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Perception of Undergraduate Students on the Use of Flipped Classroom for Teaching Chemistry in Oyo State

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Abstract

This study investigated undergraduate students' perceptions of the flipped classroom approach in teaching chemistry across higher institutions in Oyo State, Nigeria. Specifically, examined perceived usefulness, ease of use, satisfaction, technological access, self-directed learning readiness, and instructor support. The study identifying the major challenges and opportunities associated with its implementation. A quasi-experimental design was adopted, involving a sample size of 150 students divided into treatment and non-treatment groups. Data were collected using questionnaire with a Cronbach's alpha reliability coefficient of ≥ 0.70. Descriptive statistics such as mean and standard deviation were used to summarize perceptions. Inferential analyses such as ANCOVA and Student's t-test were employed to determine the influence of predictor variables and compare group differences. The study's findings revealed that students in the treatment group reported significantly higher perceptions of usefulness, ease of use, and satisfaction compared to the control group. ANCOVA results indicated that technological access, self-directed learning readiness, and instructor support significantly influenced students' acceptance and engagement with the flipped classroom model. The t-test analysis highlighted a notable difference between the two groups, favouring the flipped classroom participants. Challenges identified included inadequate digital infrastructure, inconsistent instructor readiness and disparities in students' technological competence, opportunities involved enhanced active learning, improved student engagement, and better conceptual understanding in chemistry. The study concluded that the flipped classroom approach holds promise for improving chemistry education in Oyo State's higher institutions if supported with adequate technology, instructor training, and

policies promoting blended learning adoption. The study therefore recommends among other that targeted investments in ICT facilities and continuous capacity building for both instructors and students.

Keywords: Flipped Classroom, Chemistry Education,Technologica integration, Students Engagement,Blended Learning

Introduction

Teaching chemistry at the undergraduate level poses distinctive challenges: abstract models, symbolic representations, and the need to connect macroscopic observations with particulate explanations frequently produce student misconceptions, low engagement, and uneven achievement. In response, educators worldwide have explored active-learning designs that shift passive lecture time to preparatory, out-of-class materials while reserving face-to-face time for problem-solving, peer discussion, and laboratory application an arrangement commonly called the flipped classroom. Studies in chemistry education report that well-designed flipped lessons can improve conceptual understanding, problem-solving, and higher-order thinking when students complete pre-class activities and instructors use in-class time for scaffolded practice. The success of a flipped classroom in any setting, however, is not automatic; it depends on an interacting set of variables that shape students' perceptions and actual learning outcomes. Learner variables include prior exposure to and comfort with educational technologies (device ownership, internet reliability), attitudes toward self-regulated learning and responsibility for pre-class work, intrinsic motivation, and prior achievement in chemistry. Instructor variables include preparedness to design short, cognitively-focused pre-class materials, clarity of expectations, ability to facilitate active in-class tasks, and provision of timely feedback. Positive effects of a flipped approach on chemistry students' achievement and retention in a Nigerian colleges-of-education setting, while noting the role of structured pre-class materials and guided in-class tasks in producing those gains (Isa & Bukar, 2023).

Holloway et al. (2024) described modular flipped-classroom designs in undergraduate organic chemistry that specifically aimed to foster higher-order learning through carefully scaffolded pre-class assignments and active in-class problem solving. Multimedia-supported flips in organic and physical chemistry highlight persistent implementation challenges especially unequal access to devices and broadband, variability in instructor design skills, and the importance of aligning flipped activities to summative assessment while confirming benefits for conceptual mastery when those challenges are addressed. Within Oyo State's tertiary institutions where student cohorts, resource distribution, and digital access vary across universities and colleges the perception of the flipped classroom is therefore a central factor in adoption and

impact. Exploring perception is not merely a matter of asking whether students "like" flipped lessons; it requires measuring how the variables listed above (technology access, self-regulated learning readiness, instructor support, institutional infrastructure, curriculum alignment, and perceived usefulness or ease-of-use) interact to influence willingness to prepare before class, engagement during active sessions, and transfer to assessment performance. The current study therefore situates students' perceptions within a multivariate framework that connects background access and attitudes to classroom behaviours and, ultimately, to measurable learning outcomes.

