretest-posttest control group quasi-experimental research design. The target population of this study comprised of all the one hundred and fifty (150) intact class of three hundred level (300 level) pre-service teachers offering Genetics (ZOO 301) at College of Education, Nsugbe. They were purposively selected on the criteria that: they were not yet preparing for external exercise such as teaching practice, and they were judged to be matured enough to effectively collaborate. The students were further randomly assigned to treatment and control group.

Instrument

Eight instruments were used for data collection, two response scales and four stimulus instruments. The instruments are: The Biology Achievement Test (BAT), Questionnaire on Students Attitude to Biology (QSATB), Flipped Learning Instructional Package (FLIP), Flipped Instructional Mode Guide (GFIMG), and Conventional Teaching Method Mode Guide (CTMMG).

The Biology Achievement Test (BAT) was a multiple choice self-constructed instrument used to measure the level of students' knowledge of selected biology concepts based on six levels of cognition according to Bloom's taxonomy of Cognitive Skills (Bloom 1956). The original 50 test-items were validated to 40 items after the instrument difficulty and discrimination indices were determined. The 40 test-items was trial-tested and the reliability was ascertained using Kuder-Richardson 20 which yielded a value of ($r=0.79$) which shows that the instrument is reliable enough for the study.

An Attitude Scale Questionnaire developed by Okanume (2024) was adapted for the study. The instrument was used to measure pupils' level of engagement, emotion or feelings, knowledge acquired and value they placed on Biology as a subject and Genetic as a course. The questionnaire comprises of twenty-six (26) items that requires pupils to tick from the four-likert type scale which were graded as: SA (Strongly Agree) 4, A (Agree) 3, D (Disagree) 2, and SD (Strongly Disagree). It consists of two sections. Section A contains the personal data of respondents' demographic information. While section B consists of 24 items on pupils' attitude towards BST. To ensure that the items in the instrument are consistently reliable, the questionnaire was administered to 30 biology students who were not part of the main study. Cronbach Alpha was used to analyse the data and a reliability coefficient of 0.96 was obtained which indicated that the instrument was consistently reliable.

The Flipped learning Instructional Package (FLIP) validated by three experts from Educational Technology was developed using PowerPoint, Camtasia application (360), Google form for

online quizzing. It contains multimedia elements like animated pictures, sounds (audio), and videos. In order to save cost on the side of the students, the package was sent to the students in experimental group using data saving application (Bluetooth and Xender) before and after each class time.

Method of Data Analysis

The data collected were analysed using Mean and Standard Deviation and inferential statistics of t-test, and two-ways analysis of covariance (ANCOVA) with the pre-test scores as covariates to test the hypotheses at 0.05 level of significance. Analysis of covariance was used to single out the initial group differences. Also, the Estimated Marginal Means (EMM) of the ANCOVA was used to detect the magnitude and direction of differences.

Procedure for Data Collection

The study was carried out in a College of Education, Anambra. Firstly, approval was sought from the Head of Department of Biology Education, and the lecturer in charge of the course (General Biology). They were brief on the purpose of the research in order to get correct responses without influence and bias in their opinion. The research ethics guiding the confidentiality of the respondents' data were highly maintained. The experiment lasted for 7 weeks with the help of two research assistants trained by the researchers. The procedure for data collection was done in phases using the chart below which was designed by the researchers. Thus;

