Impact of Anchored Instructional Model on the Academic Performance of Biology Secondary School Students in Sokoto State

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Abstract

The study examined the effect of Anchored Instruction on the academic performance of secondary school Biology students in Sokoto State, Nigeria. A quasi-experimental research design was adopted, employing a pre-test and post-test non-randomized control group format. Intact classes were used, and participants were assigned to either the experimental group, which received instruction through the Anchored Instruction model, or the control group, which was taught using conventional teaching methods. The study was guided by two research objectives, two research questions, and two null hypotheses. Data were collected using the Biology Performance Test (BPT), an instrument validated by experts from the Faculty of Education and Extension Services at Usmanu Danfodiyo University, Sokoto, as well as experienced secondary school Biology teachers. The reliability of the instrument was determined using the test-retest method, yielding a reliability coefficient of 0.81. The population of the study comprised 16,342 Senior Secondary II (SSII) students across six educational zones in Sokoto State. A sample of 622 SSII students was selected for the study, including 324 males and 298 females. Findings revealed that students taught using Anchored Instruction significantly outperformed those taught using conventional methods. Furthermore, both male and female students exposed to Anchored Instruction demonstrated significantly higher performance, indicating the gender-inclusive effectiveness of the method. Based on these findings, it is recommended that Biology teachers receive training in the use of Anchored Instruction, as it has been shown to be more effective than traditional teaching methods.

Keywords: Anchored Instruction, biology and academic performance

Introduction

Education is a fundamental sector and serves as the backbone for the sustainable development of any nation. The classification of countries into developed, developing, and underdeveloped is largely based on their levels of advancement in science, technology, and mathematics (Matazu & Ismail, 2023). As a critical investment in human capital development, education plays a pivotal role in enhancing productivity and fostering economic growth at both micro and macro levels. This underscores the consistent attention given to the state of education in Nigeria as a matter of national concern. However, despite its acknowledged importance, the quality of education in Nigeria has continued to decline across all levels, with adverse implications for the nation's progress in science and technology. Indeed, no nation can surpass the quality of its education system.

Science and technology are integral to the socio-economic development of any country. Biology, as a core science subject at the secondary school level, plays a significant role in preparing students for further scientific pursuits in tertiary institutions. Several empirical studies, including those of Amir and Sarac (2020), Kelvin (2021), Mohammed (2020), Zanny (2023), Ibrahim (2019), Danladi (2023), and Amed and Shaheen (2022), have been conducted with the objective of improving the teaching and learning of Biology at the secondary school level.

Stakeholders across the educational sector have continued to express concern over the persistently low academic achievement in relation to the attainment of educational objectives (Danladi, 2023). Researchers in the field of Science Education, such as Matazu and Ismail (2023) and Danladi (2023), have identified this downward trend and are actively investigating its root causes in an effort to propose effective interventions. Content analysis findings by Tom, Coetzee, and Heyns (2022) highlight a range of factors affecting students' academic performance in Biology. These include the complexity of Biology content, teacher characteristics, pedagogical strategies, availability of instructional resources, teaching methods, and assessment practices in the subject.

The conventional methods of instruction, which are predominantly teacher-centered, have been employed consistently over the years but are now yielding increasingly unsatisfactory outcomes when compared with modern and innovative teaching approaches (Jackson, 2022). The shortcomings inherent in these traditional methods, such as passive learning, limited student engagement, and reduced critical thinking, pose significant challenges to effective teaching and learning, particularly at the secondary school level. In response to these limitations, Idris (2023) emphasized the need to transition from conventional instructional practices to more student-centered, engaging, and interactive pedagogical approaches.

Anchored Instruction represents one such innovative, technology-driven teaching model that aligns with the current digital age where technology is central to nearly all aspects of life. Rooted in the paradigm of social constructionism, Anchored Instruction is a form of situated learning that emphasizes problem-solving and critical thinking within a meaningful, integrated context. Learning in this model is contextualized, allowing students to assume realistic roles that promote active engagement and deeper understanding, especially in science and related disciplines (Kelechi, 2020).

