Effects of Scaffolding Approach on Senior Secondary School Two Students' Performance in Qualitative Analysis in Jos North, Plateau State

Abdullahi, Maimuna Hussaini, Jantur, Mamfa Ponfa & Areola, Emmanuel Ojo

Department of Science and Technology Education,
University of Jos, Plateau State, Nigeria
maimunabashir223@gmail.com; +234 816 951 3632
ponfamamfa@gmail.com; +234 803 206 3743
emmanuelojoareola@gmail.com; +234 806 314 7487

Abstract

The study investigated the effects of the scaffolding approach on students' performance in qualitative analysis in Jos North. The study adopted a quasi-experimental research design with a non-randomized and non-equivalent pre-test and post-test. The population for the study comprised all 22 public secondary schools located in Jos North, totaling 1, 585 students. A simple random sampling technique was used to sample 98students from the population. The Qualitative Analysis Performance Test instrument with 0.92 reliability coefficient was used for collecting data. The method of data analysis adopted by the study includes descriptive statistics and ANCOVA, for answering the two research questions and testing the two null hypotheses at 0.05 level of significance. The research findings revealed a statistically significant difference in the mean performance scores between students instructed in qualitative analysis through the scaffolding approach and those taught using the lecture method, favoring the experimental group. Additionally, the investigation unveiled that gender did not exert any discernible influence on the performance of students. Therefore, it is strongly recommended that educators integrate the scaffolding approach into the teaching of qualitative analysis as its unequivocal efficacy in enhancing students' performance surpasses the outcomes obtained through the lecture method.

Key Words: Scaffolding Approach, Performance, Qualitative Analysis

Introduction

Science embodies an organized repository of knowledge and a systematic pursuit involving empirical observation and experimentation (Ogunleye, 2010). Science education can be described as a catalyst for the technological progress of Nigeria, enabling significant advancements in development and acting as a pivotal tool for technological growth. This is evident in the specific objectives outlined for secondary and tertiary education within the Nigerian educational system, which emphasize preparing students to thrive effectively in our contemporary era of science and technology (NPSTE, 2018). Chemistry stands as a crucial science subject taught at the senior secondary school (SSS) level, delving into the properties, composition, and behavior of matter, along with its transformations during chemical reactions (Britannica, 2023).

Today, the world is perceived as a global village, and this interconnectedness owes much to globalization, wherein industrialization, with chemistry at its core, presents myriad benefits crucial for national development, spanning food production, clothing, housing, medicine, and transportation (Fowotade, 2012). However, qualitative analysis is a concept in chemistry that focuses on identifying elements, ions, functional groups, or compounds in a sample, offering descriptive insights into its chemical makeup by employing tests like flame or spot tests, as well as techniques such as cation

and anion separation, to confirm the presence or absence of specific substances (Britannica, 2023).

Furthermore, chemistry education in Nigeria, mandated for admission to tertiary science programs, focuses on cultivating students' practical skills and scientific problem-solving approaches through teaching in labs, classrooms, and real-world settings. This aligns with national policy objectives to build a strong knowledge base, laboratory proficiency, and the application of chemical sciences for problem-solving. Consequently, government-led initiatives aim to improve education through curriculum updates, teacher training, and laboratory enhancements (Shamsuddin, Arome, Aminu, Isah & Adamu, 2017).

Despite the government's efforts to enhance chemistry education in Nigeria, studies consistently indicate that students' performance in chemistry, especially at the SSCE level, has been consistently weak and unsatisfactory, despite the considerable significance of chemistry across various facets of human endeavors (Njoku & Ezinwa, 2014; WAEC, 2023). Several factors, including inadequate facilities, class sizes, shortage of qualified educators, lack of student interest, lack of funds, and the abstract nature of chemistry, have been identified as contributors to this subpar performance in chemistry (Onasanya & Omosewo, 2010; Nnoli, 2014).

A contributing factor to this decline lies in the teaching methodologies employed by chemistry educators (Adeniji, 2013). Obiekwe and Ngelita (2013) argue that due to chemistry's crucial role in navigating the dynamic landscape of globalization, it demands instruction using optimal methods and approaches to maximize performance in the subject. However, Obi (2016) reported that the dominant instructional strategy for teaching and learning chemistry in Nigeria's institutions is the lecture method.

