

EFFECT OF COMPUTER-ASSISTED INSTRUCTION ON BIOLOGY STUDENTS' ACADEMIC ACHIEVEMENT IN SECONDARY SCHOOLS IN SOKOTO METROPOLIS

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Abstract

This study investigated the effect of computer-assisted instruction on biology students' academic achievement in secondary schools in Sokoto metropolis. The study was guided by two research questions and two corresponding hypotheses, all tested at the 0.05 level of significance. A quasi-experimental research design involving a pretest-posttest non-equivalent experimental and control group was employed. The population of the study comprised of 52,160 SS II Biology students across 51 public secondary schools in Sokoto metropolis. Using a purposive sampling technique, a sample of 50 students was selected from two intact classes in two schools, with one class assigned to the experimental group and the other to the control group. Adaptation software was developed by the researcher and deployed in teaching the experimental group, while the control group received instruction through the lecture method over a period of six weeks. Biological Adaptation Achievement Test for Secondary Schools (BAATSS) was used as the research instrument. The reliability of the instrument was established through pilot testing, yielding a coefficient of 0.98 using PPMC. Data collected were analyzed using mean and standard deviation for the research questions, and ANCOVA and Independent t-test statistics for the hypotheses one and two respectively. Findings revealed that students exposed to computer-assisted instruction performed significantly better in academic achievement than those taught using the lecture method. However, no significant gender difference was found in the achievement of the male and female students taught using computer-assisted instruction. Based on these findings, it is recommended that Biology teachers incorporate computer-assisted instruction into their teaching practices to improve students' academic achievement.

Key Words: Effect, Computer-Assisted Instruction, Academic Achievement.

Introduction

The integration of technology into education began in the 1970s with the introduction of personal computers, marking a significant shift in teaching methodologies (Abdullahi & Idris, 2023). This technological evolution led to the rise of Information and Communication Technology (ICT), fundamentally reshaping classroom instruction and emphasizing the need

for both teachers and learners to be computer literate (Imhanyehor, 2021). ICT's influence on education has made learning more interactive and adaptable by moving away from rigid traditional classroom settings to more flexible, engaging environments (Rajaram, 2021).

ICT tools, especially computers, have been incorporated into instructional processes to facilitate curriculum delivery. Unlike traditional classrooms where all learners are treated uniformly, technology allows for personalized learning experiences (Laleye, 2019; Yusuf & Balogun, 2022). It has also been recognized for improving teaching effectiveness, academic achievement and fostering creativity (Mohammed & Yarinchi, 2013; Sedega et al., 2017; Ene, 2022; Akabuike & Achufusi-Akah, 2023). In this context, Computer-Assisted Instruction (CAI) has emerged as a powerful pedagogical tool that leverages software to offer interactive learning through animations, simulations, and other multimedia formats (Yilmaz, 2022; Salami & Sani, 2024; Muftawu & Benard, 2024). CAI creates a dynamic learning environment where students engage directly with content, often enhancing their academic achievement. Though, some researchers such as Owusu et al. (2010) and Nwosu & Ndanwu, (2020) reported contrasting results, indicating better outcomes using lecture method. However, the potential of computer-assisted instruction to improve students' academic achievement and provide tailored support is increasingly being recognized. Hence, it's becoming widely adopted in many developed countries (Sünbül et al., 2022).

Academic achievement is an important variable in school system because it forms the basis for measuring students' learning progress. Umar, Manklibet, and Dung (2019) consider academic achievement as outcome that indicates the extent to which an individual has achieved certain goals that have been the focus of activities in classroom settings, particularly in schools, colleges, and universities. Similarly, Covay and Carbonaro in Yilshik, Ezekiel and Umar (2020) believe that academic achievement is the extent to which a student has achieved his educational goals. Adediran, Oyediran, and Olufemi (2018) found that academic achievement is one of the most important factors that employers consider when hiring workers, especially for young graduates. Therefore, students must put in the greatest possible effort during their studies to achieve good grades while preparing for future career opportunities in order to meet the employer's requirements. Nothing important happens without a cause or in complete isolation of the factors involved. Therefore, the academic achievement level of students depends on a number of psychological, sociological and environmental factors. These diverse factors could include availability of learning opportunities, attitude toward learning, interest in learning, learning habits, self-efficacy, personality, motivation as well as gender disparity (Umar et al., 2019).

