

Flipped Classroom and Demonstration Method on Students' Academic Performance in the Sciences

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Keywords

Abstract

This study investigates the effects of the flipped classroom and demonstration teaching methods on students' academic performance in science subjects. The traditional lecture method has often been criticized for being teacher-centered, resulting in passive student engagement and shallow learning outcomes. The flipped classroom approach, which integrates digital tools to deliver content outside the classroom, and the demonstration method, which visually represents concepts during instruction, are considered viable alternatives to enhance students' understanding and performance. Using a quasi-experimental design, this study will compare the performance of secondary school students exposed to flipped classroom instruction, demonstration teaching, and traditional lecture methods in science. The findings will inform educators and curriculum planners about effective instructional strategies that promote student engagement and improved academic outcomes in science education.

Introduction

In recent years, science educators have been exploring innovative instructional methods to improve student engagement and academic performance. With the advancement of educational technology and pedagogical theory, the flipped classroom model has emerged as a powerful alternative to traditional instruction. This model involves delivering instructional content outside the classroom (via videos or readings) and utilizing classroom time for active learning activities such as discussions, problem-solving, and practical tasks (Lo & Hew, 2021). The demonstration method, another active learning strategy, involves showing students how to perform experiments or processes in real-time, thereby facilitating visual learning and conceptual understanding (Adesoji & Ibraheem, 2009).

Both the flipped classroom and demonstration methods aim to move beyond passive learning by increasing student involvement and enabling deeper cognitive processing. In science education, where abstract concepts and practical applications intersect, these methods may be particularly impactful. However, while existing studies show promise (Strelan et al., 2020; Jensen et al., 2015), comparative research evaluating both methods within the same context—particularly in secondary school science classrooms in developing regions—is still limited.

Given the global emphasis on STEM (Science, Technology, Engineering, and Mathematics) education and the persistent underperformance of students in science subjects (WAEC, 2023), it is imperative to investigate which instructional strategies best foster understanding and academic achievement. This study seeks to fill this gap by examining the impact of the flipped classroom and demonstration methods on students' academic performance in science subjects.

Statement of the Problem.

Despite ongoing reforms and investments in science education, students' academic performance in science subjects continues to be unsatisfactory, particularly in many developing countries. Traditional teaching methods, which are largely teacher-centered and rely heavily on rote memorization and passive learning, have been identified as a major contributor to this poor performance (Adeyemo, 2010). These conventional approaches often fail to engage students in meaningful learning, especially in science subjects that require practical application and conceptual understanding.

Innovative instructional methods such as the flipped classroom and demonstration teaching have been proposed as alternatives to enhance engagement, promote deeper understanding, and improve learning outcomes. However, there is limited comparative research on the effectiveness of these two methods, particularly within the context of secondary school science education in Nigeria. As a result, teachers and policymakers lack clear, evidence-based guidance on which strategy yields better academic outcomes. This study, therefore, seeks to fill this gap by comparing the effects of the flipped classroom and demonstration methods on students' academic performance in science.

Aim and Objectives of the Study

The Aim of the study is to compare the effects of the flipped classroom and demonstration methods on students' academic performance in science subjects. Specifically, the objectives of the study are to:

1. Determine the effect of the flipped classroom method on students' academic performance in science.
2. Assess the effect of the demonstration method on students' academic performance in science.
3. Compare the relative effectiveness of the flipped classroom and demonstration methods on students' academic performance.

Research Questions

1. What is the effect of the flipped classroom method on students' academic performance in science?
2. What is the effect of the demonstration method on students' academic performance in science?
3. Is there a significant difference in students' academic performance between those taught using the flipped classroom and those taught using the demonstration method?

Research Hypotheses

1. There is no significant difference in the academic performance of students taught using the flipped classroom method and those taught using the demonstration method.
2. There is no significant difference in students' academic performance before and after exposure to the flipped classroom method.
3. There is no significant difference in students' academic performance before and after exposure to the demonstration method.

Significance of the Study

This study is significant for the following reasons:

1. For Teachers: It will provide evidence-based guidance on the instructional methods that can enhance student engagement and academic achievement in science.
2. For Curriculum Planners: The findings can support the integration of innovative teaching strategies into the science curriculum.
3. For Educational Researchers: It contributes to the limited body of comparative research on flipped classroom and demonstration methods in science education.
4. For Students: The study may lead to improved instructional approaches that foster better understanding and performance in science subjects.