The lecture method, according to Kapur (2020), is very good for a large number of students and classes as it makes for easy coverage of the syllabus, saves time, and exposes students to wider knowledge, motivating them to work harder. However, Anu's (2012) study argues that the lecture method encourages rote memorization of ideas, which does not allow learners to capture comprehensively any part of the information exposed for better internalization. This approach should be discouraged in chemistry, considering the fact that chemistry is a practical-based subject. On the other hand, the scaffolding approach, as described by Nzewi & Ibeneme (2011), offers tailored support to learners, strategically addressing learning difficulties and guiding them toward achieving their learning objectives. By progressively removing barriers, scaffolding fosters skill development and enables the transition to more complex tasks through acquired knowledge and improved performance.

Additionally, studies by Ezeudu, Nwafor, Abaeme, and Chukwuka (2019) found that instructional scaffolding improved the performance of students in chemistry compared to the lecture method. This is supported by Olubunmi and Ese (2018), who demonstrated that the scaffolding teaching strategy was more effective than the lecture method in teaching some chemistry concepts in secondary schools. Similarly, Akani's (2015) study revealed that instructional scaffolding enhanced students' performance in chemistry more effectively than the lecture method.

Furthermore, Avwiri's (2020) study revealed that there is no significant relationship between students' gender performance and instructional approaches. Similarly, Akani (2015) found no significant interaction between instructional scaffolding and gender on students' performance in chemistry, as both male and female students performed exceptionally well. A separate study by Ezeudu, Nwafor, Abaeme,

and Ikuelogbon (2019) showed that male and female students performed equally well when exposed to the scaffolding approach.

Blame has also been placed on the approaches adopted by science teachers in teaching chemistry, which are more teacher-centered than learner-centered, consequently resulting in weak student performance (Amuda & Yahaya, 2020; Orbe, Espinosa & Datukan, 2018). The WAEC Chief Examiners' report highlighted students' weaknesses in knowledge of solubility, filtration, inferences, identification of cations and anions, laboratory apparatus, and other aspects of qualitative analysis (WAEC, 2022).

By implication, if these trends continue, the study of chemistry will remain abstract, learners will lose interest, and Nigerian science graduates may fail to meet the scientific challenges of the day. By arranging the literature thematically, readers can better understand the context, challenges, and potential solutions discussed in the research.

However, it is necessary to explore an effective approach to learning chemistry that familiarizes learners, removes the abstract nature of chemistry, and provides necessary support to make learners active rather than passive, thereby improving students' performance in chemistry. The study aims to determine the effects of the Scaffolding Approach on the performance of Senior Secondary Two students in Qualitative Analysis in the Jos North Local Government Area of Plateau State, with the goal of enhancing their overall performance in chemistry, specifically in qualitative analysis.

Objectives of the Study

The study addressed the following objectives:

1. To determine the difference in the mean performance scores of students taught qualitative analysis with the Scaffolding Approach and those taught with the Lecture Method.
2. To ascertain the difference in the mean performance scores of male and female students taught qualitative analysis with the Scaffolding Approach.

Research Questions

The study addressed the following questions.

1. What is the difference in the mean performance scores of students taught qualitative analysis with the Scaffolding Approach and those taught with the Lecture Method?
2. What is the difference in the mean performance scores of male and female students taught qualitative analysis with the Scaffolding Approach?

Hypotheses

The study tested the following hypotheses at a significance level of 0.05.

1. There is no significant difference in the mean performance scores of students taught qualitative analysis with the Scaffolding Approach and those taught with the Lecture Method.
2. There is no significant difference in the mean performance scores of male and female students taught qualitative analysis with the Scaffolding Approach.

Methodology

The study adopted a quasi-experimental design, employing a non-randomized pre-test and post-test structure. This design facilitated the selection of samples for both experimental and control groups, dividing them into two intact classes. The population comprised 1,585 students from 22 public secondary schools in Jos North Local

Government Area, with 790 boys and 817 girls (PSME, 2022), from which Class A (21 boys, 29 girls) and Class B (18 boys, 30 girls) were selected.

Two schools were sampled using a simple random technique from the 22 public senior secondary schools in the area. The study comprised 63 students: an experimental group of 33 students (18 boys, 15 girls), and a control group of 30 students (17 boys, 13 girls). The choice of Senior Secondary two Chemistry Students was apt as they had studied Chemistry for a year, and the study focused on the inorganic aspect of the Qualitative Analysis concept due to reported weaknesses (WAEC, 2023).

