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Effect of Flipped Classroom Strategy on Self-Efficacy in Chemistry Learning among Secondary School Students in Gumel Education Zone, Jigawa State, Nigeria

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Abstract

This study examined the effect of the flipped classroom strategy on self-efficacy among secondary school chemistry students in Nigeria, focusing on gender differences. A quasi-experimental design involved 90 Senior Secondary School II students (32 males, 58 females) from two schools in Jigawa State. The experimental group (n = 48) received flipped classroom instruction using offline video lessons on oxidation-reduction reactions, while the control group (n = 42) received conventional instruction. Data were collected using a validated 20-item Self-Efficacy Questionnaire (Cronbach's $\alpha = 0.99$) and analyzed using ANOVA. Results showed that students taught through the flipped strategy had significantly higher self-efficacy ($M = 87.71$) than those taught conventionally ($M = 32.36$), $F(1,88) = 7629.59$, $p < 0.001$, with no significant gender difference ($p = 0.209$). The study concludes that the flipped classroom significantly improves chemistry self-efficacy, offering an inclusive approach for science education in resource-limited settings.

Keywords: flipped classroom, self-efficacy, chemistry

Introduction

Education in the twenty-first century increasingly emphasizes learner-centered teaching strategies that not only transmit knowledge but also foster confidence, autonomy, and higher-order thinking skills among students. In science education, particularly chemistry, learners are often confronted with abstract concepts, symbolic representations, and complex problem-solving tasks that challenge their cognitive and affective capacities. As a result, many students develop anxiety and low confidence when engaging with chemical concepts (Özgür, 2021). To address these challenges, scholars and educators have turned attention toward approaches that actively engage learners and strengthen their belief in their capabilities. Self-efficacy, as conceptualized by Bandura (1977), refers to individuals' beliefs in their abilities to organize and execute actions required to attain specific goals. It represents a central construct in social cognitive theory, influencing motivation, persistence, and academic success. In the context of chemistry learning, students with high self-efficacy are more likely to participate actively, persevere in difficult tasks, and achieve higher learning outcomes than their low-efficacy counterparts (Gibbons & Raker, 2018). Conversely, those with diminished self-efficacy tend to disengage or avoid cognitively demanding activities, which contributes to persistent underachievement in science subjects (Badriah, 2025). Empirical studies in developed contexts have consistently demonstrated that student-centered strategies, including flipped classroom instruction, enhance learners' self-efficacy and achievement by providing greater opportunities for mastery experiences, social interaction, and self-paced learning (Sun et al., 2023; Han & Hamzah, 2024). The flipped classroom model reverses the traditional instructional sequence by introducing content outside class often through videos, readings, or multimedia while dedicating class time to active learning, collaboration, and teacher-guided practice. This design enables learners to construct knowledge at their own pace and fosters autonomy and self-reflection (Na et al., 2024). However, in Nigeria and other developing countries, chemistry instruction remains predominantly teacher-centered, characterized by rote memorization, limited practical activities, and minimal student participation (Odedokun et al., 2023). The consequences of this approach are evident in students' poor performance and negative attitudes toward chemistry. Data from the National Examination Council (2024) in Jigawa State indicated a failure rate of approximately 69.8% in chemistry, suggesting that traditional pedagogical models are insufficient for developing conceptual understanding and affective skills such as self-efficacy. Additionally, existing research in Nigeria has focused primarily on the relationship between self-efficacy and achievement rather than investigating pedagogical interventions that can systematically enhance students' confidence in learning chemistry.



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Theoretically, this study draws from Bandura's (1977) Self-Efficacy Theory, which posits that individuals' performance and motivation are influenced by their belief in their ability to succeed. The flipped classroom provides mastery experiences, vicarious learning, and positive feedback all critical sources of self-efficacy development. Conceptually, this study assumes that when learners are exposed to pre-class video content and in-class interactive activities, their sense of competence and confidence in handling chemistry tasks increases. Empirically, previous findings support this assertion, demonstrating significant gains in students' self-efficacy following the adoption of flipped classroom strategies (Sun et al., 2023; Bardach et al., 2024). Nevertheless, there is limited evidence within the Nigerian secondary school context, particularly in Jigawa State, to validate these outcomes. In summary, the review of literature reveals a consistent pattern that while the flipped classroom model has been associated with improved self-efficacy in diverse educational settings, its application and impact in Nigerian secondary chemistry classrooms remain underexplored. Furthermore, the lack of context-specific studies examining gender-based differences in chemistry self-efficacy under flipped classroom instruction underscores the need for empirical investigation.

Statement of the Research Problem

Despite the global evidence supporting flipped classroom instruction as a means of enhancing students' confidence and learning outcomes, Nigerian secondary school chemistry classes remain dominated by teacher-centered practices that limit active engagement and self-belief. Many students perceive chemistry as difficult, leading to low self-efficacy, poor motivation, and persistently low achievement levels. While studies have established correlations between self-efficacy and academic achievement, few have examined how flipped classroom strategies influence students' self-efficacy in chemistry learning within the Nigerian context, especially in Gumel Education Zone of Jigawa State. This study therefore seeks to fill this gap by empirically investigating the effect of flipped classroom strategy on students' self-efficacy in chemistry learning, with particular attention to gender differences in outcomes.

