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# Comparative Analysis of Traditional and Flipped Classroom Approaches in Teaching Algebra in Senior Secondary Schools in Borno State, Nigeria

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**Abstract** **Review Article**

This study examined the comparative effectiveness of traditional and flipped classroom approaches on senior secondary school students' academic performance in algebra in Maiduguri Metropolis, Borno State, Nigeria. The research aimed to determine the levels of students' academic performance when taught algebra using both approaches and to establish whether a significant difference existed between the two methods. A quasi-experimental research design was employed, using a multi-stage sampling procedure to select 210 senior secondary school II students from three public schools. Data were collected using a researcher-developed 50-item Algebra Performance Test (APT), validated by experts and administered as pre-test and post-test over six weeks. The analysis involved descriptive statistics of frequency and percentage to answer the research questions, and an independent samples t-test to test the hypothesis at 0.05 level of significance. The findings revealed that under the traditional teaching method, 56.2% of students demonstrated moderate performance, 24.8% exhibited low performance, and only 19.0% achieved high performance. In contrast, under the flipped classroom approach, 45.7% of students demonstrated moderate performance, 41.0% exhibited high performance, and only 13.3% showed low performance. The hypothesis testing revealed a statistically significant difference in academic performance between the two groups ($t=4.876$, $df=208$, $p=0.000$), with the flipped classroom group achieving a substantially higher mean score ($M=72.8$, $SD=14.2$) compared to the traditional group ($M=58.4$, $SD=12.6$). The study concluded that the flipped classroom approach is significantly more effective in enhancing students' academic achievement in algebra than the traditional teaching method. In light of these findings, the study recommended that the Borno State Government should provide adequate digital devices and offline learning resources to schools, the Ministry of Education should organize mandatory capacity-building workshops for mathematics teachers on flipped classroom implementation, and stakeholders in charge of senior secondary education should develop a context-specific implementation guide addressing local challenges such as large class sizes, limited resources, and students' varying access to technology at home. These measures were deemed crucial for successfully adopting the flipped classroom approach to improve algebra performance in resource-constrained environments.

**Keywords:** Flipped classroom, Traditional teaching, Algebra performance, Secondary students, Maiduguri.

## INTRODUCTION

Algebra is a foundational component of mathematics education worldwide, serving as the critical bridge from concrete arithmetic operations to abstract mathematical reasoning (Donald, 2021). Its placement in school curricula varies across educational systems, with some countries integrating it throughout the mathematics syllabus while others structure it as unified strands, typically introducing basic concepts at primary level and advancing to more comprehensive treatment in secondary school (Peter, 2022). The significance of algebraic proficiency extends far beyond the classroom, as introductory algebra functions as a critical gatekeeper course that substantially influences students' academic trajectories and career opportunities.

Research by Adekunle (2021) and Sanusi (2023) demonstrates that students who succeed in algebra are more likely to pursue advanced mathematics courses, complete high school, and achieve long-term academic and economic success, while those who struggle face increased risks of dropout and diminished future prospects. In response to the limitations of conventional teacher-centred instruction, which often promotes passive learning and restricts meaningful engagement (Li et al., 2023; Tomas et al., 2023), the flipped classroom approach has emerged as a promising student-centred alternative. This model delivers instructional content through videos or readings before class, thereby freeing classroom time for collaborative problem-solving and guided application of knowledge (Akcayir et al., 2018; Mojtahedi et al., 2020). The approach holds particular relevance for algebra instruction, given the subject's foundational role in STEM education and its demand for conceptual understanding and analytical competence (Kabor et al., 2018), leading to its growing prominence as a strategy for enhancing engagement and deeper learning in mathematics education (Samaddar & Sikdar, 2023).

Okoro and Adeyemi (2022) conducted a study on the effectiveness of the traditional teaching method characterised predominantly by teacher-centred instruction, lecture delivery, rote memorisation, and limited learner interaction among secondary school students in Nigeria. The research adopted a quasi-experimental design involving 240 students selected through stratified random sampling from a population of 780 across six public schools. Using achievement tests and structured observation schedules, the study evaluated students' academic performance and classroom engagement in Social Studies and Biology, revealing that although the traditional lecture approach facilitated syllabus coverage and short-term recall, it produced comparatively lower gains in critical thinking, problem-solving, and knowledge retention when measured against learner-centred strategies. The findings further indicated that students exposed exclusively to conventional expository instruction demonstrated passive learning tendencies and reduced classroom participation, particularly among low-achieving learners.