Instruction under this model is structured around an "anchor", often a narrative, scenario, or adventure, culminating in a problem that students must solve. The concept of "anchoring" refers to the linkage established between academic content and authentic, real-world contexts. These anchors are designed to embed all the necessary information, data, clues, and guidance, required for problem resolution, thereby fostering autonomous exploration and knowledge construction. Although similar to problem-based learning (PBL), Anchored Instruction is distinguished by its open-ended nature and emphasis on multimedia and interactive learning tools.

Developed by the Cognition and Technology Group at Vanderbilt (CTGV) in 1990, Anchored Instruction utilizes technologically enriched materials such as videos, simulations, and real-life cases to facilitate learning. As an application of the constructivist approach, it advocates for organizing learning activities around authentic problems or stories that serve as anchors. The model's integration of technology and contextualized content

has demonstrated its capacity to significantly enhance students' academic performance and engagement in science education.

Anchored instruction is an attempt to help students become more actively engaged in the process of teaching and learning by situating or anchoring instruction around a realistic technology-based presentation. Anchored instruction anchors or situates instruction that provide the students with relevant details to help solve problems at hand (Barab, 2020 in Danladi 2023). According to Lonny (2022), Cena and Mitchell (2021), the primary goal of anchored instruction is to solve the inert knowledge problem by permitting students and teachers to comprehend not only the problems and opportunities that experts encounter in different areas but also how experts use knowledge as a tool. Video based anchored instruction provides background knowledge about the problem and creates a shared learning experience for the students with the view to solve problem and brings about meaningful learning. Bottage (2019) revealed that video based anchored instruction are typically shown in a short video usually 8 to12 minutes, which students explore interactively and construct knowledge from the instruction. Video programme results in superior memory because information is dual-coded as both verbal and non-verbal representation. Also, Bottage (2019) opined that all these elements of video programme are necessary tools that will assist the teacher in teaching the skill requirements of students' work which will consequently improve their academic performance.

Several researches were carried out on the effects of anchored instruction some of which are; Adepoju, Shina, Elis and Seracus (2022) who examined the effects of video-based multimedia instruction on secondary school students' performance in biology in Nigeria. Three hundred (300) students (150 boys and 150 girls) were randomly selected from four secondary schools assigned either into one of three experimental groups. The results revealed that there was no statistically significant difference among the experimental groups. Generally, students under multimedia instruction performed better than their colleagues in the conventional teaching method.

In another study Bello (2019) investigated the effects of anchored instruction on senior secondary school performance in biology. The

findings of the study revealed the presence of significant effects of anchored instruction on secondary school students' performance in biology but no significant effect was observed in terms of gender. It was recommended that biology teachers should use anchored instruction during their lessons to improve students' performance. Terry and Tabby (2020) conducted a study where three methods of teaching were compared. Anchored videotapes, cooperative and videotapes. Seventy-two (72) students were involved in this study, and each method was taught by different instructors. The results of this study highlighted there were no significant differences among these three teaching methods with respect to students' scores in the tests. In another study, Kris and Mike (2019) investigated the extent in which lecture anchored instruction affect the students' performance and retention. Twenty-five (25) students were randomly selected to participate in this study. The conclusion of this study reported that there was a significant difference existing between the lecture and anchored instructional approaches on the students' examination. Students taught biology using anchored instruction outperformed those taught using lecture method though.

Research on the influence of gender on students' academic performance has produced inconclusive and often contradictory findings. While some studies report significant gender-based differences in student performance, others suggest that gender has no measurable impact on academic outcomes. Several studies have established that gender interacts with learning processes and may influence academic achievement. For instance, Patrick (2021) conducted a study on gender differences in biology performance among secondary school students in Kumasi, Ghana. The study, which involved 386 students from 23 public secondary schools, revealed that gender was significantly associated with performance in biology, with male students outperforming their female counterparts. This finding implies that instructional models such as Anchored Instruction may exhibit gender sensitivity.