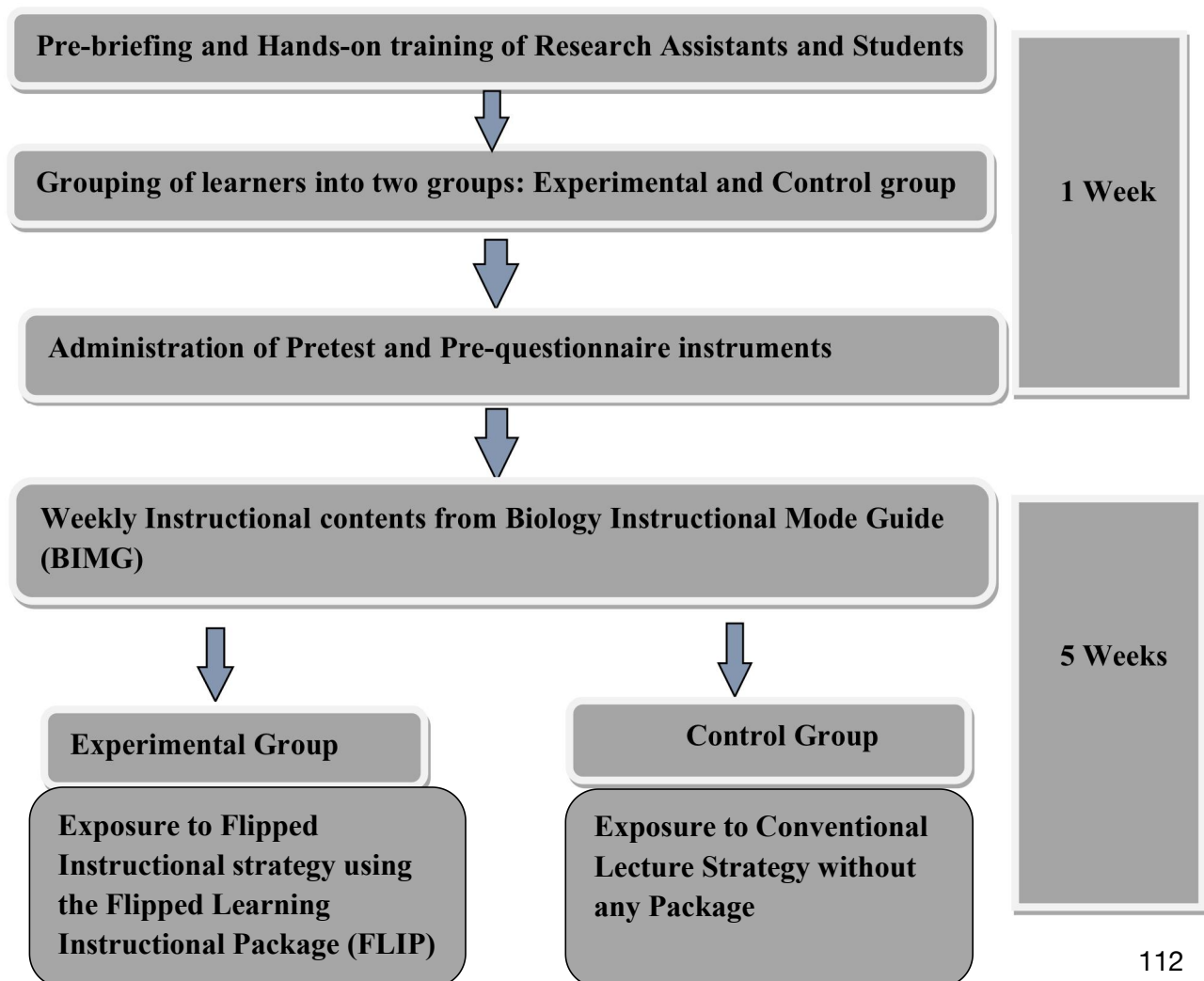




Figure 1: Phases for Data Collection Designed by the Researchers

RESULTS

Table 1: Descriptive Statistics of Respondent: Demographic information of students

Gender	Frequency	Percentage
Male	70	47%
Female	80	53%
Total	150	100%

Table 1, shows the frequency distribution of pre-service teachers who were randomly sampled to actively participate in the study. A total of 150 students from intact classes participated. By gender; out of 150 respondents sampled, 70(47%) were male and 80(53%) were female for both experimental group and control group. The experimental and control groups consists of 87 and 63 participants respectively. More students were assigned to experimental group on the purpose that they have the mobile phone that would enable them receive lesson video contents before class time through data saving application (Xender).

Research Questions

Research Question 1: What are the pretest and posttest mean achievement scores of pre-service teachers taught with flipped learning instructional strategy and those taught with conventional lecture instructional strategy?

This question was answered using mean and standard deviation, which were computed using the scores of pre-service teachers in the experimental and control group, before and after the treatment. The results of the analysis are as presented in Table 2.

Table 2: Pretest and Posttest Mean Achievement scores of the Experimental and Control groups.