Gender nuances become evident in learning outcomes, engagement levels, and preferences among students. Joseph, John, Eric, Sada and Olubunmi (2015) see gender as the range of physical, biological, mental and behavioural characteristics pertaining to and differentiating between the feminine and the masculine population. Joseph, et al. (2015) maintained that, gender is one of the factors that have considerable effects on the academic achievement of students especially in science subjects. Studies reveal that variations exist in how male and

female students interact with CAI due to diverse learning styles, cultural influences, and prior experiences with technology (Umar et al., 2019). Ajai and Imoko (2015) posed that understanding gender dynamics in the use of CAI is critical to creating inclusive and effective learning environments that meet the diverse needs of all students. Though, some researchers like Nweke, Okeke, Anusiuba and Egbo (2019), Ekundayo (2022), Salami and Sani (2024), and Gada and Muhammed (2025) found no gender disparities in technology-based learning environments.

Biology is a foundational subject for careers in medicine, agriculture, nursing, and environmental sciences. It covers diverse areas like genetics, ecology, and physiology, which underscores its potential to drive national development (Hillis et al., 2020). However, despite its importance, students' achievement in the subject remains relatively low, particularly in complex topics like biological adaptation (Etobro & Fabinu, 2017). The WAEC Chief Examiner's reports from 2019 to 2023 consistently highlight students' poor understanding of adaptation, cell division and genetics (Abdullahi & Idris, 2023). Olaleye, Ajayi and Oyebola (2017) noted that such failure could be attributed to factors like overcrowded classrooms, poor teaching methods and strategies as well as lack of active engagement of students. Moreover, Olabiyi, Aiyelabowo and Keshinro (2013) confirmed that traditional teaching methods often fail to convey complex biological concepts effectively to students. Hence, the study sought to determine the power of CAI in offering a viable solution to the problem by transforming abstract content into engaging, concrete experiences, thereby enhancing comprehension and achievement. The adoption of CAI in Nigerian secondary schools, particularly in subjects like Biology has the potential to improve students' academic achievement thereby addressing gender-related disparities in learning.

Objectives of the Study

The study was guided by the following objectives:

1. To determine whether any difference exist in the mean academic achievement score of Biology students taught adaptation using CAI and that taught using lecture method in secondary schools in Sokoto metropolis.
2. To determine whether any difference exist in the mean academic achievement score of male and female Biology students taught adaptation using CAI in secondary schools in Sokoto metropolis.

Research Questions

The research is intended to provide answers to the following questions:

1. What is the difference in the mean academic achievement score of biology students taught adaptation using computer-assisted instruction and those taught with lecture method in secondary schools in Sokoto metropolis?

2. What is the difference in the mean academic achievement score of male and female biology students taught adaptation using computer-assisted instruction in secondary schools in Sokoto metropolis?

Hypotheses

The following hypotheses are formulated to be tested at 0.05 level of significance:

Ho₁. There is no significant difference in the mean achievement score of biology students taught adaptation using computer-assisted instruction and that taught using lecture method in secondary schools in Sokoto metropolis.

Ho₂. There is no significant difference in the mean achievement score of male and female biology students taught adaptation using computer-assisted instruction in secondary schools in Sokoto metropolis.

Methodology

The study employed a quasi-experimental research design involving pretest, post-test, nonequivalent control groups. This design was chosen due to the use of intact classes, thereby avoiding disruptions that might arise from random assignment. Both experimental and control groups undertook a pretest to establish equivalence before the treatment. The experimental group then received instruction using computer-assisted instruction over six weeks, after which both groups completed a post-test.

