

## EFFECT OF FLIPPED CLASSROOM STRATEGY ON SECONDARY SCHOOL STUDENT ACADEMIC ACHIEVEMENT IN BIOLOGY IN DELTA STATE

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### **Abstract**

*This study evaluates the effect of the flipped classroom strategy on secondary school students' academic achievement in biology in Delta State, Nigeria using Quasi-experimental research design with pre-test and post-test control groups. A total of 200 Senior Secondary School II (SS II) students from four public secondary schools participated in the study, with 100 students in the experimental group and 100 in the control group. The experimental group was taught using the flipped classroom strategy, while the control group received traditional instruction. Data were collected using a Biology Achievement Test (BAT), an Engagement and Participation Scale (EPS), and an Observation Checklist. Descriptive and inferential statistical analyses revealed that students in the experimental group achieved significantly higher post-test scores (mean = 78.45, SD = 6.32) than their counterparts in the control group (mean = 60.89, SD = 7.45). The flipped classroom strategy also significantly enhanced students' engagement and participation during lessons. However, challenges in implementing the strategy, including limited access to technology, insufficient teacher training, and inadequate classroom infrastructure, were identified as significant barriers. The study concludes that the flipped classroom strategy is an effective teaching approach for improving students' academic achievement and engagement in biology. To optimise its implementation in Delta State schools, policymakers and educational stakeholders must address infrastructural and technological barriers and invest in teacher training programs. Recommendations for future research include exploring the long-term effects of the flipped classroom model and its applicability to other subjects and educational levels.*

**Keywords:** Flipped Classroom, Academic Achievement, Biology Education, Delta State, Secondary School, Teaching Strategies, Student Engagement

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## Introduction

The flipped model supports the tenets of social constructivism. The model supported by the constructivist social learning theory enables learners to engage in interactive, creative, and collaborative activities during knowledge construction (Kim & Bonk, 2006). The flipped classroom model is also poised on peer support while constructing knowledge, members of the class are all actively involved. Constructive controversy is based on the idea that discussions and controversies can serve as a good starting point in trying to understand complex problems (Daniel & Canjander, 2020). Students will improve their skills to constructively and innovatively think and find solutions to complex problems. When one person's ideas, information, conclusions, theories, or opinions are incompatible with those of another and the two seek to reach an agreement (Cimpian, Kim & McDermott, 2020). This then is the ultimate goal of the constructive controversy theory. The learners help one another out in the process of knowledge construction under the leadership and support of the teacher. The teacher here is more like a guide and a coach rather than a disseminator in the process of knowledge acquisition.

Different articles documented an increase in academic performance within the flipped classroom itself, such as Davies et al. (2023), and Talley and Scherer (2023). Davies et al. (2023) compared a traditional introductory spreadsheet skills course to a flipped model and found the flipped model of instruction to be more effective. The flipped classroom students demonstrated higher motivation levels and improved academic performance compared to the

traditional students. In traditional large-lecture introductory biology classes at the University of California at Irvine that were switched to an inverted classroom format, there was an average increase of 21% on exam questions that were formerly covered in lecture but moved to pre-recorded videos watched outside of class and followed up by interactive exercises. (Moravec, et. al., 2010). This shows that once comprehension is improved achievement is likely to be improved. In spring 2010, Stone (2012) checked the impact of flipped classroom on undergraduates' general Biology course and find out that students perform over 10% better on assignment and as well or slightly better in harder, higher level thinking examinations. Many students agreed with statements that indicated the positive influence flipping the class had on their learning and performance in class. The flipped classroom strategy is basically a pedagogical model that flips the traditional learning model of students.

Instead of delivering lectures in class and assigning homework, teachers provide instructional materials (such as pre-recorded videos, reading assignments, or online resources) for students to study at home, while the classroom time is utilized for interactive and practical learning activities like discussions, problem-solving, and collaborative projects (Bergmann & Sams, 2022). This model aims to engender deeper learning and active engagement by catering to different learning needs. Biology, being a core science subject, poses some special challenges in learning.

It requires an understanding of the concepts, application of knowledge, and execution of practical skills. Traditional teaching methods, often relying on rote

memorization, may not adequately prepare students for these demands (Tanner & Allen, 2004). The flipped classroom model holds promise for improving outcomes by promoting active participation and personalized learning, both of which are critical for mastering biological concepts and practices (O'Flaherty & Phillips, 2021). Research has demonstrated that flipped classrooms can positively affect academic achievement. Studies show that this strategy enhances students' understanding of content, fosters critical thinking, and improves their overall academic performance (Bishop & Verleger, 2023; Karaca & Ocak, 2017). In science education, flipped classrooms have been related to increased conceptual clarity and more effective practical skills development than those of traditional lecture-based methods (Lage et al., 2000). Similarly, Talley and Scherer (2023) flipped an undergraduate psychology course, comparing it to previous semesters of the traditional format, and found that retention and engagement were greater in the flipped model of instruction.