Group	N	Pre-test Mean (X)	SD	Post-test Mean (X)	SD	Mean Difference	Gain Mean
Experimental	87	42.55	8.64	73.33	9.05	30.78	

							24.25
Control	63	40.26	7.37	46.79	7.92	6.53	

Results in table 2 reveal that the mean scores of pre-service teachers before and after exposing them to flipped learning instructional strategy (intervention) are 42.55 and 73.33 respectively while that of the control group that received no intervention were 40.26 and 46.79 respectively. It can be deduced that the mean score of pre-service teachers after exposing them to flipped learning instructional strategy increased, with the gained mean of 24.25. Thus, flipped learning instructional strategy has positive effect on the pre-service teachers' achievement in Biology.

Research Question 2: What are the pretest and posttest mean achievement scores of male and female pre-service teachers taught with flipped learning instructional strategy and those taught with conventional instructional strategy?

Table 3: Mean achievement scores of the pretest and posttest of the experimental and control groups based on gender.

Group	Gender	N	Pre-test Mean (X)	SD	Post- test Mean (X)	SD	Mean Difference	Gain Mean
Experimental	Male	42	48.26	6.43	69.89	8.75	46.59	37.06
	Female	45	42.29	5.49	67.27	8.64		
Control	Male	28	48.24	6.37	54.79	6.20	9.53	
	female	35	49.02	6.44	52.00	6.02		

Results in table 3 show that after the treatment, in the posttest, the male in the experimental group obtained a mean score of 69.89 while their male counterpart in the control group obtained a mean score of 54.79 resulting to between group mean score of 15.10 which was in favour of the male in the experimental group. Additionally, from the posttest results of the female in the experimental group revealed that they obtained a mean score of 67.27 while their female counterpart in the control group obtained a mean score of 52.00, resulting to a between group mean score of 15.27 in favour of the female in the experimental group. This shows that male and female in the experimental group performed better. Also male in the experimental group with a mean score of 69.89 performed better than female in the control group with a mean score of 52.00. However, female in the experimental group with a mean score of 67.27 performed better than male in the control group with a mean score of 54.79. Hence, the flipped learning instructional strategy greatly improved the performance of students in biology concepts when properly implemented.

Research Question 3: What are the attitude scores of pre-service teachers before and after the intervention?

This question was answered using mean and standard deviation, which were computed using the attitude mean scores of pre-service teachers in the experimental group before and after the treatment. The results of the analysis are as presented in Table 4.

Table 4: Mean on the attitude scores of Pre-service Teachers before and after using Flipped learning Instructional Strategy

Mode of test	N	Mean	SD	Weighted Mean
Post-Attitude	87	3.54	0.446	1.20
Pre-Attitude	87	2.34	0.260	

Results in table 4, show that the attitude mean scores of pre-service teachers before and after exposing them to flipped learning instructional strategy are 2.34 and 3.54 respectively. And it can be seen that the mean attitude score of pre-service teachers after exposing them to gamified flipped learning increased with the gained mean of 1.20. Thus, the flipped learning instructional strategy has positive effect on pre-service teachers' attitude towards Biology.

Testing of Null Hypotheses

Hypothesis 1: There is no significant main effect of treatment on the achievement scores of the pre-service teachers exposed to the intervention and those taught using conventional lecture instructional strategy.

Table 5: Analysis of Covariance (ANCOVA) of Biology Achievement Test scores by Treatment, and Gender

Source	Type III Sum of Squares	Df	Mean (X) Squares	F	Sig	Partial Eta Squared
Corrected Model	31341.143	12	2611.762	47.704	0.000	.807
Intercept	24786.454	1	24786.45	452.724	0.000	.768
Pretest	43.041	1	4	.787	0.377	.006
Treatment	7986.168	1	43.071	145.867	0.000	.516
Gender	21.263	1	7986.168	.388	0.543	.003

Treatment* Gender	70.637	1	21.263	1.290	0.258
Error	75000.697	137	70.637		
Total	617676.000	150	54.750		
Corrected Total	38841.840	149			

R Squared = .807 (Adjusted R Squared = .790*) Denote significant difference at 0.05 level of sig
Table 5 revealed that there is significant main effect of treatment on pre-service teachers' Biology Achievement Test scores in ($F(1,137) = 145.87; P < 0.05$, partial $\eta^2 = 0.52$). The effect size is 52.0%. This indicates that 59.0% of the variation in pre-service teachers' achievement is as a result of the significant main effect of the treatment. Thus, the null hypothesis 1 was rejected. In order to determine the magnitude of the significant main effect across treatment groups, the estimated marginal means of the treatment groups was calculated and the result was presented in (Table 5.1).

