



Effects of Computer-Based Tutorial Instructional Strategy on ... Abdulrashid, A., Et. al. (2026)

Effects of Computer-Based Tutorial Instructional Strategy on Academic Achievement in Biology Among Senior Secondary School Students in Katsina State, Nigeria

ABDULRASHID, Aisha¹

aabdulrashid1@fudutsinma.edu.ng

+2348104695897

SADA, Aishatu Ibrahim²

Aishatu.ibrahim@umyu.edu.ng

+2348038030806

SALEH, Khadija Ado³

Kasaleh.ste@buk.edu.ng

+2348062116194

¹Department of Science Education, Faculty of Science Technology and Vocational Education, College of Education, Federal University, Dutsinma, Katsina State, Nigeria

²Department of Science Education, Faculty of Education, Umaru Musa Yar'adua University Katsina, Katsina State, Nigeria

³Department of Science and Technology Education, Faculty of Education, Bayero University Kano, Kano State, Nigeria

Abstract

The integration of computers in to teaching and learning science and technology has yielding positive results in improving the quality of education over the years in learning institutions across the globe. Studies have been on board to determine the efficacy and validity of this innovation as regards quality of teaching and learning in various learning institution yet with varied results. On this background, this study investigated the effects of a Computer-Based Tutorial Instructional Strategy (CBTIS) on academic achievement of Senior Secondary School students in Katsina State, Nigeria. A quasi-experimental design was adopted, precisely pre-test, post-test, non-equivalent control group design. The population comprised all Biology students across the 12 zones of the Science and Technical Education Board (STEB) and Ministry of Education in Katsina State. A sample size of 247 students was selected from four co-educational schools using multi-stage sampling. The instrument used for data collection was the Biology Achievement Test (BAT), validated by three experts with a split-half reliability coefficient of 0.85. Research questions were answered using mean and standard deviation, while hypotheses were tested at 0.05 level of significance using Independent Samples t-tests. Findings revealed that students exposed to the CBTIS achieved significantly higher post-test mean scores than those exposed to conventional lecture methods, $t(245) = .55$, $p < 0.05$. Conversely, gender exerted no significant effect on the academic achievement of students exposed to CBTIS $t(123) = 0.03155$, $p > 0.05$. Based on these findings, it was concluded that CBTIS enhances student performance in Biology regardless of gender. It was recommended that Biology teachers in secondary schools in Katsina State Ministry should adopt CBTIS in teaching Biology

Keywords: Biology Education, Computer-Based Tutorial, Achievement, Biology, Students

Background of the Study

Science and Technology Education has been the driving force for scientific breakthrough and industrial advancement globally over a long period of time, Biology as a core science subject occupies a critical position as it bridges the gap between natural phenomena and applied sciences such as Medicine, Agriculture, and Biotechnology. Despite its foundational importance and high enrollment rates among senior secondary school students in Nigeria, the subject has been plagued by persistent low performance rates in external assessments like the West African Senior School Certificate



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Examination (WASSCE) and the National Examinations Council (NECO). This academic deficit is often tied to the continuous reliance on teacher-centered, conventional instructional strategies. The standard lecturing approach turns classrooms into passive environments where abstract biological concepts (e.g., cell division, genetics, nutrient cycles) are explained without interactive visual support. To counter this, modern educational frameworks emphasize student-centered, technology-driven pathways. Among these innovations, the computer-Based Tutorial (CBT) instructional strategy stands out. CBT uses interactive software to present self-paced lessons, break down complex concepts into dynamic steps, offer immediate electronic feedback, and provide remediation pathways based on student input (Fasha u &Omotayo,2024, Orji et al., 2026). In Katsina State, efforts by the State Government to distribute computers and establish digital laboratories across educational zones emphasize the regional drive for digital integration. However, the pedagogical application of these tools in classroom settings remains under-researched (Azih,et al 2022, Orji et al.,2026,) Furthermore, discussions regarding student outcomes must address gender parity. Examining whether technology-driven interventions benefit male and female students equally remains crucial for establishing equitable educational practices in the region.