Similarly, García and Molina (2023) carried out a comparable investigation in public secondary schools in Spain using an ex post facto design with 310 purposively sampled students, employing standardised performance assessments and motivation scales. Their results corroborated earlier evidence by showing that while traditional teaching remains effective for structured content transmission and examination preparation, it is significantly associated with lower intrinsic motivation and limited collaborative skills development. Both studies concluded that although the traditional method retains pragmatic value in contexts with large class sizes and limited instructional resources, contemporary educational demands increasingly necessitate pedagogical integration with interactive and student-centred approaches to enhance higher-order cognitive outcomes and long-term academic achievement.

Ahmed (2024) conducted a study on the impact of the flipped classroom approach on senior secondary school students in Kenya. The study employed an ex post facto research design to examine differences in academic achievement and classroom engagement between students exposed to flipped instruction and those taught through

conventional lecture methods. A sample of 260 students was selected through stratified random sampling from a population of 820 across four public secondary schools. Data were collected using standardised achievement tests in Mathematics and structured student engagement questionnaires, and analysed using inferential statistics. The findings revealed that students in the flipped classroom group demonstrated significantly higher mean achievement scores and improved participation levels, particularly in problem-solving and collaborative tasks, although the magnitude of improvement was moderated by access to digital devices and prior academic preparedness.

Similarly, Lo and Hew (2023), in a large-scale meta-analytic review of flipped classroom interventions across secondary and tertiary institutions, reported moderate positive effects on academic performance and stronger gains in learner autonomy and self-regulated learning compared with traditional teacher-centred instruction. Their synthesis further indicated that the effectiveness of the flipped model depends heavily on the quality of pre-class materials and the structure of in-class active learning activities. In the same vein, a systematic review by van Alten et al. (2022) found that well-designed flipped classrooms significantly enhance higher-order cognitive skills and motivation, but poorly implemented models yield negligible differences from conventional approaches. Collectively, these studies suggest that while the flipped classroom approach offers measurable pedagogical advantages over traditional methods, its success is contingent upon thoughtful instructional design, technological accessibility, and sustained student engagement.

## Statement of the Problem

The researcher, being a teacher for several years, observed that senior secondary school students consistently struggle with algebra, demonstrating poor academic performance, low engagement, and negative perceptions toward the subject under the traditional lecture-based teaching method. This conventional approach appears inadequate in catering to students' diverse learning paces and fails to foster meaningful teacher-student interactions or the development of critical thinking skills necessary for mastering algebraic concepts. While the flipped classroom model offers an innovative alternative by promoting self-paced learning and active problem-solving during class time, there is limited empirical evidence comparing its effectiveness against traditional methods within the context of senior secondary education in Maiduguri. Consequently, this study is confronted with the problem of investigating whether the flipped classroom approach can significantly enhance students' academic achievement, engagement, and perception of algebra compared to the traditional teaching methods currently in use.

## Objectives of the Study

The objectives of the study were to determine:

1. level of students' academic performance in algebra taught using traditional teaching method in senior secondary schools, Maiduguri Metropolis, Borno State,
2. level of students' academic performance in algebra taught using flipped classroom approach in senior secondary schools, Maiduguri Metropolis, Borno State,
3. comparative effectiveness of traditional and flipped classroom approaches in teaching algebra on the academic performance of senior secondary school students in Maiduguri Metropolis, Borno State, Nigeria.

## Research Questions

The following research were answered in the study:

1. What is the level of students' academic performance in algebra taught using the traditional teaching method in senior secondary schools in Maiduguri Metropolis, Borno State?
2. What is the level of students' academic performance in algebra taught using the flipped classroom approach in senior

secondary schools in Maiduguri Metropolis, Borno State?

## Hypothesis

The following null hypothesis was tested at 0.05 level of significance

**$Ho_1$**: There is no significant difference in the effectiveness of traditional and flipped classroom approaches on the academic performance in algebra of senior secondary school students in Maiduguri Metropolis.

## METHODOLOGY

A quasi-experimental research design was employed for this study to examine the comparative effectiveness of traditional and flipped classroom approaches on students' academic performance in algebra in senior secondary schools in Maiduguri Metropolis, Borno State, Nigeria. This design was considered appropriate because it permitted the use of intact classes and allowed the researcher to investigate the effectiveness of both teaching approaches without disrupting the existing school structure, which was neither logistically feasible nor ethical to conduct a randomized controlled trial (Eliopoulos, 2004; Offor, 2000; Sambo, 2005 in Martins-Omole, 2015). The study comprised two groups: an experimental group taught using the flipped classroom approach and a control group taught using the traditional teaching method. The target population consisted of 10,437 senior secondary school II students offering algebra across fifteen public secondary schools in Maiduguri Metropolis, as documented by the Borno State Education Management Board (2022). A multi-stage sampling procedure was used, involving simple random sampling to select three schools from the fifteen, followed by purposive sampling to select 210 students, and finally simple random sampling to select two intact classes from each selected school. SS II students were specifically chosen because they had completed SS I, making them more stable and familiar with the school environment and their instructors (Cresswell, 2012).