Table 5.1: Estimated Marginal Means for Post-test by Treatment (Control and Experimental group)

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control (Conventional Strategy)	47.377	1.163	45.078	49.676
Experimental (Gamified Flipped Learning)	68.311	1.177	65.984	70.639

Table 5.1 revealed that pre-service teachers in Experimental group (Flipped Learning instructional strategy) had the highest adjusted post-Biology Achievement Test mean score (68.31) while those in the Control group (Conventional lecture instructional Strategy) had the least adjusted post- Biology Achievement Test mean scores (47.38).

Hypothesis 2: There is no significant main effect of treatment on the mean achievement scores of pre- service teachers taught with the intervention and those taught using conventional lecture method based on gender.

Table 5.0 shows that there is no significant main effect of gender on pre-service teachers' Biology Achievement Test Scores ($F(1; 137) = 0.39, p > .05$, partial $\eta^2 = 0.003$). Thus, hypothesis 2 was accepted.

Hypothesis 3: There is no significant main effect of treatment on the attitudes of pre-service teachers after the intervention.

Table 6.0: Analysis of covariance of Post-Attitude to Biology by Treatment and Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
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Corrected Model	14.458 ^a	12	1.205	7.858	0.000	.408
Intercept	39.926	1	39.926	260.38	0.000	.655
Pre-Attitude	.391	1	.391	2.547	0.113	.018
<u>Main effects</u>						
Treatment	8.526	1	8.526	55.601	*0.000	.289
Gender	.002	1	.002	.011	0.916	.000
<u>2-way interaction</u>						
Treatment * Gender	.374	1	.374	2.442	0.120	.018
Error	21.007	137	.153			
Total	1655.135	150				
Corrected Total	35.465	149				

R Squared = .408 (Adjusted R Squared = .356) * Denote significant difference at 0.05 level of sig.

Table 6.0 shows that there is significant main effect of treatment on pre-service teachers' attitude in ($F(1,137) = 55.60$; $p < 0.05$, partial $\eta^2 = 0.29$). The effect size is 29%. This indicates that 29% of the variation in pre-service teachers' attitude score is as a result of the significant main effect of the treatment. Thus, the null hypothesis was rejected. Therefore, there is significant main effect of treatment on pre-service teachers' attitude towards Biology. In order to determine the magnitude of the significant main effect across treatment groups, the estimated marginal means of the treatment groups was calculated and the result was presented in Table 6.1.

Table 6.1: Estimated Marginal Means for Post-Attitude by Treatment (Control and Experimental groups)

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control (Conventional Lecture Strategy)	2.944	.057	2.831	3.057
Experimental (Flipped Learning Instructional Strategy)	3.542	.060	3.443	3.681

Table 6.1 revealed that pre-service teachers in Experimental group exposed to (Flipped Learning Instructional Strategy) had the highest adjusted post-Attitude mean score (3.56) while the pre-service teachers in the Control group (Conventional Lecture Strategy) had the least adjusted post- Attitude mean scores (2.94).

Hypothesis 4: There is no significant main effect of gender (male and female) on pre-service teachers' attitude towards Biology

Table 6.0 result analysis shows that there is no significant main effect of gender on pre-service teachers' attitude towards Biology ($F(1; 137) = 0.01, p > .05, \text{partial } \eta^2 = 0.00$). Thus, the null hypothesis was accepted.

Hypothesis 5a: There is no significant interaction effect of treatment and gender on pre-service teachers' achievement in Biology

Table 5.0, shows that there is no significant interaction effect of treatment and gender on pre-service teachers' Biology Achievement Test Scores ($F(1; 137) = 1.29, p > .05, \text{partial } \eta^2 = 0.009$). Thus, hypothesis 5a was not rejected.

Hypothesis 5b: There is no significant interaction effect of treatment and gender on pre-service teachers' attitude towards Biology

Table 6.0, shows that there is no significant interaction effect of treatment and gender on pre-service teachers' attitude towards Biology ($F(1; 137) = 2.44, p > .05, \text{partial } \eta^2 = 0.02$). Thus, hypothesis 5b was not rejected.

