EFFECT OF COMPUTER-AIDED INSTRUCTION STRATEGY ON SENIOR SECONDARY SCHOOL STUDENTS' PERFORMANCE IN BIOLOGY

BY

Adebayo Gbenga Mathew
Department of Science Education, Faculty of Education,
Ekiti State University, Ado-Ekiti
Email: adebayogbenga5099@gmail.com | (+234) 703 419 5099

Abstract

This study examined the effects of Computer-Aided Instruction (CAI) on students' performance in Biology. The population comprised all Senior Secondary School Two (SS II) Biology students across public secondary schools, with a sample of 109 students from two schools selected using a multistage sampling procedure. One group received instruction through CAI (experimental), while the other (control group) was taught using conventional methods. The Biology Performance Test (BPT) was used and this instrument was validated by experts and tested with reliability coefficient of 0.82. Data were analyzed using means, standard deviations, and independent samples t-tests. Results showed that both groups improved after instruction, but the CAI group performed significantly better than the control group. Pre-test scores showed no significant difference, confirming the two groups homogeneity. The findings indicate that CAI enhances understanding, retention, and engagement, making it more effective than conventional methods in improving Biology performance. The study concludes that integrating CAI into Biology instruction significantly improve students' academic achievement and interest. It is recommended that schools adopt CAI, provide teachers with training, and ensure adequate computer facilities and instructional software to maximize learning outcomes.

Keywords: Academic Performance, Computer-Aided Instruction, Nigeria, Student Engagement, Teaching Strategies.

Introduction

Education remains one of the most potent instruments for personal development, self-reliance, and national growth. In contemporary societies, the demand for education that equips individuals with relevant scientific, technological, and problem-solving skills has become increasingly important. Education is not merely the acquisition of knowledge but a process through which learners develop abilities that can be applied to solve real-life problems and contribute meaningfully to societal development. Ayeni (2022) emphasized that education serves as the bedrock of human progress, enhancing national productivity, reducing poverty, and preparing individuals for leadership roles in various sectors of society.

Science education plays a critical role in achieving these educational goals, as science drives technological advancement, improves health outcomes, and promotes sustainable development. Usman et al. (2022) noted that science contributes significantly to national wealth creation, environmental sustainability, and improved

quality of life. Through science education, learners develop critical thinking skills, inquiry abilities, and evidence-based reasoning necessary for addressing societal challenges

Biology is the scientific study of life and living organisms, encompassing the structure, function, growth, origin, evolution, and interactions of organisms with their environment. It is one of the three major science subjects in the Nigerian senior secondary school curriculum and has the highest enrollment among science subjects (Akinsolu & Fadokun, 2016). Biology is fundamental to careers such as medicine, pharmacy, nursing, agriculture, biotechnology, and environmental sciences. As such, effective teaching and learning of Biology are essential for human development and national progress. Despite the importance of Biology, students' academic performance in the subject has remained a major concern.

Table 1: Students' Performance in Biology in WASSCE (2019–2024) in Ekiti State, Nigeria

Year	Total Candidates	A1–B3	%	C4–C6	%	D7–D8	%	F9	%	% Pass	% Fail
2019	6,691	744	11	3,200	48	1,657	25	1,060	16	59	41
2020	6,022	1,622	27	3,108	52	668	11	624	10	79	21
2021	5,641	1,120	20	3,333	59	761	13	427	8	79	21
2022	2,499	491	20	1,509	60	185	7	314	13	80	20
2023	5,563	824	15	3,098	56	1,069	19	572	10	71	29

Source: Ministry of Education, Planning, Research and Statistics Department, Ekiti State (2024)

Evidence from the West African Senior School Certificate Examination (WASSCE) results in Ekiti State between 2019 and 2023 shows a fluctuating and generally unsatisfactory performance trend, particularly at the credit level required for admission into science-related university courses. Although some improvement was recorded in certain years, the percentage of students attaining high grades (A1–B3) remains low, while failure rates persist. This situation limits Students' opportunities to pursue competitive science-based careers and raises concerns about the effectiveness of current instructional practices.