Literature Review

Studies abound at local and international levels on the effects of CBT instructional strategies and different learning outcomes. The most reoccurring learning outcomes are academic achievement retention motivation attitudes, and interest. This study is mainly focusing on achievement and gender effect on the achievement. Empirical studies on this dimension appeared to be with differential findings, but mostly reported positive effects of CBT instructional strategy. For example, Azih *et al.* (2022) conducted a study on the computer-based programmed instructional study and tertiary students' achievement, using tertiary students in Nigeria and adopting quasi experimental research. From their findings, it appeared that CBIS enhanced learners' knowledge, motivation and classroom engagement during instruction. In another study by Jean *et al* (2022) on the impact of computer-assisted instruction on students' academic performance in Biology appeared another fact. The researchers adopted quasi experimental study using pretest posttest non randomized control group with 90 sampled senior secondary school students in Ngagatere. With a valid and reliable instrument of 0.70 coefficient data was generated. The findings revealed that there was significant difference between the performance of students taught biology with CBI and those taught with conventional teaching. Nebert (2023) studied effects of computer-based instruction on senior secondary school learners ' academic achievement in Biology using the same design and methodology. The result indicated a significant difference in performance in favour of the experimental group. In the same vein, Orji et al. (2026) studied the effects of computer-mediated strategy (CMIS) on students achievement and retention in Biology in Abuja Nigeria. The sample were 110 SS2 students, adopting quasi experimental design and generating data using valid and reliable Biology Achievement Test and treatment instruments. The results indicated that the students taught Biology with CMIS out-performed those taught with conventional method of teaching. In the same dimension, Fashanu and Omotayo (2026) investigated the effect of computer-based instructional strategy on students' learning outcomes in Biology among secondary schools in Ekiti state, Nigeria. Using a population of 12690, sample of 159 SS2 and Biology Performance Test, data was generated and analysed using t-test. The results indicated that students learned with computer- based instruction significantly performed better than those learned using conventional teaching strategy. From the reported empirical studies, there was no significant effect of gender on the students' learning outcomes (Azih et al., 2022, Jean et al. 2022, Orji et al. 2026, Fashanu &Omotayo 2026).



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By implication, it proved that CBTIS has been gender friendly in teaching and learning activities across various institutions of learning within and outside the nation.

Statement of the Problem

The academic output of senior secondary school students in Biology within Katsina State has fallen short of standard benchmarks in national exams (NECO, 2024, WAEC, 2024) Reports from local inspectors and educational boards consistently point to poor retention of abstract concepts, lack of student engagement, and instructional rigidity as key factors (Azih et al., 2026). The traditional lecturing style often fails to provide the multi-sensory experiences needed to master complex biological pathways. While computer networks and digital devices have been distributed to several public schools across Katsina State, they are often restricted to basic computer literacy classes. Their systematic use as direct teaching aids in core sciences like Biology is limited. There is also a lack of localized quantitative data detailing how computer-based tutorials affect student performance in the state. This study directly addresses this gap by investigating the impact of a structured Computer-Based Tutorial (CBT) instructional strategy on the academic achievement of Senior Secondary School Biology students in Katsina State.

Aim and Objectives of the Study

The aim of this study was to examine how a Computer-Based Tutorial Instructional Strategy (CBTIS) has effect on academic achievement in Biology among secondary school students in Katsina State. The specific objectives sought to:

1. compare the post-test academic achievement scores of Biology students taught using the CBT instructional strategy against those taught using the conventional instructional method.
2. assess the post-test academic achievement scores of male and female Biology students exposed to the CBT instructional strategy.

Research Questions

The following research questions were formulated as to achieve the stated objective of the study:

1. What is the difference in the post-test academic achievement mean scores between Biology students taught Biology with the Computer-Based Tutorial (CBTIS) strategy and those taught with the conventional instructional method?
2. What is the difference in the post-test academic mean achievement scores between male and female Biology students taught Biology with the CBT instructional strategy?

Null Hypothesis

The following null hypotheses were formulated and tested at 0.05 level of significance:

H₀₁: There is no significant difference between the post-test mean academic achievement scores of students taught Biology using the Computer-Based Tutorial Instructional Strategy and those taught using the conventional instructional method.

H₀₂: There is no significant difference between the post-test mean academic achievement scores of male and female students taught Biology using the CBTIS

Research Methodology

Research Design:

This study adopted a quasi-experimental design, specifically, pre-test, post-test, non-equivalent control group design. This design is appropriate for educational settings because it allows researchers to study real-world classroom interventions without disrupting existing class groupings through random individual placement (Fraenkel, 2019)



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Population of the study:

The target population comprised all senior secondary school year-two Biology students in public co-educational institutions across Katsina State. Records from the Ministry of Education indicated a total population of students taking Biology across the state's educational zones. The cohort was selected because their curriculum covers highly complex biological topics, and they are free from the immediate pressures of final external examinations.