Increased retention and engagement led to higher performance on the midterm and final exams. Davies et al. (2013) and Talley and Scherer (2023) also agreed that students valued the flexibility of being able to access course materials, most especially course lectures, from different mobile devices at a time suitable for them. In addition, flipped classrooms contribute to encouraging and improving skills in the domains of application, analysis, synthesis and evaluation which are all mental skills and processes not covered by traditional curricula. It also contributes to what is known as ownership for learning, where students can watch a video or lecture several

times. This model led to building confidence and enjoying the content and it provided more chances for interaction, learning, positive change and responsibility towards education (Akinyemi, 2014). Memler (2017) in their study on the efficacy of flipped classrooms on students' academic achievement and gender gap, observed that students' achievements did not differ by gender because there is no significant difference in achievement of males and females, when exposed to flipped classrooms,

Likewise, Gambari, Bello, Agboola and Adeoye (2021) in their study finds out that both males and female exposed to the flipped classroom method performed equally better. On the contrary, Chiquito, Castedo, Santos Lopes and Alarcon (2019) in their study found that female students performed higher than their male counterparts on their exposure to flipped classrooms and there was a significant difference in their achievement. In Delta State, Nigeria, secondary school education faces significant challenges, including large class sizes, limited instructional resources, and varying levels of student readiness (Akinyemi, 2014).

These are some of the issues that always seem to get in the way of traditional teaching methods, especially in subjects like biology, where practical application is necessary. The Flipped Classroom strategy offers a potential solution by optimizing the use of limited classroom time and providing students with more opportunities to engage with learning materials at their own pace. However, the actual implementation of this flipped classroom strategy in Delta State requires several preconditions: teacher training, access to technology, and student

adaptability. The evaluation of its effect on academic achievement in biology is highly essential in understanding its practicality and effectiveness in this region. This appraisal shall provide evidence for educators and policymakers in adopting innovative teaching methods that enhance learning outcomes.

### **Theoretical framework**

The flipped classroom strategy aligns closely with constructivist theories of learning, particularly those proposed by Jean Piaget and Lev Vygotsky. According to constructivist theory, learners actively construct their own knowledge through experiences and reflection (Bergmann & Sams, 2017). The flipped classroom creates opportunities for learners to engage in active, hands-on activities during class time (e.g., discussions, problem-solving), thereby supporting deeper learning through social interaction and collaborative activities. Piaget emphasizes that learners should be active participants in their learning process, and that cognitive development happens through interaction with the environment. The flipped classroom supports this by allowing students to explore content independently at home (constructing knowledge at their own pace), and then apply it in real-world contexts during classroom activities. Vygotsky's concept of the Zone of Proximal Development (ZPD) suggests that learning is most effective when students are guided by peers or teachers in tasks just beyond their current ability (Freeman, et al., 2014). The flipped classroom model allows for such peer-supported learning during class time, where students can collaborate and apply knowledge with scaffolding from peers or

instructors.

### **Purpose of the study**

The study aims to investigate the effect of flipped classroom strategy on secondary school students' academic achievement in biology in Delta State. The specific objectives:

1. determine the effect of the flipped classroom strategy on students' understanding of biology concepts compared to traditional teaching methods.
2. assess how the flipped classroom strategy influences students' performance in practical biology tasks.
3. evaluate the role of the flipped classroom strategy in enhancing students' engagement and participation in biology lessons.
4. identify the challenges associated with implementing the flipped classroom strategy in Delta State schools.

### **Hypotheses**

This study was guided by the following hypotheses which were tested at 0.05 level of significance:

- H01:** There is no significant difference in the academic achievement of students taught using the flipped classroom strategy and those taught using traditional teaching methods.
- H02:** The flipped classroom strategy has no significant effect on students' engagement and participation in biology lessons.

**H03:** There are no significant challenges in implementing the flipped classroom strategy in Delta State schools.

## Methods

This study adopted a quasi-experimental research design to examine the effect of the flipped classroom strategy on secondary school students' academic achievement in biology in Delta State. Specifically, a pre-test and post-test control group design was employed. The experimental group was taught using the flipped classroom strategy, while the control group was taught using traditional teaching methods.