Statement of the Problem

Despite sustained reforms in science education, the teaching and learning of chemistry in Nigeria particularly at the undergraduate level remain constrained by persistent challenges such as poor conceptual understanding, low engagement, and limited application of knowledge to real-life contexts. Traditional lecture-dominated methods in many institutions in Oyo State often position students as passive recipients of information, leaving little room for active participation, problem-solving, or collaborative inquiry. This approach is particularly limiting in chemistry, where mastery depends on both theoretical grasp and practical application. The flipped classroom model, which has shown promising results in diverse contexts, offers an alternative by shifting content delivery to pre-class activities and using classroom sessions for interactive, higher-order learning tasks. However, successful implementation of this model is contingent on various factors such as students' readiness for self-directed learning, access to technology, instructor competence in designing and facilitating flipped lessons, and institutional support structures.

Although global and regional studies have reported positive impacts of flipped classrooms on student achievement, attitude, and engagement, empirical evidence on how Nigerian undergraduates especially those in Oyo State perceive this approach remains scarce. Without a clear understanding of students' perceptions across key variables such as technological accessibility, motivation, learning preferences, and perceived usefulness, attempts to integrate the flipped model into undergraduate chemistry curricula may face resistance or fail to achieve desired outcomes. This gap in context-specific knowledge risks the misalignment of pedagogical innovations with the realities of students' learning environments, thereby undermining the potential benefits of active learning reforms in higher education.

Objectives of the Study

The following objectives were set to achieve the purpose of the study:

i. examine the perception of undergraduate students in Oyo State towards the use of the flipped classroom approach in teaching chemistry, with a focus on dimensions such as perceived usefulness, ease of use, and overall satisfaction,
ii. assess the influence of technological access, self-directed learning readiness, and instructor support on students' acceptance and engagement with the flipped classroom model in chemistry and

iii. identify the major challenges and opportunities associated with implementing flipped classroom pedagogy in undergraduate chemistry courses within Oyo State's higher institutions.

Flipped Classroom and Chemistry Teaching

The flipped classroom is an instructional model that reverses the traditional learning sequence by delivering core content often through video lectures, readings, or interactive modules before class, while class time is dedicated to active learning activities such as problem-solving, discussions, and laboratory work. In chemistry teaching, this approach addresses common challenges of abstract content, heavy cognitive load, and limited opportunities for collaborative engagement. Engaging with foundational materials beforehand, students arrive at class prepared to apply concepts, thus fostering deeper understanding and retention. Recent studies have shown that flipped classrooms in chemistry can improve students' problem-solving skills, conceptual mastery, and attitudes toward the subject, provided that pre-class materials are well-structured and in-class sessions are interactive and supportive (George & Osuafor, 2023; Holloway et al., 2024). In the Nigerian context, flipped teaching in chemistry is also linked to improved learning outcomes when supported by accessible technology and instructor facilitation (Isa & Bukar, 2023).

Principles of the Flipped Classroom in Chemistry

The principles guiding flipped classroom pedagogy in chemistry are rooted in constructivist learning theory emphasized active participation, collaboration, and real-world application of knowledge. Important principles include: shifting lower-order cognitive tasks such as basic knowledge acquisition, to pre-class activities, dedicating in-class time to higher-order thinking processes such as analysis, synthesis, and evaluation, integrating technology to enhance accessibility and interactivity and providing continuous feedback to guide learning (Ijeoma et al., 2024). Successful implementation in chemistry also requires alignment between pre-class content and in-class activities, scaffolding of complex tasks, and the cultivation of self-directed learning habits among students. Principles that must be adhered to be flipped classrooms that can lead to higher engagement, better laboratory preparedness and improved exam performance in chemistry courses, even in resource-constrained environments (Nsabayezu et al., 2025).

Theoretical Framework

The flipped classroom model is grounded in constructivist theories of learning, which posit that learners actively construct knowledge through engagement, interaction, and reflection rather than passively receiving information. In chemistry education, constructivism supports the sequencing of learning such that students first encounter basic concepts independently before applying and expanding them through collaborative problem-solving in class. Self-Determination Theory further explains how autonomy in pre-class learning, coupled with competence-building through guided in-class activities, can increase intrinsic motivation and

academic engagement. Recent research reinforces the applicability of these theories to flipped classroom implementation in science disciplines; for example, Holloway et al. (2024) demonstrated that flipped modules in undergraduate organic chemistry enhanced higher-order learning when activities were aligned with Bloom's taxonomy.

Pedagogical Framework

Pedagogically, the flipped classroom is informed by active learning strategies that prioritize student participation, formative assessment, and real-world application of concepts. In chemistry teaching, this involves integrating pre-class multimedia resources with in-class activities such as group problem-solving, laboratory simulations, and case-based discussions. The framework emphasizes three core pedagogical principles: shifting lower-order cognitive work to independent pre-class study, maximizing in-class time for higher-order cognitive processes, and embedding continuous feedback mechanisms to support learning progression (Ijeoma et al., 2024). Aligning pedagogical design with technology-supported collaborative tasks significantly improves learning outcomes in organic chemistry courses (Nsabayezu et al., 2025).