Data collection utilized the Qualitative Analysis Performance Test (QAPT), comprising essay questions from the WAEC syllabus, focusing on inorganic qualitative analysis. This instrument underwent validation by subject experts and exhibited high reliability (K-R20 coefficient = 0.85). Lesson plans were prepared, aligning Chemistry content between the schools, and a face-to-face pre-test was administered to gauge students' knowledge.

The researcher and assistants taught stoichiometry for five (5) weeks using the Scaffolding approach for the experimental group and the lecture method for the control group. Both groups underwent a pre-test before teaching commenced and a post-test after five (5) weeks of instruction. The Statistical Package for Social Sciences (SPSS) version 26.0 was employed for data analysis, utilizing descriptive (mean, standard deviation) and inferential statistics (ANCOVA) at a significance level of 0.05.

Results

Research Question One

What is the difference in the mean performance scores of students taught qualitative analysis with the Scaffolding Approach and those taught with the Lecture Method?

Table 1: Mean Achievement Scores of Students Taught Using Scaffolding Approach and Lecture Method.

Groups	Number of Students	Pre-test Mean	S.D	Post-test Mean	S.D	Mean Gain
Experimental	33	2.55	1.56	21.52	2.20	**18.97**
Control	30	4.37	0.96	14.17	2.12	**0.98**

The data presented in Table 1 illustrates the difference between the experimental and control groups in terms of their performance. The experimental group, when taught using the scaffolding approach for qualitative analysis, showcased a notable increase from a pre-test mean of 2.55 (S.D = 1.56) to a post-test mean of 21.52 (S.D = 2.20), resulting in a mean gain of 32.14. Conversely, the control group, instructed through the lecture method for the mole concept, displayed a pre-test mean of 4.37 (S.D = 0.96) and a post-test mean of 14.17 (S.D = 2.12), yielding a mean gain of 15.88. The significant difference emerges as the experimental group's mean gain of 18.97 surpasses the control group's mean gain of 0.98, indicating a marked divergence in performance scores favoring the experimental approach.

To determine the statistical significance of this difference in mean achievement scores between the two groups, an ANCOVA statistic was employed to test hypothesis one.

Research Question Two

What is the difference in the mean performance scores of male and female students taught qualitative analysis with the Scaffolding Approach?

Table 2: Mean Achievement Scores of Male and Female Students Taught Using Scaffolding Approach.

Groups	Number of Students	Post-test Mean	S.D	Re-test Mean	S.D	Mean Gain
Experimental	33	21.52	2.20	13.36	2.01	**8.16**
Control	30	14.17	2.12	8.33	1.94	**5.84**

The data presented in Table 2 illustrates distinct patterns between the male and female genders regarding their pre-test and post-test performance in qualitative analysis taught through the Scaffolding approach.

For the male gender, the pre-test mean stood at 21.52 (S.D =2.20), while the post-test mean escalated to 13.36 (S.D =2.01), resulting in a mean gain of 8.16. Conversely, the female gender exhibited a pre-test mean of 14.17 (S.D =2.12) and a post-test mean of 8.33 (S.D =1.94), leading to a mean gain of 5.84. Remarkably, the mean gain of the female group 8.16 surpassed that of the male group 5.84.

This difference in mean gains indicates a noteworthy difference in the performance scores between male and female students taught stoichiometry through the problem-solving approach. The female cohort demonstrated a higher mean gain, suggesting a potential advantage in learning outcomes over their male counterparts.

To ascertain the statistical significance of the difference in mean performance scores between the male and female groups, an ANCOVA statistic was employed to rigorously test hypothesis two.

Testing the hypotheses

Hypothesis One

There is no significant difference in the mean performance scores of students taught qualitative analysis with the Scaffolding Approach and those taught with the Lecture Method.