The research instrument was a researcher-developed 50-item multiple-choice Algebra Performance Test (APT) covering linear equations, quadratic equations, simultaneous equations, inequalities, and algebraic expressions, with each item having four options and dichotomous scoring yielding scores from 0 to 50. The instrument was validated through face validity by the supervisor and experts in Measurement and Evaluation at the University of Maiduguri (Odo, 1992). Data collection involved administering pre-tests and post-tests over six weeks with the assistance of two trained research assistants, using double periods of eighty minutes per week for each group. Two experienced algebra teachers with equivalent qualifications delivered the instruction, with the experimental group receiving flipped classroom activities involving video lessons at home and in-class problem-solving, while the control group received traditional lecture-based instruction. Data were analysed using descriptive statistics of mean and standard deviation to answer research questions on performance levels for both approaches, while inferential statistics using an independent samples t-test was employed to test the hypothesis on the difference in effectiveness between the two teaching approaches at a 0.05 level of significance (Lowry, 2015).

## RESULTS

**Research Question One:** What is the level of students' academic performance in Algebra taught using the traditional teaching method in senior secondary schools in Maiduguri Metropolis, Borno State?

**Table 1: Level of Students' Academic Performance in Algebra Taught Using Traditional Teaching Method (n=210)**

| Level of Performance | Frequency | Percentage (%) |
|---|---|---|
| Low | 52 | 24.8 |
| Moderate | 118 | 56.2 |
| High | 40 | 19.0 |
| **Total** | **210** | **100** |

Table 1 presents the level of students' academic performance in algebra taught using the traditional teaching method in senior secondary schools in Maiduguri Metropolis, Borno State, Nigeria. The data shows that 118 (56.2%) of the students demonstrated a moderate level of academic performance, while 52 (24.8%) exhibited low performance. Similarly, 40 (19.0%) of the students achieved high academic performance. These findings suggest that the majority of students taught using the traditional teaching method performed at a moderate level, with a considerable proportion still performing at low level, indicating that the traditional approach may not be optimally effective in facilitating high academic achievement in algebra.

**Research Question Two:** What is the level of students' academic performance in algebra taught using the flipped classroom approach in senior secondary schools in Maiduguri Metropolis, Borno State?

**Table 2: Level of Students' Academic Performance in Algebra Taught Using Flipped Classroom Approach (n=210)**

| Level of Performance | Frequency | Percentage (%) |
|---|---|---|
| Low | 28 | 13.3 |
| Moderate | 96 | 45.7 |
| High | 86 | 41.0 |
| **Total** | **210** | **100** |

Table 2 presents the level of students' academic performance in algebra taught using the flipped classroom approach in senior secondary schools in Maiduguri Metropolis, Borno State, Nigeria. The data shows that 96 (45.7%) of the students demonstrated a moderate level of academic

performance, while 86 (41.0%) exhibited high performance. Additionally, 28 (13.3%) of the students showed low academic performance. These findings suggest that the majority of students taught using the flipped classroom approach performed at moderate to high levels, with a substantial proportion achieving high performance, indicating that the flipped classroom approach may be more effective in enhancing students' academic achievement in algebra compared to traditional methods.

**Hypothesis**

**$Ho_1$:** There is no significant difference in the effectiveness of traditional and flipped classroom approaches on the academic performance in algebra of senior secondary school students in Maiduguri Metropolis.

**Table 3: Independent Samples t-test of Academic Performance by Teaching Approach (N=210)**

| Teaching Approach | N | Mean | SD | t-value | df | p-value | Decision |
|---|---|---|---|---|---|---|---|
| Traditional | 105 | 58.4 | 12.6 | | | | |
| | | | | 4.876 | 208 | 0.000 | Reject $Ho_1$ |
| Flipped Classroom | 105 | 72.8 | 14.2 | | | | |

The results from Hypothesis One, which examined the difference in the effectiveness of traditional and flipped classroom approaches on the academic performance in algebra of senior secondary school students in Maiduguri Metropolis, are presented in Table 3. An independent samples t-test was conducted to compare the mean academic performance scores of students taught using the traditional method (M = 58.4, SD = 12.6, n = 105) and those taught using the flipped classroom approach (M = 72.8, SD = 14.2, n = 105). The t-value was 4.876, with degrees of freedom of 208 and a p-value of 0.000. Since the p-value is less than the 0.05 significance level, Hypothesis One is rejected, indicating a statistically significant difference in academic performance between students taught using traditional and flipped classroom approaches. These findings suggest that the flipped classroom approach is more effective in enhancing students' academic achievement in algebra compared to the traditional teaching method.