Discussion

Effect of Treatment on pre-service teachers' achievement in Biology

The findings of the study revealed that the experimental group which were exposed to flipped learning instructional strategy significantly performed better than those in the control group which were denied the opportunity. The findings showed that the instructional strategy (flipped learning) is more effective than the conventional teaching strategy in improving pre-service teachers' achievement in Biology. However, this high achievement of students in the experimental group could be as a result of materials (scaffolding) such as: video lesson and printed text which were given to students to study on their own learning pace ahead of class time. Students had first-hand information about each lesson prior to the scheduled class time. Nevertheless, when learning environment is fun, engaging, friendly and competitive students' level of enthusiastic tends to increase leading to high performance in their classwork. This greatly helped them attain their level of proximal development at the end of the treatment process. The result is in support of the findings of (Seggie and Oguzi, 2020; Hassan, 2020; Turan, 2020). Their study confirmed that flipped classroom improves students' academic achievement in Biology. Their findings also revealed that participants in the flipped classroom showed high levels of motivation because their needs for competence, autonomy, and relatedness were satisfied. This is as a result of scaffolding such as video lessons that were integrated into the flipped classroom, which created a more engaging, enjoyable learning experience, increases students' participation, and promotes deeper and more meaningful learning experience for the students. All these have a positive effect on the academic achievement of students especially in learning concepts in biology. Therefore, we can conclude that using flipped learning instructional strategy can improve the academic achievements of pre-service teachers in Biology.

Effect of Treatment on pre-service teachers' attitude in Biology

The results from the study revealed that there is a significant effect of treatment on the attitude of pre-service teachers towards biology. Pre-service teachers in the experimental group which were exposed to the intervention particularly had the highest adjusted post-attitude mean score while

those in the control group had the least adjusted post-attitude mean score. The positive effect could be as a result of the lesson videos which were carefully designed with animations, sounds and pictures to capture the interest of the students. This result is in line with the findings of Dorji and Dorji (2022), affirmed that students taught with the flipped learning approach performed better and had more positive attitudes compared to those taught with conventional methods. Since flipped learning approach changes the order of classroom activities by delivering instruction outside of class, it creates room for more interactive and in-depth learning during class time. Other studies by Turan (2020) and Hassan (2020) also highlighted the positive influence of scaffolding on learners' attitudes and success because it enhanced motivation, engagement, and performance and as well to cultivate a positive attitude towards the subject.

Effect of Gender on pre-service teachers' achievement and attitude towards Biology

The study found that gender does not have a significant effect on the achievement and attitude of pre-service teachers. This findings is in consonance with the findings of (Tugba et al., 2018; Godpower-Echie & Ihenko, 2017) which revealed that gender had no significant influence on the achievement of students in science subjects, as students of different genders were found to have performed well. Nevertheless, they emphasized that female students do not have the tendency to outperforming the male students in the class, and male students do not have the tendency of outperforming their female counterpart. Hence, Some studies showed that male students see biology as feminine subject and well suited for females, and as a result, have developed negative attitude in biology subject (Ekineh & Adolphus, 2019), and have had poor performances in the subject when compared to their female counterparts (Makarova & Aeschlimann, 2019). Furthermore, the studies of (Jung et al., 2018) posited that women exhibit greater interest and demonstrate heightened engagement in digital environments relative to males. However, this study proves that using interactive and engaging instructional strategy such as flipped learning instructional strategy can bridge the performance gap and attitude gap between both genders.

Conclusion

Since biology plays a crucial role in a nation's scientific and technological advancement, it is imperative to incorporate active and engaging instructional strategies that will not only improve academic achievement but also foster creativity, critical thinking, and collaboration and enhance effective communication skills among students in this 21st century. This study demonstrated that using a flipped instructional strategy effectively enhances the academic achievement of pre-service teachers in biology. Educators can promote positive attitudes, engagement, motivation, collaboration, critical thinking and overall learning outcomes by incorporating active and hands-on teaching methods. Additionally, the study revealed that gender does not impact the achievement of pre-service teachers in biology when utilising an active instructional approach. Both male and female students performed equally well in a flipped learning environment, as they became immersed in the class activities, faced challenges and experienced improved behaviour and learning outcomes.