Sample and Sampling Techniques:

The sample for this study consisted of senior secondary school students selected via a rigorous multi-stage sampling technique: Stage I (Purposive Sampling): Four distinct Educational Zones within Katsina State were chosen based on the availability of functional, solar-powered or grid-connected computer laboratories in their public schools; Stage II (Simple Random Sampling): One co-educational public senior secondary school was selected from each chosen zone, giving a number of four schools. Co-educational institutions were chosen to ensure gender representation within the same school environment. And Stage III (Cluster Sampling): In each selected school, one intact science class was assigned to either the Experimental Group or the Control Group via a coin toss. This resulted in two schools forming the experimental group (60 males, 65 female = 125) and two schools forming the control group (58 males, 64 females = 122).

Research Instruments

The primary tool for data collection was the Biology Achievement Test (BAT), designed by the researcher based on the national senior secondary school curriculum. The BAT consisted of 50 multiple-choice questions covering topics such as *Cellular Respiration*, *Plant Nutrition*, *Excretory Systems*, and *Ecology*. Each item carried four options (A–D) worth one mark each, for a maximum score of 50. To ensure validity, the initial draft of 70 items was reviewed by two experts in Science Education and one psychometric expert from Umaru Musa Mai'adua University, Katsina. They evaluated content validity, language clarity, and alignment with curriculum benchmarks. Following their feedback, 20 items were removed or reworded, leaving a 50-item instrument. The BAT was pilot-tested on an intact class of 20 students in a school outside the main sample. Using the split-half reliability method paired with the Spearman-Brown prophecy formula, the instrument yielded a high internal consistency coefficient of 0.85, making it reliable for field research.

Two detailed operational frameworks were used during the study: The Computer-Based Tutorial Instructional Strategy (CBTIS) Package: This interactive offline software program was installed on individual desktops in the school labs. It presented information in structural blocks, used animated diagrams to illustrate processes like mitosis and digestion, required students to answer checkpoint questions before advancing, and provided instant feedback with explanations. And the Conventional Lecture Framework: This traditional lesson plan relied on the blackboard and teacher-led explanations. The teacher delivered the exact same curriculum content over the same duration, using standard static textbook illustrations without digital interactivity. Before starting lessons, the pre-test BAT was administered to both groups by the researcher and trained research assistants to measure baseline knowledge. The experimental group then attended Biology classes in the computer laboratory using the CBTIS software, while the control group met in standard classrooms using traditional lectures. The study ran for four weeks across both groups. At the end of the intervention, the post-test BAT (with randomized question numbers to prevent memorization) was administered to all participants. The collected scripts were marked and compiled numerically. Research questions were analyzed using descriptive statistics, specifically Mean and Standard Deviation. Null hypotheses were tested using Independent Samples t-tests.

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Presentation of Results

Research Question 1

What is the difference in the post-test academic achievement mean scores between Biology students exposed to the computer-Based Tutorial Instructional Strategy and those exposed to the conventional instructional method?

To answer this question, the post-test mean scores and standard deviations of both groups were calculated and compared, as summarized in Table 1.

Table 1: Descriptive Statistics of Post-test Achievement Scores by Instructional Strategy

Instructional Strategy Group	Sample Size	Post-test Mean	Standard Deviation	Mean Difference
Experimental (CBT)	190	69.27	8.79	15.31
Control (Conventional)	190	53.96	10.30	

As shown in Table 1, the experimental group exposed to the Computer-Based Tutorial Instructional Strategy achieved a post-test mean score of 69.27 with a standard deviation of 8.79. The control group taught via the conventional method achieved a lower post-test mean score of 53.96 with a standard deviation of 10.30. This resulted in a descriptive post-test mean difference of 69.27 in favor of the CBTIS group, suggesting that the digital tutorial strategy led to higher academic performance.

Research Question 2

What is the difference in the post-test academic achievement mean scores between male and female Biology students exposed to the CBTIS?

To evaluate performance across gender lines within the experimental group, the scores of male and female participants were calculated separately, as displayed in Table 2.

