

COMPARATIVE EFFECTS OF TEACHING STRATEGIES ON STUDENTS' ACADEMIC PERFORMANCE IN SECONDARY SCHOOL CHEMISTRY IN ORON LOCAL GOVERNMENT AREA

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ABSTRACT: This study investigated the effect of Teaching Strategies on Students' Academic Performance in Chemistry in Oron Local Government Area. The study adopted a quasi-experimental pretest posttest research design. The population of the study consisted of 1663 Senior Secondary One (SSS1) students in the public secondary schools in Oron Local Government Area. 140 Senior Secondary School One students were selected for the study using multistage sampling techniques, where simple random technique was used to select 3 public secondary schools out of the 5 public secondary schools in the study area, and the students were taught in their intact classes. The instrument used for data collection was the "Chemistry Performance Test on Particulate Nature of Matter". The instrument was subjected to face and content validity. A reliability coefficient of 0.85 was obtained for the instrument using the Kuder-Richardson formula 20. Mean and Standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the

hypotheses at .05 level of significance. The findings show that there is no significant difference between the mean performance scores of chemistry students taught using flipped, rotational, and supplemental teaching strategies; there is no significant difference between the mean performance scores of male and female students in chemistry when taught using flipped, rotational, and supplemental teaching strategies. It was concluded that teaching strategies improve students' academic performance. It was therefore recommended, among others, that for effective teaching strategies in enhancing students' academic performance and retention in chemistry, teachers should make use of rotational teaching strategy.

Introduction

In modern society, science is an essential cornerstone of both professional pursuits and everyday living. Today, educators and policymakers emphasize the importance of science education as a critical tool for equipping future generations with the necessary skills to navigate and succeed in a technology-driven world. Scientific advancements have far-reaching implications across various sectors, prompting nations to prioritize science education to develop a workforce capable of addressing complex global challenges. This emphasis on science is further supported by recent studies that highlight the need for innovative pedagogical approaches to meet evolving educational demands (Akintolure et al., 2023; Umoetuk et al., 2025). Human curiosity has long motivated the systematic exploration of natural phenomena, from early stargazing to modern scientific inquiry using disciplined approaches that have greatly expanded our understanding of the natural world (Uwazurike & Dike, 2019). Such inquiries are now being re-examined through modern frameworks that emphasize practical applications and retention of knowledge, particularly in disciplines like chemistry. Chemistry translates broad scientific principles into practical applications, deciphering the composition, properties, and transformations of matter to bridge theory with everyday applications.

As the central science, chemistry is fundamental to understanding matter and its transformations (Umanah & Babayemi, 2024). It underpins diverse fields such as medicine, engineering, and agriculture, making it indispensable for both academic and industrial progress (Achor et al., 2022). Chemistry drives the development of life-saving pharmaceuticals, sustainable agricultural practices, and eco-friendly technologies, thereby playing a pivotal role in addressing environmental challenges. Recent research underscores the

need for chemistry education that not only delivers content but also fosters practical problem-solving and sustainability (Azeez et al., 2022).

Despite chemistry's central role in societal development, student performance in the subject remains a significant concern, particularly in high-stakes examinations such as the West African Senior School Certificate Examination (WASSCE). Reports from WAEC Chief Examiners (2022-2024) highlight a worrying trend of poor performance, prompting investigations into the efficacy of current instructional methodologies (Ojukwu, 2016; Ibezim, 2018). Studies have noted that the abstract nature of key topics such as stoichiometry, chemical equilibrium, electrochemistry, and the particulate nature of matter, among others, often leads to poor comprehension and performance (Ajayi & Ogbeba, 2017; Umanah & Sunday, 2022). Additionally, the predominance of traditional, teacher-centred approaches tends to limit student engagement, thereby hindering effective learning. These challenges necessitate a critical evaluation of instructional methods, especially in light of recent evidence suggesting that active learning strategies can significantly enhance students' understanding and performance (Ahmad & Halliru, 2022; Hultberg et al., 2018). Thus, by integrating practical exercises, simulations, and real-life applications, blended learning provides a more interactive and engaging educational experience that can cater to diverse learning styles. As a result, blended learning has emerged as a popular method in 21st-century education, promoting improved student engagement, motivation, and academic success (Akpan et al., 2025; Tabassum et al., 2024). Blended learning is not a one-size-fits-all approach; it includes various models such as the flex model, self-blend model, enriched virtual model, flipped teaching strategies, rotational teaching strategies, and supplemental teaching strategies. This diversity of models allows educators to tailor instruction to specific educational needs and objectives, thereby potentially maximizing student engagement and performance in subjects such as chemistry (Khader, 2016; Atabang, 2024).