Recommendations

Based on the findings, this study recommends the following:

1. Biology educators should adopt the use of flipped learning instructional strategy especially, while teaching biology concepts because it is effective in fostering collaboration, engagement, critical thinking and creativity among pre-service teachers.
2. Government and professional bodies such as STAN, NTI and NUT etc., should expose biology teachers to new and active pedagogies which would help to foster creativity, collaboration and effective communication skills among students.
3. Curriculum planners should use information provided in this research as a guide in subsequent planning of biology curriculum.

Therefore in consideration of the above findings, the study focused on a particular college of education, there would be need for future studies to extend the scope of this research to two or more colleges of education.

References

- Achufusi, J.N. & Ezenduka, C.U. (2017). Improvisation as a strategy for improving senior secondary school biology curriculum delivery in private schools within Awka town. *Journal of Science Education*, 13(1), 221-228.
- Ajemba, H.E., Foluke. A. A. Ogunide, N.J. & Olatunde-Aiyedun, T.G. (2021). Problems Facing Science Teachers in Public Secondary Schools in Nigeria and Way Forward. *International Journal of Applied Sciences*.1 (50), 118-127 online: <https://creativecommons.org/licenses/by/4.0/>
- Aaron Taylor, 2017. Flipping Great or Flipping Useless? A Review of the Flipped Classroom Experiment at Coventry University, London Campus. *Journal of Pedagogical Development*. 5(3), 57-65.
- Baba, G.I. (2017). The Role and Challenges of Chemistry Education in Small and Medium Scale Industries for Science and Technology Education for the Development of Sustainable Society in Nigeria. *Being a paper presented at 2nd National Science Education Conference held at Saadatu Rimi College of Education Kumbotso, Kano*, on 31st of October-3rd November, 5(22), 34-251.
- Darling-Hammond, L., Lisa, F., Chana, C., Brigid, B. & David, O. (2020). Implications for Science, 24(2), 97-140. <https://doi.org/10.1080/10888691.2018.1537791>
- Dorji, S. & Dorji, K. (2022). Flipped classroom in teaching biology, assessing students' academic achievement in Tang Central School, Bumthang district. *Interdisciplinary Journal of Applied and Basic Subjects*, 2 (2), 1-8.
- <https://identifier.visnav.in/1.0002/ijabas-22a-10002>
- Ekineh, D. & Adolphus, T. (2019.) Influence of Gender on Students' Performance in Biology When Taught Reproduction Using Collaborative Strategy in Secondary Schools in Rivers State. *River State University Journal of Education (RSUJOE)*, 22 (2), 62-73.

- Etobro, A. B. & Fabinu, O. E., (2017). Students' Perception to Difficult Concepts in Biology in Senior Secondary Schools in Lagos State. *Global Journal of Educational Research*, 16(2), 139-148. <https://doi.org/10.4314/giedr.vi6i2.8>
- Gambari, A. I., Ajanaku, A. & Abraham, A. (2019). Development and assessment of gamification instructional package on Genetic concepts for senior secondary school achievement and gender in Minna, Nigeria. *Journal for Association for Innovative Technology Integration in Education (AITIE)* 8(2), 244-249.
- Gunduz, A.Y. & Akkoyunlu, B., (2020). Effectiveness of Gamification in Flipped Learning. *SAGE open*, 10(4), 37. <https://doi.org/10.1177/2158244020979837>
- Hassan, P.E.E. 2020. The effect of e-program based on flipped learning on academic achievement for basic eight grade students in Khartoum state and their attitude towards it. *IJRDO- Journal of Educational Research*, 5(6), 1-11.
- Jung, A., Ann, J. & Park, K.H. 2018. Analysis of satisfaction and academic achievement of medical school students in a flipped classroom. *Korean journal of Medical Education*, 30:101-116.
- Jean, E. & Floriene, H. (2021). Factors Contributing to Students' Poor Performance in Biology Subject: A case study of ordinary level in rural secondary schools of Rawamagana District. *GSC. Biological and Pharmaceutical Sciences*, 15(3), 249-261.
- Mai, M.Y., Yusuf, M. & Saleh, M. (2023). Motivation and engagement as a predictor of students' science achievement and satisfaction of Malaysian Secondary School students. *European Journal of Education*, 6(2), 96-107. ISSN 2601-8624 (online).
<https://doi.org/10.2478/ejed-2023-0019>
- Makarova, E., Aeschlimann, B. & Walter, H. (2019). The gender gap in STEM fields. The impact of gender stereotype of math and science on secondary school students' career aspiration. *Journal of Education Psychology*, 4(60), 33-43.
- Nalevska, G.P., & Kuzmanovska, M. (2020). Teaching methods as a factor of students learning motivation. *Journal of Educational Research*, 2 (3), 40-50.
- Ndayambaje, J. B, Bikorimana, E. E. & Nsanganwimana, F. (2021). Factors Contributing to the Students Poor Performance in Biology Subject: A Case Study of Ordinary Level in Rural Secondary Schools of Rawamagana Districts, GSC, Biological and Pharmaceutical Sciences. *Journal of Biological Sciences*, 15(3), 249-261.
- Ndirika, M.C. 2021. Extent of usage of blended learning for teaching and learning of biology in secondary school in Abia State, Nigeria. *Journal of the Nigerian Academy of Education*, 14(1), 33-41.
- Nja, C.O., Orim, R. E., Neji, H. A, Ukwentang, J.O. & Ideba, M.A. (2022). Students Attitude and Academic Achievement in a Flipped Classroom. *Heliyon*, 8:1-14.
<https://doi.org/10.1016/j.heliyon.2022.eo8792>