Objectives of the Study

The objectives of the study were to determine:

1. The difference in self-efficacy scores between students taught chemistry using the flipped classroom strategy and those taught using conventional methods.
2. The difference in self-efficacy scores between male and female students taught chemistry using the flipped classroom strategy.

Research Questions

1. What is the effect of flipped classroom strategy on students' self-efficacy in chemistry learning in Gumel Education Zone?
2. What is the difference in self-efficacy scores between male and female students taught chemistry using flipped classroom strategy?

Hypothesis

H₀₁: There is no significant difference in self-efficacy scores between students taught chemistry using flipped classroom and conventional strategies.

H₀₂: There is no significant difference in self-efficacy scores between male and female students taught chemistry using flipped classroom strategy.

Methodology

Research Design

This study employed a quasi-experimental, non-randomized control group design. The choice of design was appropriate because it allowed systematic comparison between two instructional strategies that is the flipped classroom and conventional lecture while maintaining the natural classroom structure without random reassignment of participants. The design enabled the researcher to determine the effect of flipped classroom strategy on students' self-efficacy in chemistry learning and to examine possible gender differences. The study framework was:



Where O_1 represents pre-intervention measures, X_1 represents flipped classroom treatment, X_2 represents conventional instruction, and O_2 represents post-intervention measures.



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Population, Sample and Sampling Technique

The population of the study comprised all Senior Secondary School II (SS II) chemistry students in public secondary schools within Gumel Education Zone of Jigawa State, Nigeria. Two mixed-gender public secondary schools with similar student demographics, resources, and academic backgrounds were purposively selected to ensure comparability and minimize bias. A total of 90 students participated in the study, consisting of 32 males and 58 females. The experimental group (n = 48) received flipped classroom instruction, while the control group (n = 42) was taught using the conventional lecture method.

Self-Efficacy Questionnaire (Se-Q):

The Self-Efficacy Questionnaire (Se-Q) was subjected to both face and content validation by a panel of experts to ensure its relevance and alignment with the study objectives. Feedback from these experts was incorporated to refine the items for clarity, construct coverage, and suitability before administration. It was a modified 20-item instrument based on Bulfone et al. (2020), adapted for chemistry learning contexts. Items assessed students' confidence in various chemistry learning activities using a 5-point Likert scale (1 = Not confident, 5 = Very confident). The instrument demonstrated high internal consistency (Cronbach's $\alpha = 0.99$).

Data Collection and Analysis

Approval was obtained from the participating schools, and consent letters were given to students for permission of use of gadget at home to which they were briefed on the instructional procedures before implementation. The study lasted for six weeks during which the experimental group was taught using the flipped classroom approach. This involved students watching short offline video lessons of 5–15 minutes before class and participating in collaborative problem-solving, group discussions, and guided inquiry activities during class. The control group, on the other hand, was taught the same chemistry content using the conventional lecture method, which focused mainly on teacher explanations, note-taking, and limited student interaction. At the end of the instructional period, the Self-Efficacy Questionnaire (Se-Q) was administered to both groups to collect post-intervention data on students' chemistry self-efficacy. Self-efficacy data were collected post-intervention using the Se-Q instrument. Data were analyzed using SPSS, employing descriptive statistics (means, standard deviations) and inferential statistics (ANOVA) to test hypotheses at $\alpha = 0.05$ significance level.

Presentation of Results

Self-Efficacy Differences

1. What is the effect of flipped classroom strategy on students' self-efficacy in chemistry learning in Gumel Education Zone?

Table 1: Mean and Standard Deviation of Self-Efficacy Scores by Group

Group	N	M	SD	Mean Difference
Experimental	48	87.71	2.63	55.35
Control	42	32.36	3.37	

Source: Field work 2025, Note: M = Mean; SD = Standard Deviation.

The descriptive results revealed a substantial difference in self-efficacy scores between the experimental and control groups, with students in the flipped classroom group (M = 87.71, SD = 2.63) outperforming those in the conventional group (M = 32.36, SD = 3.37).

H₀₁: There is no significant difference in self-efficacy scores between students taught chemistry using flipped classroom and conventional strategies

Table 2: ANOVA Summary for the Effect of Flipped Classroom on Self-Efficacy

Source	Type III Sum of Squares	df	Mean Square	F	Sig. (p)
Corrected Model	68,628.096 ^a	1	68,628.096	7,629.59	.000
Intercept	322,912.096	1	322,912.096	35,899.087	.000
Group	68,628.096	1	68,628.096	7,629.587	.000
Error	791.560	88	8.995		
Total	414,017.000	90			
Corrected Total	69,419.656	89			

Source: Field work 2025

ANOVA results above further indicated a highly significant difference between groups, $F(1, 88) = 7,629.59, p < .001$, with an exceptionally large effect size ($\eta^2 = .989$). This finding shows that the flipped classroom strategy had a profound positive impact on students' chemistry self-efficacy compared to traditional instruction.