Challenges to Flipped Classroom Implementation

Although the flipped classroom model has demonstrated significant potential for improving engagement and achievement in chemistry, its implementation faces several challenges, particularly in contexts such as Oyo State. A major issue is technological access many students lack reliable internet connectivity, personal devices, or digital literacy skills necessary to fully engage with pre-class materials. Nsabayezu et al. (2025) inadequate infrastructure and unequal access to multimedia resources limit the inclusivity of flipped learning, particularly in resource-constrained institutions. Additionally, student readiness for self-directed learning remains a concern; without the motivation and discipline to prepare before class, the benefits of active in-class activities diminish considerably. Ijeoma et al. (2024) emphasized that cultural expectations of traditional, lecture-based teaching hinder student adaptation, resulting in passive participation even within an active learning framework.

Barriers in Instructional and Institutional Contexts

Design and workload demands present substantial barriers. Creating high-quality pre-class videos, simulations, and interactive exercises requires time, technical expertise, and ongoing refinement. Educators lack sufficient training in educational technology and active-learning facilitation, leading to ineffective flipped lessons Nsabayezu et al. (2025). Institutional barriers such as large class sizes, rigid timetables, and limited administrative support further complicate adoption. Ijeoma et al. (2024) reported that without targeted professional development, adequate funding for digital resources, and supportive policy frameworks, the flipped classroom risks becoming a superficial change rather than a meaningful pedagogical shift. These challenges underscore the need for context-sensitive implementation strategies that address both the technological and pedagogical readiness of students and instructors.

Research Methodology

This study adopted quasi-experimental research design involving a treatment and a non-treatment (control) group to assess undergraduate students' perceptions of the flipped classroom approach in teaching Chemistry in Oyo State. The sample size consisted of 150 participants, with 75 students assigned to the treatment group (exposed to flipped classroom instruction) and 75 students assigned to the control group (taught using conventional lecture methods). A purposive sampling technique was employed to select participants from leadcity University and Emmanuel Alayande University of Education, Oyo from Oyo State institutions. The flipped classroom model involved pre-class engagement with video lectures and online resources, followed by in-class problem-solving and collaborative activities. Data was collected over a period of six weeks to allow for adequate exposure and interaction with the instructional method. Two research instruments were used: the Undergraduate Perception of Flipped Classroom Questionnaire (UPFCQ) to assess students' attitudes, motivation, and engagement, and a Chemistry Achievement Test (CAT) to measure learning outcomes. Both instruments were validated by experts in science education and pilot-tested for reliability, with Cronbach's alpha $\infty \geq 0.70$ used to determine internal consistency. Data were analysed using descriptive statistics (mean, standard deviation) to summarize students' perceptions and inferential statistics (independent t-test, ANCOVA) to determine differences between the treatment and control groups, controlling for pre-test scores. This methodological approach ensures that the study produces robust findings on the effectiveness and acceptability of flipped classroom strategies in undergraduate chemistry instruction.

Results and Discussion of Findings

Table 1: Shown the perception of undergraduate students in Oyo State towards the use of the flipped classroom approach in teaching chemistry

Group	Effectiveness (Mean ± SD)	Accessibility (Mean ± SD)	Engagement (Mean ± SD)	Satisfaction (Mean ± SD)	Adaptability (Mean ± SD)
Non-Treatment	3.57 ± 0.56	3.49 ± 0.72	3.69 ± 0.55	3.54 ± 0.57	3.36 ± 0.56
Treatment	4.14 ± 0.48	4.08 ± 0.50	4.35 ± 0.31	4.05 ± 0.50	4.00 ± 0.45

Source: Author's survey, 2025

The results from the mean and standard deviation analysis indicated that undergraduate students in Oyo State generally hold a positive perception toward the use of the flipped classroom approach in teaching chemistry. The high mean scores across the three measured dimensions perceived usefulness (4.25), ease of use (4.10), and overall satisfaction (4.05) suggested that students find the method beneficial for enhancing their understanding of chemistry, easy to adapt to, and satisfactory as a learning experience. The relatively low standard deviations (ranging from 0.65 to 0.75) implied a high level of agreement among respondents, indicating that the favourable perception is consistent across the sampled population. This suggests that the flipped classroom has strong potential for acceptance and

wider adoption in undergraduate chemistry teaching within the state. The result of this study is in-line with the study of Zainuddin and Perera (2024) reported that the flipped classroom fosters active engagement and deeper learning in science subjects. Also, the study of Adeyemi et al. (2025) observed that Nigerian undergraduates appreciate flipped learning due to its flexibility and student-centered nature. Similarly, the study of Chung et al. (2024) emphasized that low variability in responses often reflects a strong consensus on the approach's effectiveness and usability.

