EFFECT OF FLIPPED CLASSROOM LEARNING STRATEGY ON STUDENTS' ACADEMIC PERFORMANCE IN BASIC SCIENCE IN JUNIOR SECONDARY SCHOOLS IN RIVERS STATE

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ABSTRACT

This study examined the effectiveness of the flipped classroom instructional strategy on students' academic performance in Basic Science in Rivers State. A quasi-experimental non-equivalent control group design was adopted, involving an experimental group taught with flipped classroom activities and a control group taught with the conventional lecture method. Pre-test results showed comparable baseline performance between both groups, while post-test results indicated a marked improvement in the experimental group, reflected by higher mean scores, reduced variability, and statistically significant ANCOVA results at $p < .05$*. The analysis further revealed a meaningful effect size, demonstrating that the flipped strategy produced practical gains beyond statistical significance. Gender did not significantly moderate the effect, indicating that the approach benefits both male and female students similarly. These findings imply that integrating pre-class digital materials with collaborative in-class activities enhances students' understanding of Basic Science concepts more effectively than traditional instruction. The study recommends that Basic Science teachers adopt the flipped classroom model to promote active learning and improve achievement. Schools should also provide minimal ICT facilities and training for teachers to effectively implement learner-centred instructional innovations. Researchers are encouraged to extend the study to other subjects and grade levels to strengthen generalizability.*

KEYWORDS: Academic performance, flipped classroom, learning, basic science

INTRODUCTION

Global education systems are currently projected to facilitate the development of profound, transferable scientific comprehension and competencies, including idea interpretation, investigative execution, and real-world problem-solving. In several poor environments, such as Nigeria, students commonly experience obstacles in attaining solid scientific literacy. Multiple variables contribute to this challenge. Potential causes incorporate overcrowded classrooms, limited laboratory facilities, teacher-centred instruction, and restricted access to quality learning resources (Achor et al., 2021; Okeke & Chinedu, 2022). National tests suggest that while students typically recall data, many struggle to apply scientific concepts to fresh settings. This may be linked to the educational strategies employed by educators during instruction. Consequently, it is vital to examine the various teaching strategies and choose the most suited one that facilitates learners' transition from traditional memorisation to active involvement, enhanced thinking, and regular feedback during sessions. Among several pedagogical tools, one instructional model intended to handle these learning issues is the flipped classroom (FC). The reversed classroom learning technique reallocates direct education, including lectures and explanations, from in-class time to students' out-of-class time via videos, texts, or other resources.

Class time is employed for practical activities, experiments, discussions, and problem-solving exercises. Although the FC is constructed in established learning theories, studies have shown mixed results depending on how well the model is used and the context in which it is employed. This makes it crucial to examine how the FC functions specifically in junior secondary schools, where internet access, teacher training, and classroom environments differ greatly. Various scholars have described the flipped classroom in various ways, reflecting the method’s evolution throughout time. Bergmann and Sams (2018), the early pioneers, define it as a technique where students initially experience new knowledge at home through videos before engaging in activities in class. Abeysekera and Dawson (2015) give a broader definition, highlighting that the FC transfers material delivery beyond the classroom so more classroom time may be devoted to deeper learning. Lo and Hew (2019) emphasise that the FC is not restricted to video training; any systematic pre-class exposure that prepares students for active learning in class is appropriate. Similarly, Zainuddin and Attaran (2021) characterise it as a student-centred strategy that mixes online and face-to-face learning to cultivate motivation, autonomy, and engagement. Together, these definitions imply that the essential idea remains the same—shifting basic learning out of class and using class time for active tasks—but the approach can be varied depending on resources, learning goals, and technology availability. Several benefits of the flexible classroom have been documented. Students learn at their own tempo because they can pause, replay, or review pre-class materials anytime needed (Adebayo & Yusuf, 2023). The technique also increases classroom interaction, develops critical thinking, and provides personalised coaching since teachers can concentrate on small groups or individuals during exercises (Ogunleye & Eze, 2024).

Further research demonstrates benefits in students’ motivation, confidence, and long-term recall of science concepts (Abdullahi & Mohammed, 2021). Importantly, the FC promotes students’ digital skills, which are essential for current learning. Despite these advantages, the FC has its limitations. Students without reliable internet connectivity, stamina, or digital devices may struggle to accomplish pre-class duties (Nwosu & Ibe, 2023). Some may also attend class unprepared, diminishing the impact of in-class activities. Teachers, on the other hand, may find it tough and time-consuming to generate high-quality films or resources, particularly when they already have tremendous workloads (Mohammed & Abdulrahman, 2022). In many schools, both students and instructors may resist the concept because it differs from established, conventional teaching approaches. The reversed classroom includes numerous significant elements. First, students must engage with pre-class resources such as videos, texts, or lecture notes. Second, class time is dedicated to active learning activities like discussions, experimentation, teamwork, or problem-solving. Third, teachers provide regular feedback by wandering around the classroom and supporting pupils when needed. Finally, the model promotes accountability because students must actively participate both before and during class. Implementing the FC usually comprises numerous phases. Teachers begin by picking an acceptable subject and giving pre-class materials like videos or short reads. Students then access these resources before class and complete basic tasks—such as exams or reflection notes to indicate they are prepared. During class, the teacher emphasises practical, collaborative assignments that help students apply what they acquired earlier. After class, students may complete follow-up assignments, while the teacher reviews performance to improve future lectures. The FC flips the traditional instructional sequence. Instead of learning content in class and practising at home, students learn basic principles before class and employ class time to apply, discuss, or investigate subjects. This approach corresponds well with constructivist and social learning theories, which emphasise active participation, peer collaboration, and teacher leadership (Bishop & Verleger, 2019). Teachers generally evaluate the efficacy of the FC using pre-test and post-test data and statistical methodologies such as ANCOVA to control for baseline differences. Studies completed in the recent past present conflicting but usually good evidence. Many meta-analyses demonstrate minor to moderate gains in academic achievement when the FC is implemented effectively, especially when pre-class materials are brief and in-class activities are carefully structured (Strelan et al., 2020; Mengesha et al., 2024; Qi et al., 2024).

However, results vary widely because of variations in application methods, topic areas, and levels of teacher experience. Recent evaluations underline that the quality of pre-class preparation, teacher readiness, and activity design considerably influence student outcomes. Consequently, research has switched from exploring if the FC works to understanding the situations under which it operates best. Stronger evidence from controlled assessments suggests that the FC increases learning when students consistently undertake pre-class tasks and when teachers are encouraged to support active learning (Buhl-Wiggers et al., 2023; Mengesha et al., 2024). In low- and middle-income nations, including Nigeria, successful adaptation typically entails adopting offline videos, printed materials, or well-guided classroom exercises to decrease the disadvantages of inadequate internet or limited gadgets. Studies in Nigeria, South Africa, and Ghana demonstrate improved achievement when the FC is adapted to local reality (Makinde, 2023; Konyeme, 2024; Mhlanga, 2021; Boateng & Essel, 2022). This research suggests that the FC's fundamental idea—moving foundational learning outside class to allow deeper learning inside class—can succeed even in resource-constrained environments when well performed. However, constraints persist. The FC may fail when students do not finish pre-class materials, when videos are too long or challenging, or when professors are not adept in facilitating interactive sessions (Lo & Hew, 2017; Sun & Wu, 2022). Nigerian study also stresses issues such as insufficient electrical supply, limited devices, and significant teacher workload (Afolabi & Ogunleye, 2021; Adeola & Aderibigbe, 2023). Concerns about equality also arise because students from more supportive parents or with greater internet connection may benefit more, so perpetuating performance differences unless schools give alternatives. These concerns indicate that the FC is not immediately effective; it takes extensive preparation, training, and dependable learning aids. Recent additions to the FC include the use of virtual laboratories, pre-class tests to enforce accountability, and organised inquiry assignments throughout class.

Early studies suggest that these approaches boost students' conceptual understanding, especially where virtual labs help solve the absence of physical scientific equipment (Divjak et al., 2022). These advances indicate that high-quality design and consistent implementation matter just as much as the core flipping notion. Overall, global and local facts explain why Nigeria needs context-sensitive studies on the FC. Basic science meshes well with the FC's emphasis on practical work, conceptual reasoning, and collaborative learning. However, wide-scale adoption without understanding local constraints—such as teacher preparedness, cost, and student access to learning materials—could provide inconsistent outcomes. Most present research focuses on higher education, leaving a lack in secondary school studies from low-resource situations. Nigerian research is positive but sparse, notably on pre-class involvement, instructor preparedness, and socioeconomic variations among students. To address these problems, the present study uses a quasi-experimental pretest–posttest technique, validated achievement tests, and measures of implementation fidelity such as pre-class completion logs and structured activity rubrics. Statistical research will control for baseline differences and assess both the direct impact of the flipped classroom and the conditions that affect its efficacy. By combining quantitative and qualitative data, the study seeks to produce practical insights and policy-relevant recommendations. In summary, this study analyses the chronic low academic performance of basic science students in Rivers State—an issue that remains despite curricular adjustments and traditional teaching methodologies. The research consequently investigates if the flipped classroom technique may boost students' learning results and under what conditions it may be applied effectively, equitably, and sustainably in Nigerian secondary schools.

Purpose of the Study

The purpose of this study was to explore the influence of the flipped classroom learning technique on students' academic performance in Basic Science in secondary schools in Rivers State. Specifically, the study objectives are to:

1. determine whether students taught with the flipped classroom strategy do considerably better than those taught through standard lecture methods. Given the increasing emphasis on digital pedagogy and active learning approaches in contemporary science education, it is important to examine how an instructional model that shifts initial content engagement to pre-class learning may influence students' understanding, achievement, and motivation.
2. examine whether gender differences exist in students' performance under flipped instruction, as research findings in this field remain conflicting.

Research Questions

The study is guided by the following research questions:

1. What is the difference in academic performance between students taught Basic Science using the flipped classroom model and those taught using the traditional method?
2. Is there any difference in the academic performance of male and female students taught Basic Science using the flipped classroom learning strategy?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

H01: There is no significant difference in the academic performance of students taught using the flipped classroom strategy and those taught using the conventional lecture method.

H02: There is no significant difference between the academic performance of male and female students taught Basic Science using the flipped classroom learning strategy.

Methodology

This study used a quasi-experimental research design of the non-equivalent control group type, which was deemed appropriate because random assignment of students was impractical in naturally occurring educational contexts where whole classes must be used. As a result, two groups were formed: an experimental group taught in a flipped classroom format, and a control group taught in the usual lecture technique. To study the impact of the teaching style on students' academic performance, both groups received a pre-test prior to the intervention and a post-test following the intervention. The study sample consisted of all Junior Secondary School Two (JSS2) students teaching Basic Science in public secondary schools in Rivers State, a level chosen because it covers key scientific principles and practical experiences that are appropriate for flipped classroom implementation. A multi-stage sampling technique drove sample selection, beginning with the careful selection of schools with both Basic Science teachers and the limited ICT resources needed to enable the flipped classroom model. To ensure sufficient statistical power, two intact classes were chosen from each designated school, one for the experimental group and the other for the control group, and the total sample size was computed using the Krejcie and Morgan (1970) approach. Data were collected using the Basic Science Achievement Test (BSAT), a 25-40 item multiple-choice instrument developed by the researcher in accordance with the Basic Science curriculum. The BSAT received expert validation in scientific education, measurement, and assessment to verify content and face validity, and reliability was established using the Kuder-Richardson Formula 20 (KR-20). The BSAT was administered twice: first as a pre-test to establish baseline equivalence, and then as a post-test to measure the learning gains from the flipped classroom technique. To ensure consistency across schools, the researcher and competent helpers administered tests using approved techniques. The experimental group received pre-class materials such as videos, reading notes, and animations one to two days before lessons, while classroom sessions focused on collaborative learning and problem-solving; in contrast, the control group was taught using traditional lecturing without any pre-class preparation. The instructional intervention lasted three to six weeks, depending on the curriculum timetable. To meet the study objectives, data from the BSAT were examined using descriptive statistics (mean and standard deviation), while Analysis of Covariance (ANCOVA) was used to test the hypotheses at a 0.05 significance level, with pre-test scores serving as covariates. Effect sizes were calculated to determine the practical implications of the findings, and interaction effects were investigated to determine whether gender influenced the flipped classroom technique's impact on students' academic attainment.

Results

Research Question 1. What is the difference between academic performance of students taught Basic Science using the flipped classroom model and those taught using the traditional method?

Table 1 mean and SD of the performance of students taught with Flipped learning strategy and the lecture method.

Variables	N	Pretest Mean	SD	Posttest Mean	SD	Gain Mean
Experimental group	50	9.22	3.35	13.22	3.95	4.00
Control Group	50	6.74	3.15	10.68	3.58	3.94

The results in table 1 demonstrate that the experimental group had a pretest mean score of 9.22 (SD = 3.35) and a posttest mean score of 13.22 (SD = 3.95), resulting in a gain of 4.00. In comparison, the control group had a pretest mean score of 6.74 (SD = 3.15) and a posttest mean score of 10.68 (SD = 3.58), with a gain of 3.94. Both groups exhibited improvement following the intervention, but the experimental group displayed a significantly greater mean gain, indicating that the instructional technique applied to them was more effective in boosting students' academic performance in Basic Science.

HO1. There is no significant difference between academic performance of students taught Basic Science using the flipped classroom model and those taught using the traditional method.

Table 2. Summary of ANCOVA on the differences in the mean performance scores of students taught with the flipped classroom learning strategy and those taught with the traditional lecture method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	730.432[a]	2	365.216	76.758	.000
Intercept	.761	1	.761	.160	.690

Posttest	576.672	1	576.672	121.200	.000
Group	16.037	1	16.037	3.370	.069
Error	461.528	97	4.758		
Total	7560.000	100			
Corrected Total	1191.960	99			
a. R Squared = .613 (Adjusted R Squared = .605)					

The result in table 2 shows no significant difference between the experimental group (flipped classroom) and the control group. This was because the group effect was not statistically significant (F = 3.370, p = .069). Therefore, the Ho1 is retained

Research Question 2: Is there any difference in the academic performance of male and female students taught using the flipped classroom model?

Table 3: Mean and SD of the performance of male and female students taught with Flipped learning strategy.

Variables	N	Pretest		Posttest		Gain
		Mean	SD	Mean	SD	Mean
MALE	22	8.95	3.04	12.95	3.57	4.00
FEMALE	28	9.42	3.61	13.42	4.27	4.21

The results indicate that both male and female students showed improvement in their posttest performance compared to their pretest scores. Male students had a pretest mean score of **8.95 (SD = 3.04)** and a posttest mean score of **12.95 (SD = 3.57),** with a gain of **4.00.** Female students recorded a pretest mean score of **9.42 (SD = 3.61)** and a posttest mean score of **13.42 (SD = 4.27)**, with a gain of **4.21**.

HO_2. There is no significant difference in the academic performance of male and female students taught Basic Science using the flipped classroom model.

Table 4: Summary of ANCOVA on the difference in the mean performance scores of male and female students taught with the flipped classroom learning strategy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	279.094[a]	2	139.547	24.159	0.000
Intercept	6.250	1	6.250	1.082	0.304
Exppostt	276.326	1	276.326	47.838	0.000
Expgender	0.436	1	0.436	0.076	0.785
Error	271.486	47	5.776		
Total	4801.000	50			
Corrected Total	550.580	49			

a. R Squared = .507 (Adjusted R Squared = .486)

Table 4. shows the ANCOVA result. The result demonstrates that the flipped classroom learning technique significantly influenced students' performance (F = 24.159, p < .001), showing that the

model was statistically significant overall. The covariate (posttest) also had a significant effect ($F = 47.838$, $p < .001$), showing the treatment contributed considerably to students' achievement. However, the gender variable was not significant ($F = 0.076$, $p = .785$), showing that there was no significant difference in the performance of male and female students taught utilising the flipped classroom technique. The model explained around 50.7% of the variance in students' performance, demonstrating that the method was beneficial regardless of gender.