Conversely, Ugin (2022) investigated the effect of gender and Anchored Instruction on the academic performance of 200 senior secondary school biology students drawn from two secondary schools in Uyo, Akwa Ibom State. The findings revealed no statistically significant effect of gender on students' biology performance. This outcome suggests that Anchored

Instruction may be gender-neutral in its application and effectiveness. The disparity in these findings underscores a persistent inconsistency in the literature regarding the role of gender in academic achievement, particularly in the context of biology education.

It is against this backdrop of conflicting evidence that the present study was undertaken to examine the impact of Anchored Instruction on the academic performance of secondary school students in biology in Sokoto State, Nigeria. By doing so, the study aims to contribute to a clearer understanding of the role gender plays in relation to Anchored Instruction and academic achievement in biology.

Theoretical Basis

This study is primarily based on the behavioral learning theory proposed by Watson, which focuses on the factors that motivate and trigger learning, such as photographs, stories, and designs. The theoretical foundation of the anchored instructional strategy, upon which this study is grounded, was articulated by Andrew (1993). He argued that since anchored instruction incorporates engaging stories, complex reasoning, problem-solving, and collaboration to make learning more engaging and authentic, the behavioral learning theory is more suitable. Anchors typically enable students to adjust their behavior, either partially or fully, allowing them to actively apply knowledge to real-world scenarios, thereby ensuring that the knowledge acquired is meaningful.

Statement of the Problem

The WAEC Chief Examiners' Reports (2018, 2019, 2020, 2021, and 2022) consistently highlight the need for students to improve their understanding and application of biology, particularly in relation to genetics concepts, principles, laws, and theories. Despite the emphasis on the importance of various teaching methods and facilities in the science process, there remains a high rate of failure in biology (WAEC Chief Examiners' Reports, 2022). Several factors have been identified as contributing to the persistent issue of low academic performance in biology. These factors include the use of inappropriate and ineffective teaching methodologies, students' lack

of interest, inadequate or lack of instructional materials, large class sizes, insufficiently trained teachers, over-reliance on the conventional lecture method, and an overloaded curriculum, among others (Matazu & Ismail, 2023). This study aims to focus on instructional pedagogies to determine whether they have a significant impact on the academic performance of biology students. In light of the above issues, this study seeks to investigate the effect of anchored instruction on the academic performance of secondary school biology students in Sokoto State.

Objectives of the Study

The following objectives guided this study thus;

1. Determine the effect of anchored instruction and conventional method on Sokoto state secondary school students' academic performance in biology.
2. Investigate the difference in the performance between male and female Sokoto state secondary school students taught biology using anchored instruction.

Research Questions

The following research questions guided the study:

1. What is the effect of anchored instruction and conventional method on Sokoto state secondary school students' academic performance in biology?
2. What is the difference in the performance of male and female Sokoto state secondary school students taught biology using anchored instruction?

Null Hypotheses

The following null hypotheses were formulated to be tested in the study at 0.05 level of significance.

Ho_1: There is no significant difference in the performance of Sokoto state secondary school students taught biology using anchored instruction and those taught using conventional method.

Ho_2: There is no significant difference in the performance between male and female Sokoto state secondary school students taught biology using anchored instructional

Research Methodology

The study employed a quasi-experimental research design using a pre-test and post-test non-randomized pattern. Intact classes were utilized, and the subjects were divided into experimental and control groups. The experimental group was exposed to anchored instruction, while the control group was taught using the conventional method. The population consisted of 16,342 SSII students drawn from six educational zones in Sokoto State. A total of 622 SSII students from the 2022/2023 academic session participated in the study, including 324 male and 298 female students. The SSII students were selected for the study because they were familiar with the school environment and were not preparing for external examinations, making them the most suitable participants as they had stabilized within their schools.