The study population included 52,160 senior secondary school students offering biology across 51 public secondary schools in Sokoto metropolis. The sample consisted of two intact SS II classes drawn from two coeducational schools, with 28 students in the experimental group and 22 in the control group, totaling 50 participants. Due to infrastructural requirements like electricity and digital devices, purposive sampling was used to select schools that were genuinely coeducational and met the technical prerequisites for implementing computer-assisted instruction. This also ensured consistency and reduced variability due to gender segregation.

The CAI tool used was the Biological Adaptation Software, developed using HTML, CSS, and JavaScript for the front-end, and PHP with SQLite for the back-end. Initially hosted on a local XAMPP server, it was later deployed online at www.exam.net.ng/adaptation to increase accessibility. The system requires a minimum of 2 GB RAM, an Intel or AMD processor, and 200 GB of storage for optimal achievement. The platform features a homepage, registration and login pages, a student dashboard, instructional video content, lesson notes, auto-graded tests, and a question feature that allows students to contact instructors. Students can retake tests to reinforce learning, and test results are displayed instantly. The system was first tested within a local area network before it was launched online to ensure wider usability.

Data collection was carried out using Biological Adaptation Achievement Test for Secondary Schools (BAATSS). The BAATSS consisted of 30 multiple-choice questions adapted from WASSCE and textbooks, aligned with the curriculum and Bloom’s taxonomy. The items were randomized to avoid order bias. The instrument underwent rigorous validation. Experts from biology education as well as test and measurement reviewed the instrument for content and face validity. Recommendations were implemented to enhance alignment with learning objectives and clarity for the target population. To assess reliability, the instrument was pilot tested in two schools that are part of the population of the study after an interval of two weeks. The BAATSS showed a high test-retest reliability coefficient of 0.98 indicating strong reliability.

Results

Research Question One: What is the difference in the mean academic achievement score of biology students taught adaptation using computer-assisted instruction and those taught using lecture method in secondary schools in Sokoto metropolis?

Table 1: Mean Academic Achievement Score of Students Taught Adaptation with CAI and Those Taught Using Lecture Method

Variables	Group	N	Pre-Test Mean	Pre-Test Std. Dev.	Post-Test Mean	Post-Test Std. Dev.	Mean Gain
Academic Achievement	Experimental	28	11.04	3.316	13.39	3.107	2.35
	Control	22	9.36	3.245	9.45	2.385	0.09
Mean Difference			1.68		3.94		

Table 1 presents the pre-test and post-test mean scores, standard deviations, mean gains, and mean difference in students’ academic achievement for the experimental and control groups. The experimental group has a pre-test mean score of 11.04 (SD = 3.316) and a post-test mean score of 13.39 (SD = 3.107), resulting in a mean gain of 2.35. On the other hand, the control group recorded a pre-test mean score of 9.36 (SD = 3.245) and a post-test mean score of 9.45 (SD = 2.385), yielding a mean gain of 0.09. The results indicate that students in the experimental group achieved a higher mean gain (2.35) compared to those in the control group (0.09), suggesting a positive effect of the CAI on the students’ academic achievement in Biology.

Hypothesis One: There is no significant difference in the mean achievement score of biology students taught adaptation using computer-assisted instruction and that taught using lecture method in secondary schools in Sokoto metropolis.

Table 2: ANCOVA of the Mean Academic Achievement Score of Students Taught Adaptation with CAI and Those Taught with Lecture Method

Variable	Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	209.614	2	104.807	13.622	.000	
Intercept	407.727	1	407.727	52.995	.000	
PRE_TEST	18.528	1	18.528	2.408	.127	
GROUP	151.557	1	151.557	19.699	.000	Rejected
Total	7369.000	50				

Table 2 presents the ANCOVA results comparing the academic achievement of biology students taught using CAI and those taught using the conventional method. The analysis reveals an F-value of 19.699, with a corresponding p-value of 0.001. Since the p-value is less than the significance level of 0.05, the null hypothesis is rejected. This result indicates a statistically significant difference in academic achievement scores between students taught Adaptation using CAI and those taught using the lecture method in secondary schools in Sokoto metropolis.