Itighise and Umana (2019) defined flipped classroom model as an innovative instructional approach where traditional in-class activities, such as content delivery, are assigned as homework. In contrast, typical homework tasks are completed during classroom sessions (Akintolure et al., 2023). In this model, teachers serve as facilitators, guiding students through discussions, problem-solving exercises, and hands-on activities rather than simply delivering content (Akçayır & Akçayır, 2018). This method has been widely implemented in schools and

universities across various disciplines, including Mathematics, Social Sciences, Humanities, and Chemistry. Research indicates that the flipped teaching strategies enhance students' learning experiences and academic performance. Additionally, it fosters student engagement, motivation, teamwork, creativity, and problem-solving skills, making learning more interactive and enjoyable compared to traditional teaching methods (Umoetuk & Akpan, 2023; Awidia & Paynterb, 2019). Recent studies have examined the impact of flipped teaching strategies on academic performance, engagement, learning outcomes, and motivation. Findings suggest that it significantly improves students' academic performance, learning outcome and boosts students' academic performance (Umoetuk & Akpan 2023; Chen et al., 2017; Yılmaz, 2017). However, not all studies have reported positive results. For instance, Smallhorn (2017) found no significant improvement in students' academic achievement, while Kim et al. (2014) did not observe any correlation between the flipped classroom model and increased student grades. Similarly, Sun and Wu (2016) reported that the model did not have a notable impact on teacher-student interactions or learning satisfaction.

The rotational model is a blended learning approach in which students are divided into three to four groups and rotate through different learning activities, at least one of which is technology-based (Horn & Staker, 2015). In this model, students engage in small group instruction, where the teacher provides direct guidance on the topic; collaborative activities, where the students discuss and explore concepts together; and online learning, where they watch instructional videos related to the lesson. Each group spends a fixed amount of time, typically around twenty minutes, on an activity before rotating to the next. The online component allows students to learn at their own pace, while the classroom setup fosters teamwork and collaboration. Additionally, real-time feedback helps learners make immediate adjustments to their understanding (Yoade & Asaju, 2024). Research has shown that the rotational model can positively impact student learning outcomes. A study by Osuji and Abraham (2024) found that students taught using the rotational classroom model performed better than those in a traditional learning environment. However, findings by Tremmel (2018) suggest that while there is no conclusive evidence that the rotational model significantly boosts student engagement and achievement, it still holds potential benefits in these areas. The supplemental teaching strategy is a blended learning approach in which students receive initial instruction through traditional face-to-face teaching, followed by technology-supported activities and additional learning materials outside the classroom (Olasupo et al., 2021).

These supplementary activities may include charts, question-and-answer sessions, role-playing, quizzes, and other interactive tasks designed to reinforce classroom learning. Vygotsky's (1978) social constructivist theory, as cited in Olasupo et al. (2021), supports this approach by emphasizing the importance of creating a learning environment where students actively engage in activities that promote knowledge construction. Educational media also play a significant role in facilitating classroom interactions, either by introducing new concepts or reinforcing previously learned material. In this model, teachers provide guidance when students encounter difficulties, ensuring that learning continues effectively beyond the classroom setting. Research has shown that the supplemental teaching strategies enhance student engagement, promote collaborative learning, and serve as a valuable tool for gathering feedback from students (Adebola, 2020; Budiharso & Tarman, 2020; Double et al., 2020; Sukrajh, 2018). Several studies have highlighted its role in improving student performance (Skoglund et al., 2018; Omodan & Ige, 2021; Edikpo et al., 2024), while others assert that supplemented instruction enhances students' conceptual understanding (Adebola et al., 2020; Kapur, 2018; Malm et al., 2018). Beyond academic achievement, this model fosters student participation in discussions, creating a dynamic and interactive learning experience that benefits both instructors and learners. Additionally, feedback obtained through the supplemental model plays a crucial role in refining teaching strategies and addressing students' learning needs. However, gender has emerged as a key factor influencing academic performance in secondary school chemistry.

Gender is a psychological construct that defines behaviours and attributes associated with being male or female (Umanah & Sunday, 2022; Atabang & Umanah 2024). Research findings on gender differences in academic achievement have been inconsistent, with some studies reporting performance disparities between male and female students, while others indicate no significant difference. For instance, Aniodoh and Egbo (2023) found that female chemistry students outperformed their male counterparts when taught qualitative analysis using the inquiry role instructional model. Conversely, other studies suggest that male students perform better in chemistry (Gongden, 2016). Meanwhile, some researchers argue that gender does not significantly affect students' academic performance in chemistry (Umanah & Akpan, 2024; Umanah & Sunday, 2022). Given these conflicting findings, recent research underscores the importance of exploring how gender interacts with innovative teaching models to influence learning outcomes in chemistry. Therefore, this

study seeks to systematically examine the effects of flipped, rotational, and supplemental teaching strategies on students' academic performance in chemistry in the Oron Local Government Area.