The Chief Examiner from the above Reports have attributed students' poor performance in Biology to the following factors such as ineffective teaching methods, overreliance on lecture-based approaches, inadequate instructional materials, and low student motivation and interest. Conventional teaching methods are often teacher-centered, making students passive recipients of information and limiting opportunities for active participation, inquiry, and meaningful learning (Faletiba, 2019). Such methods may not adequately support students' understanding of abstract biological concepts, leading to poor retention and performance.

Given the increasing influence of technology in education, there is a growing need to adopt instructional strategies that promote active, learner-centered, and inquiry-based learning, CAI

involves the use of computers and instructional software to present learning materials through tutorials, simulations, animations, and interactive activities. According to Fashiku (2022), CAI enhances learning by providing immediate feedback, supporting self-paced learning, and catering to diverse learning styles. In Biology, CAI has the potential to simplify complex concepts, improve visualization of abstract processes, and increase Students' engagement and understanding.

Research has shown that CAI can enhance Students' interest, retention, and academic performance when compared to conventional teaching methods (Ok et al., 2020). By promoting active participation and individualized learning experiences, CAI aligns with the demands of 21st-century education and offers a promising approach to improving students' learning outcomes in Biology.

In view of the persistent fluctuation in students' performance in Biology and the limitations of conventional teaching methods, it becomes necessary to empirically examine the effectiveness of computer-aided instruction. Therefore, this study investigates the effects of Computer-Aided Instruction on senior secondary school students' academic performance in Biology in Ekiti State, Nigeria, by comparing students taught using CAI with those taught using the conventional teaching method

Statement of the Problem

It was noted that students' academic performance in Biology at the senior secondary school level has remained inconsistent and generally unsatisfactory over the years. Despite Biology being one of the most widely offered science subjects and a prerequisite for many science and health related careers, many students experience difficulties in understanding key biological concepts, which is reflected in their poor performance in both internal and external examinations.

It was further noted that many students depend largely on rote memorization rather than meaningful understanding of biological processes. This situation is often accompanied by low interest, limited classroom participation, and negative attitudes toward the subject. Biology is frequently perceived as difficult and abstract, particularly when taught using conventional, teacher-centered instructional methods such as the lecture method, which remains predominant in many secondary schools.

In addition, it was observed that conventional teaching methods provide limited opportunities for active learning, inquiry, and visualization of complex biological concepts. Consequently, students tend to become passive learners who struggle to relate classroom instruction to real-life applications. This instructional practice may partly account for the fluctuating performance recorded in Biology in the West African Senior School Certificate Examination (WASSCE) in Ekiti-State between 2019 and 2024

Although computer-aided instruction (CAI) is recognized as a learner-centered and interactive instructional strategy capable of enhancing students' engagement and understanding through visual and self-paced learning experiences, its application in the teaching of Biology remains limited. It was noted that many Biology teachers continue to rely heavily on conventional teaching methods, with little empirical evidence available on the effectiveness of CAI in improving students' academic performance.

Therefore, the problem addressed in this study is the persistent fluctuation and generally low academic performance of senior secondary school students in Biology, which may be linked to the

continued use of conventional teaching methods. This study seeks to examine whether computer-aided instruction can significantly improve students' academic performance in Biology compared with the conventional teaching method in Ekiti State, Nigeria.

Objectives of the Study

The general objective of this study is to examine the effect of computer-aided instruction on students' academic performance in Biology.

The specific objective is to:

1. determine the performance of students taught Biology **before and after** exposure to computer-aided instruction and the conventional teaching method.

Research Questions

The following research questions was formulated to guide this study:

1. What is the performance of students taught Biology before and after exposure to computer aided instruction and conventional teaching method?

Research Hypotheses

The following research hypotheses are formulated to guide this study:

1. There is no significant difference in the performance of students in experimental and control group before treatment.
2. There is no significance difference in the performance of students in experimental and control group after treatment.