Gender Differences

What is the difference in self-efficacy scores between male and female students taught chemistry using flipped classroom strategy?

Table 3 : Mean and Standard Deviation of Self-Efficacy Scores by Gender (Experimental Group)

Gender	N	M	SD	Mean Difference
Male	17	87.06	3.19	-1.01
Female	31	88.06	2.25	

Source: Field work 2025

Although female students ($M = 88.06, SD = 2.25$) recorded slightly higher self-efficacy scores than their male counterparts ($M = 87.06, SD = 3.19$).

H₀₂: There is no significant difference in self-efficacy scores between male and female students taught chemistry using flipped classroom strategy.

Table 4 ANOVA Summary for Gender Differences in Self-Efficacy (Experimental Group)

Source	Type III Sum of Squares	df	Mean Square	F	Sig. (p)
Corrected Model	2.698 ^a	1	2.698	1.623	.209
Intercept	350,222.344	1	350,222.344	210,788.5	.000
Gender	2.698	1	2.698	1.623	.209
Error	76.478	46	1.663		
Total	354,214.000	48			
Corrected Total	79.176	47			

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Source: Field work 2025

ANOVA results shows that the difference between gender was not statistically significant, $F(1, 46) = 1.623, p = 0.209$. This result suggests that the flipped classroom strategy was equally effective for both genders in improving self-efficacy in chemistry learning.

Discussion of Findings

Impact of Flipped Classroom on Self-Efficacy

This finding strongly supports the hypothesis that flipped classroom instruction significantly enhances students' self-efficacy in their chemistry learning abilities. Students taught through the flipped classroom strategy achieved higher self-efficacy scores than those taught through conventional methods. Several mechanisms likely contributed to this enhancement. Mastery experiences were provided through the pre-class video component, which allowed students to learn at their own pace, reducing anxiety and enabling early success before class. Vicarious learning occurred during in-class collaborative activities, where students observed and learned from peers' problem-solving strategies. The flipped format also reduced performance anxiety, as students could pause, replay, and reflect on video lessons without fear of public mistakes. Active engagement during class through problem-solving and discussions created opportunities for students to demonstrate competence and build confidence. These findings align with Bandura's self-efficacy theory and support previous research that shows flipped classrooms improve affective learning outcomes (Sun et al., 2023; Han & Hamzah, 2024).

Gender Equity in Self-Efficacy Development

The lack of significant gender differences in self-efficacy development within the experimental group suggests that flipped classroom instruction may offer an equitable approach to chemistry education. This finding is important in the Nigerian context, where gender disparities in science achievement often disadvantage female students. The slightly higher, though non-significant, self-efficacy scores among females may reflect the collaborative and discussion-based nature of flipped classroom activities, which some research suggests may align with female learning preferences. However, the minimal difference indicates that both male and female students benefited from the intervention. This result agrees with Bardach et al. (2024) and Na et al. (2024), who found that flipped classroom instruction provides inclusive learning environments that reduce gender gaps in learning outcomes. Therefore, flipped classroom instruction supports gender equity and promotes equal participation and confidence among learners.

Educational and Theoretical Implications

The findings of this study have several implications for teaching, learning, and educational theory. Chemistry teachers should adopt flipped classroom methods to build students' confidence and improve achievement. The high increase in self-efficacy shows that flipped learning supports affective needs that traditional teaching often ignores. Teacher professional development programs should train educators to prepare video lessons and lead active class discussions. The success of offline video lessons also shows that flipped classrooms can be effective even in schools with limited resources. The exceptionally large effect size observed in this study demonstrates the strong link between instructional design and students' self-belief, supporting Bandura's (1977) view that learning environments influence self-efficacy development. This study also extends flipped classroom research by emphasizing affective outcomes, showing that this approach not only improves achievement but also promotes confidence, motivation, and equity in science education.

Conclusion

This study provides compelling evidence that flipped classroom instruction significantly enhances chemistry self-efficacy among secondary school students. The gender-neutral effects suggest that flipped classroom instruction offers an equitable approach to chemistry education, potentially addressing some of the motivational barriers that traditionally disadvantage students in science learning. For educational systems seeking to improve both academic and affective outcomes in chemistry education, these findings strongly support investment in flipped classroom implementation and teacher professional development. The success of offline video distribution in this resource-constrained environment demonstrates that innovative pedagogical approaches need not require extensive technological infrastructure. This accessibility makes flipped classroom instruction a viable strategy for improving chemistry education across diverse educational contexts. As chemistry education continues to grapple with low



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achievement and negative student attitudes, the profound self-efficacy benefits demonstrated in this study suggest that flipped classroom instruction deserves serious consideration as a transformative pedagogical approach.

Recommendations

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

1. Chemistry teachers should integrate flipped classroom strategies into their instructional practices to enhance students' self-efficacy and achievement in chemistry learning.
2. Teacher education institutions and ministries of education should organize workshops and professional development programs to train teachers on developing and delivering flipped classroom lessons effectively.
3. Educational authorities should provide schools with basic resources for offline video production and sharing to ensure equitable access and sustainability of the flipped classroom approach.

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