Instrumentation

The instrument used for data collection was the Biology Performance Test (BPT), which consisted of 30 items designed by the researcher in accordance with the SSII biology curriculum. The instrument was validated by experts from the Faculty of Education and Extension Services at Usmanu Danfodiyo University Sokoto, as well as by experienced secondary school biology teachers. The reliability of the instrument was established using the test-retest method, with an interval of three weeks between the first and second administrations. The result of the reliability test yielded a coefficient index of 0.81, indicating that the instrument was reliable and, therefore, suitable for the study. The anchored instructional teaching package was used to teach the experimental group, while the conventional lecture method was employed for the control group.

Method of Data Collection

While descriptive statistics was used in answering the research questions, t-test statistics was used to test the null hypotheses and the result is presented as below;

Answering Research Questions and Testing the Hypotheses

Research question 1: What is the effect of anchored instruction and conventional method on Sokoto state secondary school students' academic performance in biology?

Table 1: Mean and Standard Deviation of Academic Performance scores of students in Experimental and Control Groups

Groups	N	Mean	Standard Deviation	Mean Difference
Experimental Group	324	49.36	7.07	10.83
Control Group	298	38.53	8.64	

Source: Field work 2023

Table 1 shows that students in the experimental group, who were taught biology using the anchored instructional strategy, had a mean performance

score of 49.36 with a standard deviation of 7.07. In contrast, those taught using the conventional teaching method had a mean performance score of 38.53 with a standard deviation of 8.64. The difference between the mean performance scores of students taught using the anchored instructional strategy and those taught with the conventional method is 10.83. This suggests that there is a significant difference in the post-test mean scores between the experimental and control groups, with the students taught using the anchored instructional strategy performing better.

Research Question 2: What is the difference in the performance of male and female Sokoto state secondary school students taught biology using anchored instruction?

Table 2: Mean and Standard Deviation of Academic Performance of male and female Students in Experimental Group

Experimental Group	N	Mean	Standard Deviation	Mean Difference
Male	166	15.66	5.59	0.57
Female	158	16.23	5.64	

Source: Field work 2023

Table 2 shows that male students taught biology using the anchored instructional strategy had a mean performance score of 15.66 with a standard deviation of 5.59, while female students taught biology using the same strategy had a mean performance score of 16.23 with a standard deviation of 5.64. The difference between the mean academic performance scores of male and female students taught biology using the anchored instructional strategy is 0.57. **Hypotheses testing**

Ho_1: There is no significant difference in the performance of Sokoto state secondary school students taught biology using anchored instruction and those taught using conventional method.

Table 3: Impact of Anchored Instruction and Conventional Method on Performance of Students in Biology

Method	N	Mean	df	t-value	P-value	Decision
Anchored instruction	324	49.36				
			620	15.83		
.000	Rejected					
Conventional Method	298	38.53				

Researchers field Work (2023)

Table 3 summarizes the t-test results on the academic performance of students taught biology using the anchored instructional strategy and those taught using the conventional method. The results revealed a significant difference between the scores of the experimental group (M = 49.36), taught with anchored instruction, and the control group (M = 38.53), taught with the conventional method, with a p-value of 0.000, which is less than the 0.05 level of significance. This implies that the null hypothesis is rejected. Therefore, the results indicate that there was a significant difference in the performance of students taught biology using the anchored instructional model, compared to those taught using the conventional method, in favor of the experimental group.

Ho_2: There is no significant difference in the performance between male and female Sokoto state secondary school students taught biology using anchored instruction.