Literature Review

Students' Performance in Biology

Academic performance refers to a successful accomplishment or Performance in particular subject area. It is indicated by grades, marks and scores of descriptive commentaries. Academic performance also refers to how Student's deal with their studies and how they cope with or accomplish different tasks given to them by their teachers in a fixed time or academic year. Fajola (2018), used the notion of academic self-concept in referring to Individuals' knowledge and perceptions about themselves in academic performance, and convictions that they can successfully perform a given academic tasks at designated levels. Fajola (2018) further stated that academic self-concept represents a more past-oriented, aggregated and relatively stable judgment about one's self-perceived ability in a particular academic domain while academic self-efficacy represents a context specific and relatively future.

Performance in Biology has consistently been a challenge in secondary schools worldwide. Numerous studies have been conducted to identify the underlying causes of this persistent issue, particularly within science subjects like Biology , These studies have explored various factors influencing student performance, with a focus on general academic achievement. Gu et al. (2024) highlights that socioeconomic status and the overall family environment significantly influence students' academic achievement, with parental involvement playing a key mediating role between these family factors and learners' performance outcomes. . Additionally, factors such as the educational and occupational status of the home, as well as the teacher's engagement in teaching, have been shown to influence student outcomes. Other contributing factors include students' attitudes toward science and teachers' workloads. Interestingly, studies have found that the location of the home (urban vs. rural) does not significantly affect students' achievement. According to Kissan (2016), home background factors are often more influential than those within the school environment in shaping students' performance.

A Study was conducted by Adewale, (2016) investigating the Academic Performance in Biology at Secondary School Certificate Examination (SSCE) and the Influencing Factors among Students in Owerri Municipal of Imo State, Nigeria. This study is undertaken to ascertain the grading of the academic performances of the Students were classified into four categories. For students in these institutions. The SSCE results in Biology for five consecutive years from 2009-possible factors that account for diverse academic performances in Biology subject among the sampling information from the teachers and students on the factors that affect academic revealed that academic performances in Biology in the schools under investigation were widely 2013 were collected from each of five schools with the cooperation of the school Principals. The performances in the schools. It is recommended that schools under same administrative management structure should properly integrate students welfare especially health into school conducted for secondary school students in the English speaking countries of West Africa. Different in term of general scores per schools and candidates. Teachers' factors, school's factor, performance, different structured questionnaires were prepared for the two groups. Findings management should be uniformly staffed and equipped by the government. Moreover, school management structure should properly integrate students welfare especially health into school planning.

Concept of Computer-Aided Instruction in Education

Computer Aided Instruction (CAI) is an automated instructional strategy in which a computer is used to present an instructional program to the learners through an interactive process on the computer under the supervision of a teacher. Computer Aided Instruction (CAI) refers to using computers to present instructional materials interactively, creating a controlled, personalized learning experience for each student. Some tutorials adapt to students' progress by adjusting the pace and providing feedback, enhancing individualized instruction (Habib et al, 2019). The benefits of CAI in modern education are significant and should not be overlooked. CAI is an aspect of e-learning facilities teachers use to facilitate and enhance effective teaching in the classroom the learner and the computer. The learner responds to the computer's illustration (Gambariet et al., 2016). According to Dap-og and Orongan (2021), CAI is using the computer on a time shared basis to perform any instructional functions. The functions include presenting materials or problem situations, guiding learners' thinking, responding to learners' questions, assessing learners' performances, selecting materials to be delivered, assigning tasks to be performed, or a combination of all these functions. The computer-assisted instructional strategy could be individualize and cooperative among the learners. This depends on objectives, content, teaching, and learning experiences (Zubairu, 2019).

Computer Aided Instruction and Students' Performance in Biology

The integration of computer technology into traditional instruction is not entirely a recent development. Achor and Ukwuru (2014) stated that education evolved from learning about computers to learning with computers and to finally learning through computers. Computer-based teaching and learning has been found to always produce positive effects in the classroom, if properly adopted.

In 2022, Tantry and Sofi presented a research in determining the effectiveness of computer-aided instruction on basis of intelligence, quasi -experimental pre -test,post -test two groups design were

used . The two groups both groups before being subjected to experimentation. The experimental group was taught the first chapter of 10th grade biology, that is, LIFE PROCESSES, through computer-aided higher in biological science among secondary school children taught through computer-aided post tests were administered to both groups. The academic achievement of the students were randomly divided into experimental and control groups. A pre-test was administered to instruction, and the control group, through the traditional method of teaching for one month in the Kashmir division. The sample of the research consisted of 100 10th-class pupils from two groups were compared. Results indicated that academic achievement and retention are two groups were compared using the test similarly, the means of the scores of retention of the developed for measuring retention. The means scores of academic achievements of the government schools selected randomly. To equalize the students into two groups on the measured using the criterion reference test developed by the author; a similar test was academic achievement and retention in the biological sciences among secondary school children instruction than those taught through traditional methods of teaching.