- Nwakonobi, F. & Igboabuchi, (2016). Realizing the vision of National Economic Empowerment and Development Strategies (NEEDS) and Millennium Development Goals (MDGs): Implication for Biology Education. *Journal of Science Education*, 8(1), 58-68.
- Okanume, H.C. (2024). Effect of Gamified Flipped Instructional Strategy on the Achievement and Attitude towards Biology Concepts among Pre-service Teachers at Nsugbe, Anambra State. *An Unpublished M.Ed. Project, Faculty of Education, University of Ibadan, Nigeria*, 1-140.
- Okoye, P.C., Nwagu, A.C., Abraham-Ibe, I.G. (2018). Perception of Pre-service Teachers on the use of Blended Learning Techniques in Nwafor Orizu College of Education, Nsugbe, Anambra State. *International Journal of Educational Research*. 5(1), 59-68.
- Park, K.H., & Chae, S.J. (2018). Experiences of Medical Teachers in Flipped Learning for Medical Students: A phenomenological study. *Korean Journal of Medical Education*, 30: 91-100. [Doi: 10.3946/kjme.2018.84](https://doi.org/10.3946/kjme.2018.84).
- Riedl, A., Yeung, Fan, & Burke, T. (2021). Implementation of a flipped active –learning approach in a community college general biology course, improved students' performance in subsequent biology courses. *Journal of Life Sciences Education*, 20(2),1-9. <https://doi.org/10.1187/cbe.20-07-0156>.
- Sallau, I.A., Bello, B.A., & Sani Yau. (2018). Biology Education a Panacea for Sustainable National Development. *Frontier in Environmental Microbiology*, 4(2), 71-74.
- Shujan, B, 2022. Strategies for the Improvement of Academic Performance of Students. In H.I. Dike, & I. M. Aminigo (Eds.) *Teaching Practice Guidebook, University of Port Harcourt Press*, 231-247.
- Seggie, M, & Oguzi, B. 2021. Use of Flipped Classroom for the development of autonomy and critical thinking. *International Journal of Humanistic Review*, 12(3), 11-23.
- Tugba, T., Ali, A., & Basturk, K. (2018). Examination of Pre-service Biology Teachers' Knowledge Levels and Knowledge Source about Genetic Materials and Molecular Biology. *International Journal of Social Humanities Sciences Research (JSHSR)*, 5(5), 1962-1973. <https://doi.org/10.26450/jshsr.565>
- Turan, Z., Akdag-Cimen, B. 2020. Flipped Classroom in English language: A Systematic review. *Comput. Assisted Language Learning*, 35:590-606. [Doi:10.1080/09588221.2019.1584117](https://doi.org/10.1080/09588221.2019.1584117)
- Yilmaz, R.M., & Baydas, O. (2017). An examination of undergraduates' metacognitive strategies in pre-class asynchronous activity in a flipped classroom. *Educational Technology Research and Development*, 65: 1547-1567. [Doi: 10.1007/SII423-017-9534-1](https://doi.org/10.1007/SII423-017-9534-1)