TABLE 3: Summary of ANCOVA for mean performance scores of students taught qualitative analysis with scaffolding approach and those taught with lecture method

SOURCE	Type III Sum of Squares	df	Mean Square	F	Sig.
CORRECTED MODEL	849.506[a]	2	424.753	89.902	.000
INTERCEPT	2369.036	1	2369.036	501.422	.000
PRE-TEST	.931	1	.931	.197	.659
TREATMENT	594.115	1	594.115	125.748	.000
ERROR	283.478	60	4.725		
TOTAL	21581.000	63			
CORRECTED TOTAL	1132.984	62			

a. r squared = .750 (adjusted r squared = .741) *significant at α <0.05

The data presented in the table 6 show that the ANCOVA result F (1, 60) = 125.748, p = 0.000, in which the value of p = 0.000 < 0.05. Therefore, the null hypothesis that there is no significant difference in the mean achievement scores of students taught qualitative analysis with scaffolding approach and those taught with lecture method is rejected. This means there is significant difference in the mean

achievement scores of students taught qualitative analysis with scaffolding approach and those taught with lecture method in favour of the experimental group.

Hypothesis Two.

There is no significant difference in the mean performance scores of male and female students taught qualitative analysis with the Scaffolding Approach.

Table 4: Summary of ANCOVA for the Achievement Scores of Male and Female Students Taught Using Scaffolding Approach

SOURCE	TYPE III SUM OF SQUARES	DF	MEAN SQUARE	F	SIG.
CORRECTED MODEL	8.012[a]	2	4.006	.822	.449
INTERCEPT	3602.843	1	3602.843	739.144	.000
PRE-TEST	5.781	1	5.781	1.186	.285
GENDER	.811	1	.811	.166	.686
ERROR	146.230	30	4.874		
TOTAL	15430.000	33			
CORRECTED TOTAL	154.242	32			

a. r squared = .052 (adjusted r squared = -.011) *significant at α <0.05

The data presented in Table 4 shows that the ANCOVA result F (1, 47) = 3.485, p = .068, in which the value of p = .068 > 0.05. Therefore, the null hypothesis that there is no significant difference in the mean achievement scores of male and female students taught stoichiometry using the scaffolding approach is accepted. This means there is no significant difference in the mean performance scores of male and female students taught qualitative analysis using the scaffolding approach as both genders showed equal performance in qualitative analysis.

Discussion

The results from testing hypothesis one show that students taught qualitative analysis with the scaffolding approach performed better than those taught with the lecture method. The significant difference in academic performance in qualitative analysis favoured the experimental group and by implication, the use of scaffolding enhanced students' performance in qualitative analysis. This finding is supported by Ezeudu, Nwafor, Abaeme, Alabi, and Chukwuka (2019) study, which found that the scaffolding approach improved the performance of students in chemistry in comparison to the lecture method. Also, the finding is in conformity with that of the Olubunmi and Ese, (2018) study, which showed that the scaffolding approach enhanced students' performance than the lecture method. Moreover, the finding of the study is in line with that of Akani (2015) study, which revealed that instructional scaffolding enhanced students' performance in chemistry than the lecture method.

The result from testing hypothesis two shows that both male and female students performed equally when they were taught qualitative analysis using the scaffolding approach. The insignificant difference in academic achievement of both genders in

qualitative analysis suggests that the use of the scaffolding approach for the teaching of qualitative analysis is effective for equal performance of both genders. This finding is corroborated by the Avwiri, (2020) study, which reported that the relationship between the students' gender performance and instructional approaches is insignificant. Also, the finding is supported by Akani (2015) study, which showed that both male and female students' performance in chemistry was insignificant. In addition, the finding is in line with a separate study by Ezeudu, Nwafor, Abaeme, Alabi, and Chukwuka (2019), which showed that both students' genders performed equally when they were exposed to the scaffolding approach.

Conclusion

The utilization of the scaffolding approach demonstrates greater effectiveness in enhancing students' performance in qualitative analysis compared to the lecture method. This implies that students who underwent instruction through scaffolding methods attained significantly higher results than those taught via the lecture method. Furthermore, the absence of a notable gender difference among students exposed to the scaffolding approach suggests that this approach equally fosters learning among both male and female students in qualitative analysis.

Recommendations

Based on the study's findings, it is strongly recommended to integrate the scaffolding approach into the teaching of qualitative analysis and other Chemistry concepts, for its unequivocal efficacy in enhancing students' performance surpasses the outcomes obtained through the lecture method. Moreover, educators should make use of the scaffolding approach in teaching and learning chemistry as it stands as a valuable instructional approach for augmenting students' performance, irrespective of their gender.

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