Chieke, & Anaekwe, (2019). Also conducted a research on the Effects of computer assisted instruction on students' achievement in Biology. quasi - experimental pre-test, post-test non-equivalent control group research design was adopted for the study. Data collected after the treatments were analyzed using means, standard deviation, and Analysis of Covariance (ANCOVA). The results of the study among others indicated that CAIP had a significant effect ($F = 6.90$, $p = 0.02 < 0.05$) on students' achievement in biology. Chieke Anthonia Ifeyinwa (2024) investigated the effect of Computer Assisted Instruction Package (CAIP) on secondary school students' achievement in biology. A quasi-experimental pre-test, post-test non-equivalent control group research design was adopted for the study. The study was conducted in Awka Education Zone of Anambra State in the 2017/2018 academic session. The sample consisted of 320 senior secondary year two (SSII) male and female biology students. The instruments: Biology Achievement Test (BAT) was used for data collection. Reliability index of 0.81 was obtained using Kudder-Richardson reliability technique. Data collected after the treatments were analyzed using means, standard deviation , and Analysis of Covariance (ANCOVA). The result of the study among others indicated that CAIP had a significant effect ($F = 6.90$, $p = 0.02 < 0.05$) on students' achievement in biology.

Research Gaps

Despite numerous studies on students' performance in Biology, most research has focused on general factors such as home background, parental involvement, teacher effectiveness, and students' attitudes. While these studies provide insights into environmental and socio-demographic influences, few have examined the impact of instructional strategies, particularly technology-based methods, on learning outcomes. Previous research on computer-aided instruction has shown positive effects on students' achievement and retention in Biology; however, these studies were conducted outside Ekiti -State, often on specific topics or student groups, and provided limited comparison with conventional teaching methods. Additionally, there is insufficient empirical evidence using pre-test and post-test experimental designs within regular classroom settings to determine the effectiveness of computer-aided instruction on students' overall performance. This gap highlights the

need to investigate the effect of computer-aided instruction on senior secondary school students' performance in Biology in Ekiti -State, particularly by comparing learning outcomes before and after exposure to computer-aided and conventional teaching methods.

Methodology

This study adopted a quasi-experimental pre-test and post-test two-group design to examine the effect of Computer-Aided Instruction (CAI) on students' performance in Biology. One experimental group received instruction through CAI, while the control group was taught using the conventional method. The population consisted of all 8,961 Senior Secondary School Two (SSS II) Biology students across the 205 public secondary schools in Ekiti -State. A sample of 109 students was drawn from two schools using a multistage sampling technique, which involved randomly selecting a senatorial district and two Local Government Areas (LGAs), purposively selecting schools with functional computer facilities, and randomly assigning schools to experimental and control groups. The Biology Performance Test (BPT), developed by the researcher and based on WASSCE questions covering Plant and Animal Cells and Photosynthesis, served as both pre-test and post-test. The instrument's validity was established through expert review by lecturers, test specialists, and experienced Biology teachers, while reliability was confirmed via the test-retest method, yielding a coefficient of 0.82. The experiment was conducted over eight weeks, including one week of pre-treatment preparation, six weeks of treatment, and one week of post-testing. During treatment, students in the experimental group used the CAI package at their own pace, while the control group received conventional instruction. Data collected from pre- and post-tests were analyzed using means and standard deviations to answer research question, and independent samples t-tests were used to test hypotheses at the 0.05 level of significance.

Results

Research Question 1: What is the performance of students taught Biology before and after exposure to computer aided instruction and conventional teaching method?

Table 1: Descriptive Analysis of Students' Performance Before and After Treatment

		Before		*After*		
Group	*N*	*Mean*	*SD*	*Mean*	*SD*	*Mean Difference*
Computer-Aided Instruction (CAI)	56	43.25	7.95	68.80	8.20	25.55
Conventional Teaching Method	53	42.35	8.12	55.10	9.45	12.75

Table 1 showed that CAI group had a pretest mean of 43.25 (SD = 7.95) and a posttest mean of 68.80 (SD = 8.20), resulting in a mean difference of 25.55. In comparison, the Conventional Teaching Method group increased from a pretest mean of 42.35 (SD = 8.12) to a posttest mean of 55.10 (SD = 9.45), with a mean difference of 12.75. Hence, students in both the Computer-Aided Instruction (CAI) and Conventional Teaching Method groups improved in

their performance after instruction. This implies that while both teaching methods positively affected students' performance, the Computer-Aided Instruction (CAI) strategy produced a greater improvement in Biology performance than the conventional method, implying that it is more effective in enhancing students' academic performance. This is further depicted in figure I below.

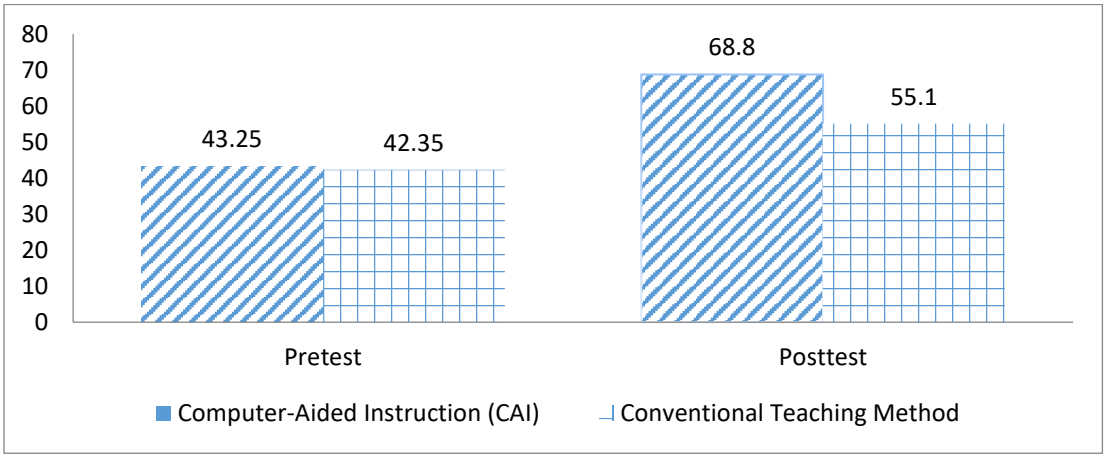

Figure I: Bar Chart showing the Students' Performance Before and After Treatment

Hypothesis 1: There is no significant difference in the performance of students in experimental and control group before treatment.

Table 2: t-test Analysis of Students' Performance in Experimental and Control Groups Before Treatment

Group	*N*	*Mean*	*SD*	*df*	*t*	*p*
Computer-Aided Instruction	56	43.25	7.95	107	0.59	0.56
Conventional Teaching Method	53	42.35	8.12			

P<0.05

Table 3 showed that the t-value is 0.59 and p-value is 0.56. The p-value (0.56) > 0.05 level of significance. Hence, the hypothesis is not rejected. This implies that there is no significant difference in the performance of students in experimental and control group before treatment. Hence students exposed to CAI and conventional method were homogenous at the commencement of the study.

Hypothesis 2: There is no significance difference in the performance of students in experimental and control group after treatment

Table 3: t-test Analysis of Students' Performance in Experimental and Control Groups After Treatment

Group	*N*	*Mean*	*SD*	*df*	*t*	*p*
Computer-Aided Instruction (Experimental)	56	68.80	8.20	107	8.34	0.000
Conventional Teaching Method (Control)	53	55.10	9.45			

P<0.05

Table 4 showed that the t-value is 8.34 and the p-value (0.000) is less than 0.05. The p-value (< 0.05) is less than 0.05 at 0.05 level of significance. Hence, the null hypothesis is rejected. This implies that there is a significant difference in the posttest performance of students exposed to Computer-Aided Instruction (CAI) and those taught using the conventional method. Students taught with CAI performed better than those taught with the conventional method, indicating that CAI is more effective in enhancing students' performance in Biology.