Table 2: Descriptive Statistics of CBTIS Post-test Achievement Scores by Gender

Gender Category (CBT Group)	Sample Size	Post-test Mean	Standard Deviation	Mean Difference
Male Students	98	70.10	8.15	0.04
Female Students	92	70.06	9.05	

Table 2 shows that male students within the experimental group achieved a post-test mean score of 70.10, while female students achieved a nearly identical post-test mean score of 70.06. The resulting mean difference of 0.04 indicates that both genders achieved very similar academic outcomes when using the interactive CBTIS package.

Testing Null Hypothesis

Hypothesis One: There is no significant difference between the post-test mean academic achievement scores of students taught Biology using the Computer-Based Tutorial Instructional Strategy (CBTIS) and those taught using the conventional instructional method.

An Independent Samples t-test was conducted to determine if the mean difference shown in Table 1 was statistically significant. The results are presented in Table 3.

Table 3: Independent Samples t-test for Post-test Scores by Instructional Strategy

Strategy Group	N	Mean	df	t	sig.2tailed	Remark	
Experimental (CBT)	125	69.27	8.79	245	15.55	0.000	Significant
Control (Conventional)	122	53.96	10.30				

The inferential data in Table 3 indicates a highly significant difference between the two instructional groups. Because $t(245) = 15.55$, $p = 0.00$, which is less than significance level of 0.05, the first null hypothesis is rejected. This indicated that the higher academic performance observed in the CBTIS group was statistically significant and directly related to the instructional intervention.



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Hypothesis Two: There is no significant difference between the post-test mean academic achievement scores of male and female students taught Biology using the CBTIS.

An Independent Samples t-test was conducted on the experimental group data to evaluate gender-based differences, as summarized in Table 4.

Table 4: Independent Samples t-Test for CBT Post-test Scores by Gender

Gender Category	N	Mean	df	t	Sig.2Tailed	Decision	
Male Students	50	70.10	8.15	123	0.031	0.975	Retained
Female Students	75	70.06	9.05				

The statistics in Table 4 show that the difference between male and female students using CBTIS was not significant. Since $t(188) = 0.031$, $p = 0.975$, which is greater than the chosen significance value of 0.05, the second null hypothesis is retained. This demonstrates that the CBTIS worked effectively for both male and female students without favoring either gender.

Discussion of Findings

The empirical findings from this study demonstrate the pedagogical value of integrating technology into science education. Reversing the first null hypothesis showed that students exposed to the CBTIS package performed significantly better than those who learned through standard lecture methods. This finding is inline with the series of findings of (Azih et al., 2022, Jean et al. 2022, Orji et al. 2026, Fashanu & Omotayo 2026) who discovered that CBT strategies have significant effects on students' academic achievement. On the other hand, it aligns with cognitive load theory, which suggests that breaking down learning into interactive steps helps students process complex information more effectively. The step-by-step modular design of the CBT system allowed students to learn at their own pace, while its immediate feedback loops helped correct misconceptions before they could disrupt subsequent lessons. In contrast, the conventional lecture method left students in a passive role, making it harder for them to fully grasp complex microscopic and ecological processes. This outcome supports earlier research highlighting that traditional, text-heavy instructional styles struggle to engage students with abstract scientific concepts. By providing an interactive learning environment, the CBT approach helped students build a stronger, more lasting understanding of the material. The analysis of the second hypothesis showed no significant performance gap between male and female students within the CBT group. Both genders achieved nearly identical mean scores, indicating that the digital tutorial strategy functions as an equitable learning tool. This is also in line with the findings of (Azih et al., 2022, Jean et al. 2022, Orji et al. 2026, Fashanu & Omotayo 2026), who found out that gender had no significant effect on students academic achievement in Biology. This lack of gender bias contradicts older educational studies that categorized computer software as a male-dominated domain. Instead, it suggests that when interactive learning materials are designed clearly and integrated directly into the classroom, they provide equal academic benefits to all students regardless of gender. These results demonstrate that a structured CBT approach can help close historical gender gaps in science education across Katsina State.

Conclusion

This study provides quantitative evidence that the computer-Based Tutorial Instructional Strategy significantly improved academic achievement in Biology compared to conventional teaching methods. By shifting the classroom from a passive lecture format to an active, self-paced learning environment, CBT helped students better master complex biological concepts. Furthermore, the intervention proved to be gender-neutral, helping male and female students improve their academic performance equally. These results suggest that expanding the use of interactive digital learning



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tools could help address long-standing challenges in secondary school science education across Katsina State.

Recommendations

Based on these findings, the following recommendations are proposed to improve secondary science education in Katsina State:

1. