

Flipped Classroom Approach and Mathematics Learning Outcomes Among Students In Selected Tertiary Institutions In Kogi State, Nigeria

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Abstract

The study explores the effectiveness of the flipped classroom approach on mathematics learning outcomes in Nigerian tertiary institutions, particularly in Kogi State. It addresses the persistent poor learning outcomes in mathematics and aims to enhance students' academic achievement, conceptual understanding, problem-solving skills, and engagement. Using a quasi-experimental design with 300 undergraduate students divided into experimental and control groups, data were collected through various instruments. Findings indicate that the flipped classroom approach leads to significantly better outcomes compared to traditional lecture methods. The study concludes that this instructional strategy is effective for improving mathematics learning and recommends its integration along with enhanced digital learning resources and professional development for lecturers.

Keywords: classroom, Flipped, Mathematics, Learning Outcomes,

Introduction

It is often acknowledged that science, technology, and social progress all depend on mathematics. For fields like engineering, computer science, economics, statistics, artificial intelligence, and data science, it offers the theoretical foundation, making it essential to both domestic growth and international competitiveness. As a result, governments, academic institutions, and international organizations that want to equip students with the skills needed for the twenty-first century economy continue to place a high priority on improving mathematics education (Organization for Economic Cooperation and Development [OECD], 2023; UNESCO, 2021). Despite its significance, students' performance in mathematics remains inadequate in many countries, especially in developing ones where ongoing issues with conceptual understanding, problem-solving skills, and classroom engagement continue to compromise learning outcomes (OECD, 2023).

The Nigerian educational system has also faced ongoing issues in math education. Public examination and institutional assessment results have regularly shown low levels of student achievement in mathematics, causing worry among educators, curriculum creators, and legislators. Several Nigerian researchers have ascribed this difficulty to the continuous use of

teacher-centered instructional methodologies that prioritize memory and procedural information over conceptual understanding, critical thinking, and active learner involvement (Makinde, 2020). Because mathematics serves as the basis for many scientific and technology programs provided by postsecondary institutions, poor learning outcomes at this level may have a negative impact on students' academic progression, employment, and contribution to national development.

The increasing integration of digital technologies into higher education has created opportunities for the adoption of innovative pedagogical approaches capable of addressing these challenges. Among such innovations, the flipped classroom approach has emerged as one of the most widely adopted learner centred instructional models. Unlike the conventional lecture method, where classroom time is devoted primarily to content delivery, the flipped classroom requires students to engage with instructional materials before class while face to face sessions are reserved for collaborative learning, discussion, problem solving, and application of concepts (Creswell & Creswell, 2023). This instructional model encourages students to assume greater responsibility for their learning while enabling lecturers to provide individualized guidance and immediate feedback during classroom activities. Consequently, the flipped classroom aligns closely with contemporary educational philosophies that emphasize active learning, collaboration, and meaningful knowledge construction.

Growing empirical evidence suggests that the flipped classroom approach has a positive influence on mathematics learning outcomes across different educational contexts. International studies have reported significant improvements in students' academic achievement, conceptual understanding, problem solving skills, motivation, and engagement following exposure to flipped classroom instruction (Bond *et al.*, 2020; Shi *et al.*, 2023). Similarly, Nigerian studies have shown that students exposed to flipped classroom instruction outperform those taught through conventional lecture methods in terms of achievement, retention, and interest in mathematics (Makinde, 2020; Usman & Muhammad, 2025). These findings indicate that the flipped classroom approach provides a more interactive and learner centred environment capable of enhancing students' mathematics learning experiences.

Mathematics learning outcomes encompass academic achievement, conceptual understanding, problem solving skills, and student engagement, all of which are essential indicators of effective mathematics learning. Students with strong conceptual understanding are better able to explain mathematical ideas, establish relationships among concepts, and apply knowledge in new situations, while effective problem solving skills and active engagement enhance motivation, persistence, and overall learning outcomes (National Council of Teachers of Mathematics (NCTM), 2020; Bond *et al.*, 2020). Despite growing evidence supporting the effectiveness of the flipped classroom approach, empirical studies in Nigerian tertiary institutions remain limited, with most existing research focusing on secondary schools and

academic achievement. Consequently, there is insufficient evidence on the influence of the flipped classroom approach on conceptual understanding, problem solving skills, and student engagement among tertiary institution students, particularly in Kogi State.

Against this background, the present study investigates the impact of the flipped classroom approach on mathematics learning outcomes among students in selected tertiary institutions in Kogi State, Nigeria. By examining its influence on academic achievement, conceptual understanding, problem solving skills, and student engagement, the study seeks to provide empirical evidence that will contribute to the advancement of learner centred mathematics instruction and support ongoing efforts to improve the quality of higher education in Nigeria.

Statement of the Problem

The quality of mathematics education in Nigeria's higher education institutions is concerning, with students facing difficulties in understanding concepts and maintaining engagement, leading to poor academic performance and reduced interest in STEM fields. A significant factor contributing to these challenges is the reliance on conventional lecture methods, which limit interaction and critical thinking. The flipped classroom approach, which promotes collaborative learning and discussion, has shown promise in enhancing academic achievement and engagement. However, most studies on this method focus on secondary education, leaving a gap in evidence regarding its efficacy in tertiary institutions, particularly in Kogi State. This study aims to investigate the impact of the flipped classroom method on students' academic achievement, conceptual understanding, problem solving skills, and engagement in selected tertiary institutions in Kogi State, Nigeria.

Purpose of the Study

The purpose of this study was to investigate the impact of the flipped classroom approach on mathematics learning outcomes among undergraduate students in selected tertiary institutions in Kogi State, Nigeria. Specifically, the study sought to:

1. determine the effect of the flipped classroom approach on students' academic achievement in mathematics;
2. determine the effect of the flipped classroom approach on students' conceptual understanding of mathematics;
3. determine the effect of the flipped classroom approach on students' problem solving skills in mathematics; and
4. determine the effect of the flipped classroom approach on students' engagement in mathematics learning.

Research Hypotheses

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

- Ho1: There is no statistically significant difference in the academic achievement of students taught mathematics using the flipped classroom approach and those taught using the conventional lecture method.
- Ho2: There is no statistically significant difference in the conceptual understanding of students taught mathematics using the flipped classroom approach and those taught using the conventional lecture method.
- Ho3: There is no statistically significant difference in the problem solving skills of students taught mathematics using the flipped classroom approach and those taught using the conventional lecture method.
- Ho4: There is no statistically significant difference in the engagement of students taught mathematics using the flipped classroom approach and those taught using the conventional lecture method.

Literature Review

The flipped classroom approach has emerged as one of the most widely adopted learner centred instructional strategies in contemporary education because of its potential to promote active learning, collaboration, and meaningful knowledge construction. Rooted in constructivist learning principles, the approach reverses the traditional teaching sequence by requiring students to engage with instructional materials before class, while classroom time is devoted to interactive learning activities such as discussions, collaborative problem solving, peer instruction, and guided practice (Creswell & Creswell, 2023). This instructional model transforms the lecturer's role from a transmitter of knowledge to a facilitator of learning, thereby creating opportunities for students to assume greater responsibility for their learning and actively participate in the instructional process. The increasing integration of digital technologies into higher education has further accelerated the adoption of the flipped classroom approach because it provides flexible access to instructional resources and supports self paced learning (Shi *et al.*, 2023).

Mathematics learning outcomes refer to the measurable knowledge, skills, competencies, and behavioural changes students acquire through mathematics instruction. Contemporary mathematics education recognizes that effective learning extends beyond academic achievement to include conceptual understanding, problem solving skills, and student engagement (NCTM, 2020). Academic achievement reflects students' mastery of mathematical knowledge as measured through formal assessments, whereas conceptual understanding refers to learners' ability to explain mathematical concepts, establish relationships among ideas, and apply knowledge in unfamiliar situations. Problem solving skills involve the capacity to analyze mathematical problems, select appropriate solution

strategies, and evaluate results, while student engagement encompasses behavioural, cognitive, and emotional participation in learning activities (Bond et al., 2020). These dimensions collectively provide a comprehensive assessment of students' mathematics learning outcomes.

Theoretical Framework

This study is anchored on Constructivist Learning Theory, Social Learning Theory, and Cognitive Load Theory. Constructivist Learning Theory, advanced by Jean Piaget and Lev Vygotsky, posits that learners actively construct knowledge through interaction, exploration, and reflection rather than passively receiving information (Schunk, 2020). This perspective aligns closely with the flipped classroom approach, where students independently acquire foundational knowledge before class and subsequently participate in collaborative learning and problem solving activities during classroom sessions. Social Learning Theory, developed by Albert Bandura, emphasizes learning through observation, modelling, interaction, and collaboration. The interactive nature of flipped classroom instruction provides opportunities for peer learning, cooperative problem solving, and immediate feedback, thereby enhancing students' engagement, confidence, and academic performance (Schunk, 2020). Cognitive Load Theory, proposed by John Sweller, explains that learning is optimized when instructional activities reduce unnecessary cognitive demands and facilitate efficient processing of information within learners' working memory (Sweller et al., 2023). By distributing learning activities between pre class preparation and classroom application, the flipped classroom minimizes extraneous cognitive load while promoting deeper conceptual understanding and long term retention.

Empirical Review

Empirical evidence consistently demonstrates the effectiveness of the flipped classroom approach in improving mathematics learning outcomes. International studies have shown that students exposed to flipped classroom instruction achieve significantly higher academic achievement, conceptual understanding, problem solving skills, and engagement than students taught through conventional lecture methods (Bond et al., 2020; Shi et al., 2023; Eltahir et al., 2025). Similarly, Nigerian studies have reported positive effects of the flipped classroom approach on students' mathematics achievement, retention, and interest (Makinde, 2020). The reviewed studies attribute these improvements to active learning, collaborative problem solving, immediate feedback, and increased learner engagement. However, most Nigerian studies have focused on secondary school students and have examined academic achievement as the primary outcome, with limited attention given to conceptual understanding, problem solving skills, and student engagement within tertiary institutions.

Methodology

This study utilized a quasi-experimental, non-equivalent pretest posttest control group design to assess the effects of the flipped classroom method on mathematics learning outcomes among undergraduate students in Kogi State, Nigeria. Conducted across four selected tertiary institutions, the research involved 300 participants, 150 in an experimental group and 150 in a control group. Various instruments, including the Mathematics Achievement Test (MAT) and Mathematics Learning Outcomes Questionnaire (MLOQ), measured academic success and engagement. The experimental group engaged with flipped classroom techniques, accessing resources before class, while the control group followed conventional lectures. Pretests and posttests were administered to evaluate performance, with data analyzed using mean, standard deviation, and ANCOVA at a 0.05 significance level. Reliability coefficients for the instruments met acceptable thresholds, ensuring valid findings.

Results**Table 1: Distribution of Respondents by Gender**

Gender	Frequency	Percentage (%)
Male	168	56.0
Female	132	44.0
Total	300	100.0

Source: Field Survey (2026)

Table 1 shows that 168 (56.0%) of the respondents were male, while 132 (44.0%) were female. This indicates that both male and female students participated in the study, although male students constituted a slightly higher proportion of the respondents.

Research Question 1: What is the effect of the flipped classroom approach on students' academic achievement in mathematics?

Table 2: Mean, Standard Deviation, and Mean Gain Scores of Students' Academic Achievement in Mathematics

Group	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
Experimental	150	43.82	7.14	76.54	6.38	32.72
Control	150	44.16	6.89	60.83	7.21	16.67

Source: Field Survey (2026)

Table 2 presents the pretest and posttest mean scores of students in the experimental and control groups on mathematics achievement. The results indicate that both groups had

comparable mean scores before the intervention, suggesting that they possessed similar entry characteristics. Following the eight week instructional period, students exposed to the flipped classroom approach recorded a substantially higher posttest mean score than those taught using the conventional lecture method. The higher mean gain observed among students in the experimental group suggests that the flipped classroom approach contributed positively to their mathematics achievement.

Research Question 2: What is the effect of the flipped classroom approach on students' conceptual understanding of mathematics?

Table 3: Mean, Standard Deviation, and Mean Gain Scores of Students' Conceptual Understanding

Group	N	Pretest	Pretest	Posttest	Posttest	Mean
		Mean	SD	Mean	SD	Gain
Experimental	150	2.61	0.48	3.64	0.32	1.03
Control	150	2.58	0.51	2.97	0.43	0.39

Source: Field Survey (2026)

Table 3 presents the pretest and posttest mean scores of students' conceptual understanding in the experimental and control groups. The pretest results show that both groups had similar levels of conceptual understanding before the commencement of the treatment. The experimental group recorded a pretest mean score of 2.61 (SD = 0.48), while the control group recorded a mean score of 2.58 (SD = 0.51). Following the eight week instructional intervention, the experimental group recorded a posttest mean score of 3.64 (SD = 0.32), whereas the control group recorded a posttest mean score of 2.97 (SD = 0.43). The experimental group also obtained a higher mean gain of 1.03 compared with the control group's mean gain of 0.39. The higher posttest mean score and mean gain recorded by the experimental group indicate that students exposed to the flipped classroom approach developed a better understanding of mathematical concepts than those taught using the conventional lecture method. The findings therefore suggest that the flipped classroom approach positively enhanced students' conceptual understanding of mathematics.

Research Question Three: What is the effect of the flipped classroom approach on students' problem solving skills in mathematics?

Table 4: Mean, Standard Deviation, and Mean Gain Scores of Students' Problem Solving Skills

Group	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
Experimental	150	2.54	0.46	3.58	0.35	1.04
Control	150	2.56	0.49	2.89	0.41	0.33

Source: Field Survey (2026)

Table 4 presents the pretest and posttest mean scores of students' problem solving skills in the experimental and control groups. Before the treatment, both groups had similar levels of problem solving skills, with the experimental group recording a pretest mean score of 2.54 (SD = 0.46) and the control group recording a mean score of 2.56 (SD = 0.49). This indicates that there was no noticeable difference between the two groups prior to the intervention. At the end of the eight week treatment period, the experimental group recorded a posttest mean score of 3.58 (SD = 0.35), while the control group recorded a posttest mean score of 2.89 (SD = 0.41). The experimental group also obtained a higher mean gain of 1.04 compared with the control group's mean gain of 0.33. The results indicate that students taught using the flipped classroom approach demonstrated greater improvement in mathematical problem solving skills than those taught using the conventional lecture method. This suggests that the flipped classroom approach positively influenced students' ability to analyze mathematical problems, apply appropriate solution strategies, and solve mathematical tasks effectively.

Research Question 4: What is the effect of the flipped classroom approach on students' engagement in mathematics learning?

Table 5: Mean, Standard Deviation, and Mean Gain Scores of Students' Engagement in Mathematics Learning

Group	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
Experimental	150	2.63	0.44	3.71	0.29	1.08
Control	150	2.61	0.46	3.02	0.38	0.41

Source: Field Survey (2026)

Table 5 presents the pretest and posttest mean scores of students' engagement in mathematics learning for the experimental and control groups. The pretest results indicate that both groups had nearly the same level of engagement before the commencement of the treatment. The experimental group recorded a pretest mean score of 2.63 (SD = 0.44), while

the control group recorded a mean score of 2.61 (SD = 0.46), suggesting that the two groups were comparable at the beginning of the study. Following the eight week instructional intervention, the experimental group obtained a posttest mean score of 3.71 (SD = 0.29), whereas the control group recorded a posttest mean score of 3.02 (SD = 0.38). The experimental group also achieved a higher mean gain of 1.08 compared with the control group's mean gain of 0.41. The findings indicate that students taught using the flipped classroom approach demonstrated higher levels of behavioural, cognitive, and emotional engagement in mathematics learning than students taught using the conventional lecture method. This suggests that the flipped classroom approach positively enhanced students' participation, interest, interaction, and commitment to mathematics learning.

Test of Hypotheses

Hypothesis 1: There is no statistically significant difference in the academic achievement of students taught mathematics using the flipped classroom approach and those taught using the conventional lecture method.

Table 6: ANCOVA Summary of Students' Academic Achievement

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	15874.263	2	7937.132	164.286	.000	.525
Intercept	48562.418	1	48562.418	1005.371	.000	.772
Pretest	2846.511	1	2846.511	58.927	.000	.166
Group	10982.346	1	10982.346	227.376	.000	.434
Error	14347.295	297	48.307			
Total	1425630.000	300				
Corrected Total	30221.558	299				

Table 6 presents the ANCOVA results for students' academic achievement after controlling for the influence of the pretest scores. The results show that there was a statistically significant difference between the academic achievement of students taught using the flipped classroom approach and those taught using the conventional lecture method ($F(1,297) = 227.376$, $p < .05$, Partial $\eta^2 = .434$). The result indicates that the flipped classroom approach significantly improved students' academic achievement in mathematics compared with the conventional lecture method. . Since the calculated probability value was less than 0.05, the

null hypothesis was rejected. This finding indicates that the flipped classroom approach significantly improved students' academic achievement in mathematics.

Hypothesis 2: There is no statistically significant difference in the conceptual understanding of students taught mathematics using the flipped classroom approach and those taught using the conventional lecture method.

Table 7: ANCOVA Summary of Students' Conceptual Understanding

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	64.812	2	32.406	139.284	.000	.484
Intercept	216.745	1	216.745	931.618	.000	.758
Pretest	8.314	1	8.314	35.742	.000	.107
Group	55.287	1	55.287	237.647	.000	.445
Error	69.102	297	0.233			
Total	3168.540	300				
Corrected Total	133.914	299				

Table 7 presents the ANCOVA results for students' conceptual understanding after adjusting for differences in the pretest scores. The analysis revealed a statistically significant difference between the conceptual understanding of students taught using the flipped classroom approach and those taught using the conventional lecture method ($F(1,297) = 237.647$, $p < .05$, Partial $\eta^2 = .445$). This indicates that the flipped classroom approach significantly enhanced students' conceptual understanding of mathematics compared with the conventional lecture method. Consequently, the null hypothesis was rejected, indicating that students exposed to the flipped classroom approach developed significantly higher conceptual understanding than those taught through the conventional lecture method.

Hypothesis 3: There is no statistically significant difference in the problem solving skills of students taught mathematics using the flipped classroom approach and those taught using the conventional lecture method.

Table 8: ANCOVA Summary of Students' Problem Solving Skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	67.483	2	33.742	145.591	.000	.495
Intercept	228.614	1	228.614	986.643	.000	.769
Pretest	9.173	1	9.173	39.588	.000	.118
Group	57.216	1	57.216	246.953	.000	.454

Error	68.825	297	0.232
Total	3152.670	300	
Corrected Total	136.308	299	

Table 8 presents the ANCOVA results for students' problem solving skills after controlling for pretest differences. The findings revealed a statistically significant difference between the problem solving skills of students taught using the flipped classroom approach and those taught using the conventional lecture method ($F(1,297) = 246.953$, $p < .05$, Partial $\eta^2 = .454$). The null hypothesis is therefore rejected. This result indicates that the flipped classroom approach significantly enhanced students' mathematical problem solving skills compared with the conventional lecture method. Therefore, the null hypothesis was rejected, suggesting that the flipped classroom approach significantly enhanced students' mathematical problem solving skills.

Hypothesis 4: There is no statistically significant difference in the engagement of students taught mathematics using the flipped classroom approach and those taught using the conventional lecture method.

Table 9: ANCOVA Summary of Students' Engagement in Mathematics Learning

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	71.654	2	35.827	153.964	.000	.509
Intercept	236.438	1	236.438	1016.054	.000	.774
Pretest	8.946	1	8.946	38.443	.000	.115
Group	61.842	1	61.842	265.720	.000	.472
Error	69.107	297	0.233			
Total	3265.130	300				
Corrected Total	140.761	299				

Table 9 presents the ANCOVA results for students' engagement in mathematics learning after controlling for pretest differences. The analysis revealed a statistically significant difference between the engagement of students taught using the flipped classroom approach and those taught using the conventional lecture method ($F(1,297) = 265.720$, $p < .05$, Partial $\eta^2 = .472$). Consequently, the null hypothesis is rejected. The result indicates that the flipped classroom approach significantly improved students' behavioural, cognitive, and emotional engagement in mathematics learning compared with the conventional lecture method.

Discussion of Findings

The study finds that the flipped classroom approach significantly enhances undergraduate students' mathematics learning outcomes, including academic achievement, conceptual understanding, problem-solving skills, and engagement. Students using this method outperformed those in traditional lecture settings, underscoring the effectiveness of learner-centered strategies aligned with Constructivist Learning Theory. Key improvements include higher academic achievement attributed to pre-class access to materials and collaborative classroom activities. The study also highlights enhanced conceptual understanding and problem-solving abilities, corroborated by previous research. Increased student engagement is noted, with behavioral, cognitive, and emotional participation outpacing that of traditional methods. Overall, the flipped classroom proves to be a superior instructional strategy for mathematics in Nigerian tertiary institutions.

Conclusion

This study investigated the impact of the flipped classroom approach on mathematics learning outcomes among undergraduate students in selected tertiary institutions in Kogi State, Nigeria. The findings indicate that students exposed to the flipped classroom approach achieved significantly better academic achievement, conceptual understanding, problem solving skills, and engagement than students taught using the conventional lecture method. The study therefore concludes that the flipped classroom approach is an effective learner centred instructional strategy capable of enhancing mathematics learning outcomes in tertiary institutions. The findings further demonstrate that integrating technology supported active learning strategies into mathematics instruction can improve students' learning experiences and academic success.

Recommendations

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

1. Mathematics lecturers in tertiary institutions should adopt the flipped classroom approach to promote active learning, conceptual understanding, and problem solving skills.
2. Tertiary institutions should provide adequate technological infrastructure, including reliable internet access and digital learning facilities, to support the effective implementation of flipped classroom instruction.
3. Institutional administrators should organize regular professional development programmes to equip lecturers with the knowledge and skills required for designing and implementing flipped classroom pedagogy.

4. Curriculum developers should integrate learner centred instructional strategies, including the flipped classroom approach, into mathematics curricula and instructional guidelines for tertiary institutions.
5. Educational policymakers should formulate policies that encourage technology integration and innovative pedagogical practices capable of improving mathematics learning outcomes in higher education.

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