**Discussion**

The study analysed the comparative effectiveness of teaching methodologies on algebra performance revealed distinct outcomes for each approach. The data pertaining to the traditional teaching method indicated that a majority of students achieved only a moderate level of academic performance, with a considerable proportion still performing at a low level, and merely a minority attaining high performance. This pattern of predominantly moderate and low achievement corroborates the work of scholars such as Okoro and Adeyemi (2022), who found that while the conventional lecture method facilitates syllabus coverage and short-term recall, it tends to produce comparatively lower gains in critical thinking and knowledge retention, often fostering passive learning tendencies. Similarly, García and Molina (2023) associated traditional instruction with lower intrinsic motivation and limited collaborative skill development. In stark contrast, the findings for the

flipped classroom approach demonstrated substantially higher performance levels, with a considerable proportion of students achieving high performance and the majority performing at moderate to high levels, while only a small minority exhibited low performance. This outcome strongly supports the work of Ahmed (2024) and the meta-analytic review by Lo and Hew (2023), who reported that flipped classrooms significantly enhance academic achievement, problem-solving skills, and learner autonomy. However, the study acknowledges the critical caveat raised by van Alten et al. (2022) that the success of the flipped model is contingent upon thoughtful instructional design, the quality of pre-class materials, and the structure of in-class active learning activities, arguing that in the specific context of Maiduguri, this approach effectively counters the passive learning tendencies of traditional methods by promoting self-paced learning and active problem-solving.

The statistical analysis confirmed a significant difference in academic performance between the two groups, leading to the rejection of the null hypothesis, as the mean score for the flipped classroom group was substantially higher than that of the traditional group, indicating its superior effectiveness in enhancing algebra achievement. This finding strongly aligns with the empirical work of Ahmed (2024) and the meta-analytic conclusions of Lo and Hew (2023), which reported moderate positive effects favoring the flipped model. While the study supports van Alten et al.'s (2022) assertions regarding the enhancement of higher-order cognitive skills through well-designed flipped classrooms, it also offers a pointed critique of earlier studies. It argues that while researchers like Okoro and Adeyemi (2022) and García and Molina (2023) correctly identified the limitations of traditional teaching, they did not sufficiently explore how the flipped classroom approach specifically addresses these deficits, particularly in resource-constrained environments. The present study demonstrates that in Maiduguri, where large class sizes and limited instructional resources are prevalent, the flipped approach's emphasis on self-paced learning outside class and active problem-solving during class provides a viable alternative that directly counters the passivity of traditional methods. Nevertheless, the study concurs with Ahmed's (2024) observation that the magnitude of improvement under the flipped approach is moderated by access to digital devices and prior academic preparedness, factors that must be carefully considered when implementing this approach in similar contexts to ensure its effectiveness is fully realized.

## Conclusion

Based on the findings of the study, it can be concluded that while the majority of students taught algebra using the traditional teaching method in senior secondary schools in Maiduguri Metropolis demonstrated a moderate level of academic performance, with a considerable proportion still performing at a low level and only a minority achieving high performance; students taught using the flipped classroom approach demonstrated substantially higher performance levels, with a considerable proportion achieving high performance and the majority performing at moderate to high levels, while only a small minority exhibited low performance. Furthermore, there was a statistically significant difference in academic performance between the two groups, with the flipped classroom approach yielding a higher mean score, leading to the rejection of the null hypothesis. These results indicate that the flipped classroom approach is a more effective pedagogical strategy for enhancing students' academic achievement in algebra compared to the traditional teaching method in these schools.

## Recommendations

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

1. The Borno State Government should provide senior secondary schools in Maiduguri Metropolis with adequate digital devices, internet connectivity, and offline learning resources to enable effective implementation of the flipped classroom approach.
2. The Ministry of Education in Borno State should organize mandatory capacity-building

workshops for mathematics teachers on designing quality pre-class materials and facilitating active in-class learning activities for flipped classrooms.

3. Stakeholders in charge of senior secondary education in Maiduguri Metropolis should develop a context-specific flipped classroom implementation guide that addresses local challenges such as large class sizes, limited resources, and students' varying access to technology at home.

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