Table 2: Shown the result of ANCOVA on the influence of technological access, self-directed learning readiness, and instructor support on students' acceptance and engagement with the flipped classroom model in chemistry

Source of Variation	SS	Df	MS	F	P-value	Partial η^2
Technological Access	15.72	1	15.72	8.54	0.004	0.092
Self-Directed Learning	12.36	1	12.36	6.71	0.011	0.074
Instructor Support	18.05	1	18.05	9.89	0.002	0.104
Covariate (Prior GPA)	9.44	1	9.44	5.17	0.025	0.057
Error	141.82	77	1.84			
Total	**197.39**	**81**				

Source: Author's survey, 2025

The results of this study is in-line with a Cronbach's alpha coefficient ($\infty = 0.78$) indicating high internal consistency of the instrument, revealed that technological access, self-directed learning readiness, and instructor support have a statistically significant influence on students' acceptance and engagement with the flipped classroom model in chemistry ($p < 0.05$). The findings of this study supported the study of Adeyemi and Ajibola (2024) reported that robust digital infrastructure significantly enhances student participation in flipped learning environments and aligns with Mensah and Oduro (2025) emphasized that both instructor support and learners' self-directed readiness are critical to maximizing engagement. Similarly, the study of Omole and Ibrahim (2023) found that the interplay between access to technology and instructional scaffolding determines the success of flipped classroom adoption in STEM education.

Table 3: shown the t-test results of the major challenges and opportunities associated with implementing flipped classroom pedagogy in undergraduate chemistry courses within Oyo State's higher institutions

Group	Mean	Std. Deviation
Treatment Group	77.43	4.79
Non-Treatment Group	71.70	5.59

Source: Author's survey, 2025

The independent samples t-test revealed a statistically significant difference in perceptions toward the flipped classroom pedagogy between the treatment group ($M = 77.43$, $SD = 4.79$) and the non-treatment group ($M = 71.70$, $SD = 5.59$), $t(148) = 6.73$, $p < 0.001$. This indicates that undergraduate chemistry students exposed to the flipped classroom model in Oyo State demonstrated more positive perceptions compared to those taught through traditional methods, suggesting that the flipped classroom approach may enhance students' engagement and receptiveness toward learning. This finding aligns with the study of Chen et al. (2024) reported that flipped classroom instruction in chemistry significantly improved students' attitudes and engagement compared to conventional teaching methods. Similarly, the study of Adewale and Yusuf (2025) discovered that Nigerian undergraduates exposed to flipped pedagogy demonstrated higher enthusiasm and active participation in science classes. Also, the study of Roehl, Reddy, and Shannon (2023) emphasized that the active learning elements of flipped classrooms foster deeper student involvement and improved perceptions in STEM disciplines.

Conclusion

The study investigates how Oyo State undergraduate students viewed the flipped classroom method of teaching chemistry. The findings indicated that most students value the model's interactive and student-centered features. Students' acceptance and engagement are greatly influenced by their access to technology, their readiness for self-directed learning and their instructors' support. Obstacles like uneven instructor preparedness and a lack of digital infrastructure still exist. Chemistry education can be enhanced by focused technological investments, thorough teacher preparation and on-going student involvement.

Recommendations

The study recommended the following:

i. the study recommended that chemistry educators in Oyo State should integrate the flipped classroom approach to be more systematic into their teaching that would support by adequate training and access to digital resources, maximize its benefits for students engagement and comprehension.

ii. The study recommended that higher institutions in Oyo State should invest in improving students' access to reliable digital technologies and provide structured capacity-building programs for both students and instructors to enhance self-directed learning skills and instructional support by fostering greater acceptance and engagement with the flipped classroom model in chemistry.

iii. The study recommended as well that higher institutions in Oyo State should integrate flipped classroom pedagogy into undergraduate chemistry curricula by providing adequate technological infrastructure, structured instructor training, and continuous student orientation programs to maximize engagement, acceptance, and learning outcomes.

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