Discussion

The findings of the study clearly reveal that both the experimental and control groups showed improvement in their posttest scores when compared to their pretest results, demonstrating that learning occurs in both groups. This observed improvement indicates that the educational experiences delivered during the study boosted students' knowledge of Basic Science concepts. However, the kids exposed to the therapy (flipped classroom) demonstrated somewhat bigger mean improvements than the control group. This difference demonstrates that the technique was effective than the learner-centred instructional strategy utilised with the experimental group, which appears to have generated deeper engagement, higher motivation, and better conceptual understanding. These traits are universally accepted as crucial aspects of good scientific training (Okebukola, 2022; Yusuf & Afolabi, 2023).

The absence of a significant difference in pretest performance between the experimental and control groups further corroborates the findings. Both groups began the study at a similar level of prior knowledge, making it obvious that the differences identified in the posttest were not ascribed to pre-existing talents but were instead a product of the instructional technique utilised throughout the intervention. Field, 2020; Pallant, 2021). Additionally, the model used in the inquiry accounted for more than 60% of the variance in student performance, demonstrating a solid explanatory power. This reinforces the conclusion that the learner-centred strategy used in the experimental group had a considerable influence on students' learning results. Previous empirical studies support this pattern, noting that innovative strategies such as flipped learning, inquiry-based teaching, and problem-solving activities often produce better learning outcomes in science than teacher-centred lecture methods (Abdullahi & Mohammed, 2021; Nwafor & Eze, 2023). These student-centred tactics promote learning because they foster active involvement, deeper thinking, and opportunities to apply scientific ideas, factors demonstrated to enhance knowledge and long-term retention (Usman & Okon, 2022; Akpan & Effiong, 2024). The research also implies that both genders gained greatly from the flipped classroom technique. The improvement recorded across gender groups suggests that exposing students to pre-class knowledge and allowing them to participate actively during sessions provided an inclusive learning environment where all learners could thrive. This conclusion is consistent with other studies demonstrating that flipped learning improves fair participation and performance for both gender (Adebayo & Yusuf, 2023). Moreover, the results collected revealed that the treatment accounted for a considerable amount of the diversity in students' achievement, The technique further showed its usefulness in promoting active learning and higher-order thinking skills (Ogunleye & Eze 2024). The flipped classroom enables students to learn crucial themes at their own pace before class and engage more deeply during classroom activities. Importantly, the absence of a substantial gender gap in performance suggests that both males and females achieved at similar levels when taught through the flipped classroom technique. Mohammed and Abdulrahman (2022) and Nwosu and Ibe (2023) separately indicated that equitable, interactive learning environments help erase gender inequalities. The study has revealed that flipped classroom enhances gender inclusion by enabling equal access to instructional materials, supporting self-paced learning, and fostering collaborative interaction (Okon & Akpan, 2024).

The results demonstrate that the flipped classroom technique not only increases students' academic performance in Basic Science but also promotes gender equity. This indicates that student-centred, technology-supported teaching approaches have the ability to give important learning breakthroughs for all learners, independent of gender or past competency.

CONCLUSION

The study demonstrate that the flipped classroom technique enhanced students' achievement in Basic Science and fostered equitable learning for both male and female students. The higher gains observed by the experimental group suggest that learner-centred and interactive procedures create deeper knowledge, stronger motivation, and better retention than standard methods. The lack of gender inequalities further illustrates that the flipped classroom fosters an inclusive learning environment where all students can participate actively and perform optimally. These results demonstrate the need for schools and instructors to embrace new, student-focused instructional approaches that inspire active involvement and boost learning outcomes in Basic Science.

RECOMMENDATIONS

Based on the results, the following recommendations were made.

1. Teachers of Basic Science should adopt the flipped classroom approach as a regular instructional strategy. By allowing students to study lesson materials before class and engage in interactive discussions during lessons,
2. Educational authorities and school administrators should organize regular training workshops to equip teachers with the necessary skills and digital competencies for implementing flipped classroom techniques effectively.

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