Statement of the Problem

The poor academic performance in chemistry is a persistent concern, with consistently low external examination scores highlighting significant deficiencies in student understanding. However, traditional teacher-centred methodologies dominate the instructional landscape, often resulting in passive learning environments that fail to engage students with complex topics such as stoichiometry, chemical equilibrium, and electrochemistry, among others. Recent studies suggest that while the flipped teaching strategy has shown promise in enhancing engagement and academic performance, other blended learning models, such as the rotational and supplemental teaching strategy, may offer additional benefits. However, empirical evidence on their effectiveness in improving chemistry performance, particularly in the context of external examinations, remains scarce. Furthermore, inconsistent findings regarding gender-specific outcomes indicate that the impact of these instructional models may differ between male and female students. This underscores the necessity for a nuanced investigation into how these innovative teaching strategies affect academic performance across different genders. Thus, this study is designed to systematically evaluate the effects of teaching strategies on students' performance in chemistry, with a particular focus on secondary school chemistry students and gender-related differences.

Research Questions

1. What are the mean differences in academic performance scores of students in chemistry when taught using flipped, rotational, and supplemental teaching strategies?
2. What are the mean differences in performance scores of male and female students in chemistry when taught using flipped, rotational, and supplemental teaching strategies?

Hypotheses

1. There is no significant difference in the mean academic performance scores of students in chemistry when taught using flipped, rotational, and supplemental teaching strategies.

2. There is no significant difference in the mean performance scores of male and female students in chemistry when taught using flipped, rotational, and supplemental teaching strategies.

Methodology

This study was conducted in Oron Local Government Area using a quasi-experimental design. Specifically, a non-randomized pretest-posttest, non-equivalent control group design. The population of the study consisted of 1663 Senior Secondary One (SS1) Chemistry students in the five (5) public secondary schools in the study area. 140 Senior Secondary One students were selected for the study using multistage sampling techniques, where the simple random technique was used to select 3 public secondary schools out of the 5 public secondary schools in the study area, and the students were taught in their intact classes. The instrument used for data collection was the Chemistry Performance Test on Particulate Nature of Matter (CPTPNM). The instrument is a multiple-choice test with a total of fifty (50) items. A reliability coefficient of 0.85 was obtained for the instrument using the Kuder-Richardson formula 20. The instrument was validated by two Chemistry lecturers and an expert in measurement and evaluation in the Department of Science Education, Akwa Ibom State University. The three (3) schools were taught the same concepts of Particulate Nature of Matter in Chemistry as prepared by the researcher in the lesson plan. After the classroom instruction, the reshuffled version of the CPT was administered as a posttest to measure the effect of the treatment on the students' performance by the research assistants under the strict supervision of the researcher. Mean and standard deviation were used to answer the two (2) research questions, while analysis of covariance (ANCOVA) at the 0.05 level of significance was used to test the two null hypotheses of this study.

Results

Research Question 1: What are the mean differences in academic performance scores of students in chemistry when taught using flipped, rotational, and supplemental teaching strategies?

Table 1: Mean and standard deviation of mean academic performance scores of students on pretest and posttest based on treatment groups.

Instructional Teaching Strategies	N	Pretest X	SD	Posttest X	SD	Mean gain
Flipped	45	3.77	12.60	41.15	12.43	7.93
Rotational	50	33.10	12.81	9.08	11.24	4.02
Supplemental	45	32.68	9.57	5.17	9.19	3.91

The result in Table 1 shows that in the pretest, students in FTS and STS (rotational teaching strategy and supplemental teaching strategy) had mean scores of 33.10 and 32.68 with standard deviations of 12.81 and 9.57, respectively. In the posttest, students taught using RTS and STS had mean scores of 49.08 and 45.17 with standard deviations of 11.24 and 9.19, respectively, while those in FTS (Flipped Teaching strategy) had a mean and standard deviation score of 41.15 and 12.43, respectively. Also, the mean gain scores of RTS (rotational teaching strategy) 15.98 is higher than that of STS (supplemental teaching strategy), 13.09 and FTS 7.38. This indicates that students taught Chemistry using RTS had the highest performance mean gain. While those in STS performed higher than those in FTS.

Research Question 2: What are the mean differences in performance scores of male and female students in chemistry when taught using flipped, rotational, and supplemental teaching strategies?