The population for this study consisted of all senior secondary school students (SS II) offering biology in public secondary schools in Delta State, Nigeria. The sample for this study included 200 SS II students drawn from four randomly selected public secondary schools in Delta State. The schools were stratified based on location (urban and rural) to ensure a representative sample. A purposive sampling technique was used to select intact classes for the experimental and control groups, with 100 students in each group (50 per school). The instruments for data collection were:

- 1. Biology Achievement Test (BAT):** This is a researcher-developed test consisting of 40 multiple-choice questions covering selected topics in the SS II biology curriculum.
- 2. Engagement and Participation Scale (EPS):** This is a structured questionnaire designed to assess students' engagement and participation during biology lessons. It includes Likert-scale items ranging from "Strongly Agree" to "Strongly Disagree," focusing on classroom interaction, motivation, and active

learning behaviours.

- 3. Observation Checklist:** This was used to record classroom activities and monitor the implementation of the flipped classroom strategy.

## Procedure

- 1. Pre-Test:** Both Flip and conventional groups took the BAT before the commencement of the teaching intervention to assess their baseline knowledge.
- 2. Intervention:** The experimental group received flipped classroom instruction, including pre-class materials (videos, readings) and in-class active learning sessions. The intervention lasted for six weeks, covering the same biology topics in both groups.
- 3. Post-Test:** Both groups took the BAT again to measure the impact of the teaching strategies on their academic achievement.
- 4. Data Collection:** Data from the BAT, EPS, and observation checklists were collected for analysis.

Descriptive Statistics of Mean and standard deviation were used to describe the performance of students in the experimental and control groups, while Independent Samples t-test was used to compare the post-test scores of the experimental and control groups, determining the significance of the flipped classroom strategy on academic achievement. A paired Samples t-test was used to assess the pre-test and post-test performance within each group.

**Results**

**H01:** There is no significant difference in the academic achievement of students

taught using the flipped classroom strategy and those taught using traditional teaching methods.

**Table 1: Descriptive Statistics of Pre-Test and Post-Test Scores**

Group	N	Pre-Test Mean (SD)	Post-Test Mean (SD)	Mean Difference
Experimental Group	100	45.32 (8.45)	78.45 (6.32)	33.13
Control Group	100	44.98 (7.92)	60.89 (7.45)	15.91

The pre-test mean scores for both groups are similar, indicating that students in both groups had comparable baseline knowledge in biology. After the intervention, the post-test mean score of the experimental group (78.45) is significantly higher than that of the control group (60.89). The mean

difference in scores for the experimental group (33.13) is more than double that of the control group (15.91), suggesting a substantial effect of the flipped classroom strategy on students' academic performance.

**Table 2: Independent Samples t-test for Post-Test Scores**

Variable	t-value	df	p-value	Interpretation
Post-Test Scores	9.68	198	< 0.001	Significant difference

The t-test result shows a statistically significant difference between the post-test scores of the experimental and control groups ( $p < 0.001$ ). This indicates that the flipped classroom strategy significantly improved students' academic achievement compared to traditional teaching methods.

**H02:** The flipped classroom strategy has no significant effect on students' engagement and participation in biology lessons.

**Table 3: Engagement and Participation Scores**

Group	Mean Engagement Score (SD)	t-value	p-value	Interpretation
Experimental Group	4.25 (0.52)	7.84	< 0.001	Significant difference
Control Group	3.15(0.68)			

Engagement and participation scores are significantly higher for the experimental group (mean = 4.25) compared to the control group (mean = 3.15). This supports the hypothesis that the flipped classroom

strategy enhances students' engagement and participation during biology lessons.

**H03:** There are no significant challenges in implementing the flipped classroom strategy in Delta State schools.

**Table 4: Perception of Challenges in Implementing the Flipped Classroom Strategy**

<b>Challenges</b>	<b>Mean Score (SD)</b>	<b>t-value</b>	<b>p-value</b>
Access to technology	3.85 (0.74)	7.12	< 0.001
Teacher training and preparedness	4.12 (0.58)	9.45	< 0.001
Student adaptability	3.25 (0.68)	5.45	< 0.001
Parental support for pre-class learning	2.98 (0.89)	1.45	0.15
Classroom infrastructure	3.67 (0.81)	6.22	< 0.001

Access to technology, teacher training and preparedness, student adaptability, and classroom infrastructure were identified as significant challenges, with mean scores above the midpoint (3.0) and p-values below 0.05. These factors are critical in determining the successful implementation of the flipped classroom strategy in Delta State schools. However, parental support for pre-class learning had a mean score close to the midpoint (2.98) and a p-value above 0.05, indicating it is not perceived as a significant challenge.

### Discussion

The results of this study provide evidence that the flipped classroom strategy significantly improves academic achievement and engagement in biology among secondary school students compared to the traditional teaching methods. These findings are discussed below in detail.