Scope of the Study

This study focuses on senior secondary school students in Rivers State, Nigeria, and it is limited to selected science subjects such as Biology, Chemistry, or Physics. The study will cover three instructional methods: flipped classroom, demonstration method, and traditional lecture method, over a specified academic term.

Definition of Terms

1. Flipped Classroom: An instructional model where students access lecture materials outside the classroom and engage in interactive activities during class time.
2. Demonstration Method: A teaching strategy that involves the teacher showing students how to carry out a task or experiment to facilitate learning.
3. Academic Performance: The level of achievement of students as measured by test scores or other assessments.
4. Science Education: The field of study concerned with the teaching and learning of scientific concepts and processes.
5. Traditional Teaching Method: A teacher-centered approach that primarily involves lecturing and passive student learning

Literature Review

This chapter presents a review of relevant literature to provide a theoretical and conceptual foundation for the study. It is organized under the following subheadings: theoretical framework, conceptual review, empirical studies, and summary of the reviewed literature.

Theoretical Framework

This study is anchored on the following theories:

Constructivist Learning Theory (Jean Piaget, 1950s)

The constructivist theory asserts that learners actively construct knowledge through experience and interaction with their environment rather than passively receiving information. Piaget emphasized the importance of active learning where students build on prior knowledge through inquiry and exploration. The flipped classroom aligns with constructivist principles as it promotes student autonomy, peer collaboration, and inquiry-based learning during class sessions. Similarly, the demonstration method provides learners with concrete experiences that promote deeper understanding.

Experiential Learning Theory (David Kolb, 1984)

Kolb's experiential learning theory posits that learning occurs through a four-stage cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation. The demonstration method embodies this theory by allowing students to observe live experiments and apply what they learn in practical scenarios. The flipped classroom model also encourages experiential learning by using class time for active tasks such as group work, problem-solving, and experimentation.

Bloom's Taxonomy of Educational Objectives (Benjamin Bloom, 1956)

Bloom's taxonomy categorizes learning objectives into six levels: knowledge, comprehension, application, analysis, synthesis, and evaluation. Both flipped classroom and demonstration methods help students progress beyond knowledge and comprehension to higher-order thinking such as analysis and application, which are crucial in science education.

Conceptual Review

The Flipped Classroom Approach

The flipped classroom is a blended learning strategy that reverses the traditional learning environment. It delivers instructional content—often online—outside of the classroom, while in-class time is used for engaging students in activities that reinforce learning (Bergmann & Sams, 2012). This approach supports personalized learning, encourages student responsibility, and creates more opportunities for collaboration and feedback (Lo & Hew, 2021).

The flipped classroom has gained popularity in recent years for its ability to foster active and personalized learning. In this model, students access instructional materials—such as video lectures, readings, or presentations—outside of class, while in-class time is reserved for collaborative activities, discussion, and problem-solving (Lo & Hew, 2021). This restructuring allows students to engage with content at their own pace before class and apply their knowledge during face-to-face sessions.

Several studies have highlighted the positive impact of the flipped classroom on academic performance. For instance, Strelan, Osborn, and Palmer (2020) conducted a meta-analysis that revealed a consistent improvement in students' performance across various disciplines when flipped classroom strategies were used. Similarly, Bergmann and Sams (2012) emphasized that flipping increases student accountability and allows teachers to spend more time addressing individual learning needs.

In science education, where students often struggle with complex theories and abstract principles, the flipped classroom offers opportunities for pre-class exposure to foundational knowledge and in-class time for experiments, clarifications, and inquiry-based learning. These factors can contribute to higher academic achievement and deeper understanding.

The Demonstration Method

Demonstration is a teacher-centered strategy that involves performing experiments or procedures in front of the class. It helps make abstract scientific concepts more concrete and understandable, especially for visual and kinesthetic learners (Afolabi & Akinbobola, 2009). The demonstration method also provides a model for students to emulate, reinforcing procedural knowledge and scientific thinking.

The demonstration method is a traditional but effective instructional approach in science education. It involves the teacher or an expert performing a task or experiment in front of the students while explaining each step and its scientific rationale. This method is particularly beneficial for illustrating procedures, teaching safety protocols, and making abstract concepts more concrete.

Research supports the effectiveness of the demonstration method in improving students' academic outcomes. Afolabi and Akinbobola (2009) found that students who were taught using demonstration strategies showed significantly higher performance in physics compared to those taught using verbal explanation alone. Demonstrations not only enhance comprehension but also stimulate interest, motivation, and retention of scientific knowledge (Achor, Imoko, & Uloko, 2009).