Research Question Two: What is the difference in the mean academic achievement score of male and female biology students taught adaptation using computer-assisted instruction in secondary schools in Sokoto metropolis?

Table 3: Mean Academic Achievement Score of Male and Female Students Taught Adaptation with CAI

Variables	Group	N	Post Test Mean Score	Std. Dev.	Mean Difference
Academic Achievement	Male	13	11.00	3.764	0.2
	Female	15	10.80	4.346	

Table 3 presents the post-test mean scores, standard deviations, and mean difference for male and female students' academic achievement within the experimental group. The male students had a mean academic achievement score of 11.00 and a Standard Deviation of 3.764. While the female students had a mean academic achievement score of 10.80 and a Standard Deviation of 4.346. The results indicate that the male students performed slightly better than the female students within the experimental group.

H₀₂. There is no significant difference in the mean achievement score of male and female biology students taught adaptation using computer-assisted instruction in secondary schools in Sokoto metropolis.

Table 4: t-Test of the Mean Academic Achievement Score of Male and Female Students Taught Adaptation with CAI

Variables	Group	N	F-Value	t- Value	Df	P-Value	Remark
Academic Achievement	Male	13	.480	.129	26	.898	Accepted
	Female	15	.480	.129	26		

Table 4 shows the results of the academic achievement of male and female Biology students taught using CAI method. The analysis reveals an F-value of 0.480, a t-value of 0.129, and a corresponding p-value of 0.898. Since the p-value is greater than the significance level of 0.05, the null hypothesis is retained. Therefore, the result indicates no statistically significant difference in academic achievement scores of male and female students taught Adaptation using CAI method in secondary schools in Sokoto metropolis.

Discussion of Findings

This study examined the impact of Computer-Assisted Instruction (CAI) on academic achievement among secondary school students in Sokoto Metropolis. Analysis of research question one and hypothesis one revealed that students taught using CAI performed significantly better than those taught using lecture method in terms of academic achievement. This finding aligns with previous studies that have consistently reported improvements in student academic achievement through CAI (Yusuf & Balogun, 2022; Sedega et al., 2017; Ene, 2022; Akabuike & Achufusi-Akah, 2023; Salami & Sani, 2024; Muftawu & Benard, 2024). These studies support the assertion that CAI enhances academic achievement by promoting interactive, learner-centered environments. However, some researchers have reported contrasting results, indicating better outcomes with lecture method (Owusu et al., 2010; Nwosu & Ndanwu, 2020). Such discrepancies may be attributed to contextual differences in technological infrastructure, teacher preparedness, student digital literacy, or subject specificity, highlighting the need for further contextualized investigations.

Furthermore, the analyses on research question two and hypothesis two indicated that there was no statistical difference in the mean achievement score of male and female students taught using CAI. This finding aligns with the works of Nweke, Okeke, Anusiuba and Egbo (2019), who found no gender disparities in technology-based learning environments. In the same vein, Ekundayo (2022), Salami and Sani (2024), and Gada and Muhammed (2025) similarly observed equitable outcomes across genders.

In conclusion, the findings of this study provide strong empirical support for the positive impact of CAI on students' academic achievement in Biology. Interestingly, the study also found that gender did not significantly influence students' responses to CAI. This suggests that CAI is a gender-friendly instructional approach, equally effective for learners regardless of sex. The gender-neutral impact of CAI is particularly important in educational contexts where gender-based disparities in achievement are prevalent, and it positions CAI as an instructional approach that could promote greater educational equity.

Conclusions

The study concluded that CAI significantly improves students' academic achievement in Biology in secondary schools in Sokoto Metropolis. In the same vein, there is no significant difference in academic achievement between male and female biology students taught using CAI.

Recommendations

The study recommended that:

1. Teachers in Sokoto and other regions should use Computer-Assisted Instruction to teach Biology.
2. The government should provide computers, internet access, and educational software to schools.
3. The Ministry of Education should include the use of CAI in national and regional education policies.

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