Discussion

The finding of the study revealed that students in both groups improved in performance, but those taught using Computer-Aided Instruction (CAI) showed greater improvement. This suggests that while traditional teaching methods still contribute positively to students' learning, the integration of technology through CAI provides a more engaging and effective learning experience. This finding is consistent with the results of Yusuf and Afolabi (2021), who reported that students exposed to CAI performed significantly better than those taught with the conventional method because of the interactive and visual nature of the instruction. It is also corroborated the finding of Ahmed and Mohammed (2023), who found that CAI enhances students' comprehension and retention of scientific concepts by promoting self-paced learning and immediate feedback. Similarly, in consonance with Alabdulkarim (2022), the present finding supports the view that computer-based tools stimulate curiosity and motivate learners to take an active role in the learning process. However, this finding contradicts the work of Adebayo and Omotayo (2020), who reported no significant difference in performance between students taught using CAI and those taught with the conventional method, attributing this to inadequate digital infrastructure and poor teacher training. The greater improvement seen among CAI students in this study may be due to the interactive multimedia features that make abstract Biology concepts easier to visualize and understand. The implication of this result is that schools should integrate CAI into classroom instruction to foster active learning, improve student motivation, and enhance overall academic achievement in Biology.

The finding of the study revealed that there was no significant difference in performance between the groups before treatment, indicating that both groups had similar levels of understanding before the introduction of the instructional methods. This is consistent with the findings of Adegoke and Alabi (2022), who reported no significant pre-treatment difference between students exposed to computer-assisted learning and those taught traditionally. Similarly, it corroborated Yusuf and Adeoye (2021), who in their study began with comparable baseline knowledge before exposure to different teaching interventions. However, this finding contradicts that of Ibrahim and Musa (2020), who found pre-existing gaps in students' performance due to prior exposure to technology-enhanced learning in some schools. The result of this study implies that the groups were academically equivalent before treatment, ensuring that any subsequent differences in performance were likely due to the instructional strategies rather than initial disparities in ability.

The finding of the study revealed that students taught with Computer-Aided Instruction (CAI) performed significantly better than those taught using the conventional method, indicating that CAI

enhanced students' understanding and retention of Biology concepts. This result is consistent with the findings of Adeyemi and Afolabi (2021), who reported that the integration of technology in teaching science subjects led to improved academic achievement compared to traditional teaching approaches. It also corroborated by the finding of Yusuf and Aremu (2022), which revealed that CAI promotes individualized learning and active engagement, resulting in higher performance among students. Similarly, Olayinka (2023) noted that interactive computer-based learning environments stimulate curiosity and sustain students' attention, thereby improving comprehension. However, the finding contradicts the work of Ibrahim and Bello (2020), who found no significant difference in achievement between students exposed to CAI and those taught traditionally, attributing the outcome to inadequate technological infrastructure and teachers' limited digital competence. The implication of this finding is that effective use of CAI can make learning Biology more engaging and interactive, suggesting that schools should adopt computer-based instructional tools to enhance teaching efficiency and improve students' performance in science subjects.

Conclusion

Based on the findings of the study, it can be concluded that Computer-Aided Instruction (CAI) significantly enhanced students' performance in Biology compared to the conventional teaching method. The use of CAI was effective in improving students' understanding and interest in the subject. Therefore, CAI can be considered a valuable teaching strategy for improving learning outcomes in Biology.

Recommendations

Based on the findings, the following recommendations are made:

1. Schools should adopt Computer-Aided Instruction as part of the teaching strategy for Biology to enhance students' performance and foster positive attitudes toward the subject.
2. Biology teachers should receive regular training on the effective use of CAI to ensure proper implementation and maximize learning outcomes.
3. Schools should provide adequate computer facilities, instructional software, and technical support to facilitate the use of CAI in teaching.
4. Curriculum planners should consider incorporating technology-based instructional strategies into the Biology curriculum to improve engagement and comprehension.References

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