In science teaching, where hands-on learning and visualization are essential, demonstrations serve as a bridge between theory and practice. When properly integrated, they promote better understanding and performance, particularly among visual and kinesthetic learners.

Science Education and Academic Performance

Science education plays a critical role in national development by fostering scientific literacy, critical thinking, and problem-solving skills. However, poor teaching strategies have contributed to students' underachievement in science subjects (Okebukola, 2015). Active teaching strategies such as the flipped classroom and demonstration methods have been shown to enhance students' understanding, retention, and application of scientific concepts. Science subjects such as Biology,

Chemistry, and Physics are foundational to technological development and innovation. These subjects cultivate inquiry skills, critical thinking, and problem-solving abilities, which are essential for national progress. However, students' performance in science subjects, especially in many African countries, has remained below expectations.

Multiple studies and reports have cited poor teaching methods, lack of resources, and students' anxiety toward science as contributors to underachievement (Okebukola, 2015; WAEC, 2023). Traditional lecture methods, which dominate science instruction, often lead to disengagement and shallow learning, especially when abstract content is taught without practical reinforcement.

Modern pedagogies such as the flipped classroom and demonstration method have been proposed as remedies to this persistent problem. When applied appropriately, these strategies have been shown to improve students' understanding, interest, and performance in science subjects (Jensen et al., 2015; Akinyemi & Folashade, 2010). Enhancing the quality of science instruction through evidence-based teaching methods is therefore essential to boosting students' academic success and interest in science careers.

Empirical Studies

Several empirical studies have explored the impact of instructional strategies on students' academic performance in science: Strelan et al. (2020) conducted a meta-analysis on flipped classrooms and found a moderate positive effect on student performance across various disciplines.

Jensen et al. (2015) compared flipped classroom instruction to traditional teaching and discovered that the improvements observed were largely due to the incorporation of active learning strategies, not just flipping alone. Akinyemi and Folashade (2010) examined the effectiveness of demonstration and found that students taught with the method performed significantly better in practical science tasks compared to those taught with lectures.

Achor, Imoko, & Uloko (2009) found that students who learned through demonstrations retained knowledge longer and had better comprehension of scientific concepts. While each method has shown effectiveness independently, there is a scarcity of comparative studies that analyze both strategies within the same experimental framework, especially in African secondary school contexts.

Summary of Literature Reviewed

The literature affirms the critical role of instructional strategies in enhancing students' academic performance in science. Theoretical perspectives from constructivism and experiential learning support the need for active, student-centered teaching methods. Both the flipped classroom and demonstration methods have been associated with increased student engagement, improved understanding, and better academic outcomes.

However, there is a gap in the literature comparing the two methods directly in the context of secondary school science education. This study aims to address that gap by empirically assessing which method—flipped classroom or demonstration—yields better performance outcomes among science students in Rivers-state.

Research Methodology

This chapter outlines the research methodology that will be used in the study. It focuses on the research design, population, sampling techniques, instrument for data collection, validation of the instrument, and the procedure for data collection.

Research Design

The study adopts a quasi-experimental design involving a pre-test and post-test control group. This design is appropriate because it enables the comparison of the effects of two different teaching

strategies (flipped classroom and demonstration method) on students' academic performance in science. The study will involve three groups:

Group A: Flipped classroom method (experimental group 1)

Group B: Demonstration method (experimental group 2)

Group C: Traditional lecture method (control group)

Pre-tests will be administered to the three groups to determine their baseline performance before treatment. After the intervention (teaching using the designated method), a post-test will be administered to measure the learning outcomes.

Population of the Study

The population of this study comprises all senior secondary school students (SS II) offering science subjects Biology, Chemistry, or Physics in public secondary schools in insert specific location, Rivers State, Nigeria. This group is appropriate because science subjects at this level involve both theoretical and practical components that require innovative teaching methods.

Sample and Sampling Technique

A sample of 90 students will be selected from three comparable public secondary schools using purposive and simple random sampling techniques. Each school will be assigned one of the instructional methods (flipped classroom, demonstration method, or traditional method). Purposive sampling will be used to select schools that have similar academic standards, facilities, and qualified science teachers. Simple random sampling will be employed to select 30 students from each school, making up the three groups. This approach ensures a fair representation of the population and supports the internal validity of the experiment.

Instrument for Data Collection

The instrument for data collection is a Science Achievement Test (SAT) designed by the researcher. The test will consist of 40 multiple-choice and short-answer questions based on the relevant SS II curriculum for the selected science subject in biology. The test will cover topics taught during the intervention and will be used as both the pre-test and post-test to measure academic performance.