The experimental group taught through the flipped classroom strategy showed a significantly higher post-test score as compared to the control group. A mean difference of 33.13 in the experimental group against 15.91 in the control group suggests that the flipped classroom strategy is more effective in enhancing students' understanding of biology concepts. This improvement can be attributed to several factors inherent in the flipped classroom model. Pre-class materials allowed students

to learn at their own pace, which is particularly beneficial for complex biology topics. Furthermore, in-class activities provided time for interactive learning to understand better and clear the misunderstandings through discussions and problem-solving exercises. These findings correspond to other studies showing flipped classrooms to be effective for improved academic performance in science education by Bishop and Verleger (2023) and Karaca and Ocak (2017).

The study also showed that the students in the experimental group had significantly higher engagement and participation scores than those in the control group. The flipped classroom model encourages active participation during class time, with students coming prepared with foundational knowledge from the pre-class materials. This is most likely to have contributed to their improved performance. Research supports the fact that active learning environments, such as those fostered by the flipped classroom, enhances motivation and critical thinking (O'Flaherty & Phillips, 2021).

While the flipped classroom strategy has been effective, Delta State has its challenges during implementation. Inaccessibility to technologies such as computers and good internet access creates barriers in accessing pre-class materials by students. Thirdly, teachers may still need adequate training to

support them in developing and maintaining flipped classroom content. Closing these gaps is paramount for this teaching strategy. Despite these challenges, significant opportunities were also noted in the same study. The flipped classroom approach helps to overcome some of the challenges of large class sizes by maximizing classroom time use for interactive learning. Furthermore, it allows the integration of technology into teaching, thus responding to trends within a globalized world. From the result of this study, significant challenges face the implementation of the Flipped Classroom strategy in public secondary schools in Delta State. These challenges are very important in understanding the feasibility of adopting the approach on a wider scale. One of the major challenges identified was access to technology, with a mean score of 3.85 ( $p < 0.001$ ). This means that students and schools face considerable barriers in accessing the digital tools needed for the flipped classroom model, such as computers, smartphones, and reliable internet connectivity. These findings support earlier studies that identify a lack of technology as a significant obstacle to the incorporation of new teaching approaches in developing countries (Tondeur et al., 2017). Inadequate access to technology limits the ability of students to go through pre-class learning material, hence undermining the effectiveness of the flipped classroom approach.

The second most serious challenge identified was that of training and preparedness of teachers, with a mean score of 4.12 ( $p < 0.001$ ). Many teachers in Delta State may lack the skills and knowledge to create and deliver high-quality pre-class instructional materials or facilitate active learning in the classroom. This finding

echoes studies emphasizing the need for professional development programs to equip teachers with the competencies required for modern teaching strategies (OECD, 2019). Addressing this gap is essential for ensuring that the flipped classroom model is implemented effectively. With an average of 3.25, another significant problem was the students' adaptability ( $p < 0.001$ ). Students who are used to traditional, lecture-based methodologies may struggle with the idea of independent learning in a flipped classroom. This addresses the issue of gradual implementation and providing support mechanisms to help students develop the requisite skills for independent learning and managing their time accordingly (Bishop & Verleger, 2023). The physical facilities, including the facility for collaborative and practical activities in the classroom, were also a big challenge = 3.67,  $p < 0.001$ . Most schools in Delta State lack the physical resources to support the interactive learning activities central to the flipped classroom approach. This finding is consistent with studies indicating that inadequate infrastructure can hinder the adoption of innovative teaching strategies (Akinyemi, 2014). Improving classroom environments is crucial for the full realization of the benefits of this model. Surprisingly, the lack of parental support for pre-class learning was not seen as a major challenge by the instructors (mean = 2.98,  $p = 0.15$ ). This indicates that parents are either supportive or neutral about their children engaging in pre-class materials at home. However, this does not rule out the fact that parent-focused interventions may be necessary to ensure that they provide necessary encouragement and monitoring.

## Conclusion and Recommendations

The flipped classroom strategy enhances academic achievement and engagement in biology among secondary school students in Delta State. This study reiterates the potential of innovative teaching strategies to enhance learning outcomes, especially in resource-poor settings. In adopting this innovative approach, schools in Delta State can create an environment that is more engaging and effective for learning, preparing students with the knowledge and skills necessary for academic success. While the flipped classroom strategy offers immense promise for enhancement in academic achievement and engagement, there are also some striking challenges in its implementation in Delta State. The effort to overcome these barriers will be highly needed from schools, policymakers, and

communities. It would be an avenue for opening up the education system in Delta State to more effective and innovative teaching methodologies.

Based on these findings, the following recommendations were made:

1. Schools should adopt the flipped classroom strategy as a complement to traditional teaching methods.
2. Educational stakeholders should address infrastructure and training gaps to ensure the effective implementation of flipped classrooms.
3. Further research should explore the long-term effects of the flipped classroom strategy on students' academic achievement and its applicability to other subjects.

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