Table 4: t-test analysis of difference in the performance abilities of male and female Students taught biology using anchored instruction

Gender	N	Mean	df	t-value	P-value	Decision
Male	166	15.66				
			322	15.83		
0.20	Retained					
Female	158	16.23				

Researchers field Work (2023)

Table 4 presents the results of a t-test analysis conducted to determine the difference in the academic performance of male and female students taught biology using the anchored instructional strategy. The results indicated that there was no significant difference in the academic performance of male (M = 15.66) and female (M = 16.23) students taught biology using anchored instruction. The p-value of 0.20, which is greater than the significance level of 0.05, implies that there was no significant difference in the academic performance of male and female students taught biology using the anchored instructional model. The implication of this finding is that the anchored instructional model is gender-neutral. This means that, regardless of gender, the anchored instructional model has the potential to significantly improve academic performance, particularly in the context of learning biology.

Summary of Major Findings

From the analysis of data, the study revealed the following findings;

1. Students taught biology using anchored instruction model, academically performed significantly higher than students taught biology using conventional method

2. That male and female students that were exposed to biology concepts using anchored instruction model performed significantly well. This implies that anchored instructional model is gender friendly and capable of improving performance irrespective of gender.

Discussions of Findings

This study investigated the impact of the anchored instructional model on the academic performance of secondary school biology students in Sokoto State, Nigeria. The results of hypothesis one revealed that the mean score of students taught biology using the anchored instructional model was significantly higher than those taught with the conventional method. Moreover, the p-value of 0.000, which is less than the 0.05 level of significance, indicates that the null hypothesis is rejected. Therefore, these findings suggest a significant difference in the performance of students

taught biology using the anchored instructional model compared to those taught using the conventional method, with the experimental group performing better. The experimental treatments accounted for 41.9% of the observed variance in the dependent variable.

These findings align with the results of Adepoju, Shina, Elis, and Seracus (2022), who reported that students in multimedia instruction performed better than their counterparts in conventional teaching. Similarly, the findings of this study are consistent with those of Bello (2019), who investigated the effects of anchored instruction on senior secondary school students' performance in biology. Bello's study also found significant effects of anchored instruction on student performance, recommending its adoption by biology teachers to enhance student outcomes.

The results also align with the findings of Terry and Tabby (2020), who compared three teaching methods: anchored videotapes, cooperative learning, and traditional videotapes. The study, involving 72 students, showed no significant differences among the three teaching methods concerning students' scores and gender. Additionally, Kris and Mike (2019) reported similar results, noting that anchored instruction positively impacted student performance and retention. Their study found significant differences between lecture-based and anchored instructional approaches, with students taught using the latter outperforming those taught with lectures.

Table 2 presents the results of a t-test analysis conducted to determine the difference in academic performance between male and female students taught biology using the anchored instructional model. The analysis revealed no significant difference in the performance of male students, as indicated by a p-value of 0.20, which is greater than the significance level of 0.05. Consequently, the hypothesis stating that there is no significant difference in the performance between male and female students taught biology using the anchored instructional model is retained.

The findings of this study contradict those of Patrick (2021), who investigated gender differences in biology performance among secondary school students in Ghana. In his study, which involved 23 public secondary schools in Kumasi and about 386 students, it was found that gender was

associated with biology achievement, with boys performing better than girls.

The result of this study, however, agrees with the findings of Ugin (2022), who conducted a study on the effect of gender and anchored instruction on the academic performance of students in biology. The study involved 200 senior secondary biology students selected from two secondary schools in Uyo. The outcome of Ugin's study showed that gender did not have any significant effect on the academic performance of students in biology.

Conclusion

It can be concluded from this study that the anchored instructional strategy improves academic performance in biology. The findings indicate that students taught biology using the anchored instructional model performed significantly better than those taught using the conventional method. Additionally, both male and female students exposed to biology concepts through the anchored instruction model performed well. This suggests that the anchored instructional model is gender-neutral and capable of enhancing performance, regardless of gender.

Recommendations

On the basis of the findings emanating from this study, the following recommendations are put forward;

1. It is recommended that teachers should be trained in the use of anchored instruction as instructional model in teaching biology because the study showed that it is more effective than conventional method.

2. The use of anchored instruction should be encouraged among male and female students as a medium of learning through careful supervision.

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