Table 2: Mean and standard deviation of mean performance scores between male and female students on pretest and posttest scores based on teaching strategies

Gender	N	Pretest X	SD	Posttest X	SD	Mean difference
Male	69	38.37	11.87	4.65	10.58	6.28
Female	71	28.01	8.84	45.86	12.30	17.85

The results in Table 2 show the mean and standard deviation of mean performance scores between male and female students on a pretest and posttest basis based on gender. Male students taught the concept of the particulate nature of matter had a post-test score of 44.65, while their female counterparts had 45.86, respectively. The mean difference between males and females, as revealed in the table, is 1.21. The result further shows that females had a higher mean performance level than males when taught the concept of the particulate nature of matter in chemistry.

Hypothesis 1: There is no significant difference in the mean academic performance scores of students in Chemistry when taught using flipped, rotational and supplemental teaching strategies.

Table 3: Analysis of Covariance (ANCOVA) of students' mean performance scores when taught using FTS, RTS and STS.

Source	Type III sum of square	Df	Mean square	f	Sig,
Corrected strategy	7065.19a	6	1177.53	14.04*	.00
Intercept	3828.51	1	3828.51	45.66*	.00
Pretest	4724.11	1	4724.11	56.34*	.00
Teaching strategies	175.07	2	87.53	1.04	.35
Error	1451.49	133	83.84		
Total	306416.00	140			
Corrected Total	18216.68	139			
a. Rsquare = () Adjusted R square = ()					

ANCOVA Test result in Table 3 reveals that there is a significant difference in the mean performance scores of chemistry students taught the concept of the particulate nature of matter using FTS, RTS and STS ($F=1.04$; $p = 0.05$). Since the P-value is not less than the level of significance, null hypothesis 1 of the study is retained. Thus, there is no significant difference between the mean performance scores of chemistry students taught using flipped, rotational and supplemental teaching strategies.

Hypothesis Two: There is no significant difference in the mean performance scores of male and female students in chemistry when taught using flipped, rotational, and supplemental teaching strategies

Table 4: Results of Analysis of Covariance (ANCOVA) on the difference in the mean performance scores of male and female students based on the teaching strategies.

Source	Type III sum of square	Df	Mean square	F	Sig,
Corrected strategy	7065.19a	6	1177.53	14.04*	.00
Intercept	3828.51	1	3828.51	45.66*	.00
Pretest	4724.11	1	4724.11	56.34*	.00
Gender	50.71	1	50.71	.605	.44
Error	11151.49	133	83.84		
Total	306416.00	140			
Corrected Total	18216.69	139			

*Significant at the 0.05 level

The result in Table 4 reveals that there is no significant difference in the mean performance scores of male and female chemistry students taught the concept of the particulate nature of matter ($F = 605$; $p = 0.44$). Since the P-value is greater than the level of significance, the null hypothesis 3 is retained at 0.05 level of significance. This implies that, there is no significant difference between the mean performance scores of male and female students in chemistry when taught using flipped, rotational and supplemental teaching strategies.

Discussion of Findings

The finding revealed that there was no significant difference between the academic performance scores of students in Chemistry when taught using FTS, RTS and STS. This was not surprising since there was a significant difference in the posttest performance scores of students in the treatment groups. This implies that the treatment offered to the treatment groups played a key role in improving students' knowledge in Chemistry. These findings are in support of Udofia and Sambo (2024), who asserted that ineffective teaching strategies adopted in the teaching of Chemistry often lead to poor performance. Akpan (2025) also asserted that the expository method and teachers' centeredness have seemingly not yielded the expected positive result.

The finding further showed that there was no significant difference between the mean performance scores of male and female students in chemistry when taught using flipped, rotational, and supplemental teaching strategies. This significant difference in the posttest mean between male and female who had a higher mean difference than their male counterparts. According to Udofia (2024), male and female students taught hydrocarbon significantly differ in achievement and retention scores, thereby revealing that male and female students are capable of competing and collaborating in Chemistry. In contrast, Akpan (2025) asserted that girls tended to exhibit higher performance than their male counterparts.

Conclusion

Based on the findings of the study, it was concluded that rotational teaching strategy performed better than supplemental while flipped teaching strategy was third in academic performance, showing a significant difference between the teaching strategies concerning student academic performance and gender in chemistry.

Recommendations

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

1. Students should be constantly exposed to these teaching strategies for enhancing effective teaching and learning of chemistry concepts.
2. Teachers should adopt the use of innovative, technology-driven teaching strategies for effective teaching and learning.
3. Educational institutions should incorporate innovative pedagogical strategies like FTS, RTS, and STS into their various teacher education programmes as well as their curriculum.

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