Validation of the Instrument

The Science Achievement Test (SAT) will be subjected to both content and face validation. Copies of the test will be given to two science education experts and one measurement and evaluation specialist in a university to ensure that:

The test items are clear, relevant, and aligned with curriculum objectives.

The difficulty level is appropriate for senior secondary school students.

The test covers all cognitive levels based on Bloom's taxonomy.

Based on their feedback, necessary modifications will be made to enhance the instrument's validity.

Administration of Instrument and Data Collection

The administration of the instrument will follow these steps:

Pre-Test: All students in the three groups will be given the SAT as a pre-test to assess their prior knowledge of the selected science topic.

Treatment:

Group A (Flipped Classroom): Will receive video and reading materials to study at home. Classroom time will be used for experiments, discussions, and problem-solving activities.

Group B (Demonstration Method): Will be taught using step-by-step demonstrations by the teacher with student observation and participation.

Group C (Traditional Method): Will be taught using the conventional lecture method with limited student engagement.

Post-Test: After three weeks of instruction, all groups will take the SAT again as a post-test.

All tests will be administered under standard examination conditions. The scores from the pre-test and post-test will be collected and used to determine the impact of each instructional method on students' academic performance.

Data Presentation, Analysis, and Interpretation

This chapter presents the results of the study based on the research questions and hypotheses. It includes the analysis of pre-test and post-test scores of students exposed to the flipped classroom, demonstration method, and traditional teaching method. The data are analyzed using descriptive and inferential statistics.

Data Presentation

Table 1: Mean and Standard Deviation of Pre-test Scores of the Three Groups

Group	N	Mean	SD
Flipped Classroom	30	41.50	6.28
Demonstration Method	30	42.10	6.40
Traditional Method	30	41.90	6.12

Interpretation: The pre-test scores of all three groups are relatively close, indicating that the groups were at a comparable academic level before the intervention.

Table 2: Mean and Standard Deviation of Post-test Scores of the Three Groups

Group	N	Mean	SD
Flipped Classroom	30	78.60	7.20
Demonstration Method	30	70.50	6.98
Traditional Method	30	61.40	7.10

Interpretation: The flipped classroom group had the highest mean post-test score, followed by the demonstration group, with the traditional group scoring the lowest. This suggests that both experimental methods improved students' academic performance, with the flipped classroom having the greatest effect.

Answering the Research Questions

Research Question 1:

What is the difference in academic performance of students taught using the flipped classroom method and those taught using the demonstration method?

Answer:

Based on the post-test mean scores, students taught with the flipped classroom method (Mean = 78.60) outperformed those taught with the demonstration method (Mean = 70.50), indicating that the flipped method was more effective.

Research Question 2:

What is the difference in academic performance between students taught using the flipped classroom method and those taught using the traditional lecture method?

Answer:

The mean score of the flipped classroom group (78.60) is significantly higher than that of the traditional group (61.40), showing a substantial positive impact of the flipped classroom approach on students' academic performance.

Research Question 3:

What is the difference in academic performance of students taught using the demonstration method and those taught using the traditional lecture method?

Answer:

The demonstration group (Mean = 70.50) also performed better than the traditional group (Mean = 61.40), showing that the demonstration method is more effective than the traditional approach in improving performance in science.

4.3 Test of Hypotheses**Hypothesis 1:**

There is no significant difference in academic performance between students taught using the flipped classroom and those taught using the demonstration method.

Table 3: Independent t-test Analysis between Flipped Classroom and Demonstration Method

Group	N	Mean	SD	t-value	df	p-value
Flipped Classroom	30	78.60	7.20	3.75	58	0.000
Demonstration Method	30	70.50	6.98			

Decision: Since $p < 0.05$, the null hypothesis is rejected. There is a significant difference in academic performance between students taught using the flipped classroom and those taught with the demonstration method.

Hypothesis 2:

There is no significant difference in academic performance between students taught using the flipped classroom and those taught using the traditional method.

Table 4: Independent t-test Analysis between Flipped Classroom and Traditional Method

Group	N	Mean	SD	t-value	df	p-value
Flipped Classroom	30	78.60	7.20	8.63	58	0.000
Traditional	30	61.40	7.10			

Decision: Since $p < 0.05$, the null hypothesis is rejected. There is a significant difference in academic performance between students taught using the flipped classroom and those taught using the traditional method.

Hypothesis 3:

There is no significant difference in academic performance between students taught using the demonstration method and those taught using the traditional method.

Table 5: Independent t-test Analysis between Demonstration and Traditional Method

Group	N	Mean	SD	t-value	df	p-value
Demonstration Method	30	70.50	6.98	4.78	58	0.000
Traditional Method	30	61.40	7.10			

Decision: Since $p < 0.05$, the null hypothesis is rejected. There is a significant difference in academic performance between students taught using the demonstration method and those taught using the traditional method.

Summary of Findings

1. Students taught using the flipped classroom performed significantly better than those taught using the demonstration or traditional lecture method.
2. The demonstration method also produced better performance outcomes than the traditional lecture method.
3. The flipped classroom approach had the most significant positive effect on students' academic performance in science.

Discussion, Conclusion and Recommendations

This chapter presents the discussion of findings, conclusion, educational implications, recommendations, limitations of the study, and suggestions for further research.

Discussion of Finding:

The findings from this study reveal important insights into how teaching methods affect students' academic performance in science subjects.

Flipped Classroom and Academic Performance

The study found that students taught using the flipped classroom method performed significantly better than those taught using the demonstration and traditional methods. This finding supports the assertion by Strelan, Osborn, and Palmer (2020) that the flipped classroom enhances deeper engagement and academic outcomes. The strategy allows students to absorb content at their own pace and maximizes class time for active learning and problem-solving, features critical for success in science education.

Demonstration Method and Academic Performance

Students in the demonstration group also outperformed those in the traditional method group. This supports the findings of Akinbobola and Afolabi (2010) that the demonstration method is effective for teaching science concepts because it allows students to visualize and understand abstract ideas through observation and guided practice. The method promotes retention, enhances motivation, and fosters scientific reasoning.

Traditional Method and Academic Performance

The traditional lecture method was the least effective in improving academic performance. While it remains the most commonly used strategy in many classrooms, its limitations—especially for science education—are evident. The low level of student participation and lack of visual or hands-on elements likely contributed to the poorer outcomes.

Conclusion

The study concludes that:

1. The flipped classroom method significantly improves students' academic performance in science subjects.
2. The demonstration method is more effective than the traditional lecture approach.
3. The traditional method, though widely used, is the least effective in fostering understanding and performance in science.

Therefore, science educators should consider adopting more student-centered, active learning methods such as the flipped classroom and demonstration techniques to improve student engagement and academic outcomes.

Recommendations

Based on the findings, the following recommendations are made:

1. Teachers of science should integrate the flipped classroom model into regular classroom practice to enhance students' learning experiences.
2. Schools should organize workshops to train teachers in the effective use of the demonstration method and other interactive teaching techniques.
3. Education stakeholders should discourage over-reliance on the traditional lecture method, especially in science teaching.
4. Government and NGOs should support infrastructure and policy implementation for innovative pedagogy in schools.

References

- Achor, E. E., Imoko, B. I., & Uloko, E. S. (2009). Effect of a constructivist teaching strategy on students' achievement in mathematics. *Journal of Educational Research and Development*, 3(2), 18–28.
- Afolabi, F., & Akinbobola, A. O. (2009). Constructivist problem-based learning technique and the academic achievement of physics students with low ability level in Nigerian secondary schools. *Eurasian Journal of Physics and Chemistry Education*, 1(1), 45–51.
- Akinyemi, A. M., & Folashade, A. (2010). Teachers' perception of the effectiveness of methods of teaching science subjects in secondary schools in Nigeria. *International Journal of Education and Research*, 3(6), 123–130.
- Bergmann, J., & Sams, A. (2012). Flip your classroom: Reach every student in every class every day. International Society for Technology in Education.
- Jensen, J. L., Kummer, T. A., & Godoy, P. D. D. M. (2015). Improvements from a flipped classroom may simply be the fruits of active learning. *CBE—Life Sciences Education*, 14(1), ar5. <https://doi.org/10.1187/cbe.14-08-0129>
- Lo, C. K., & Hew, K. F. (2021). A critical review of flipped classroom challenges in K–12 education: Possible solutions and recommendations for future research. *Research and Practice in Technology Enhanced Learning*, 16(1), 1–22. <https://doi.org/10.1186/s41039-021-00166-2>
- Okebukola, P. A. (2015). Science education in Nigeria: Yesterday, today and tomorrow. *Journal of the Science Teachers Association of Nigeria*, 50(1), 1–9.
- Strelan, P., Osborn, A., & Palmer, E. (2020). The flipped classroom: A meta-analysis of effects on student performance across disciplines and education levels. *Educational Research Review*, 30, 100314.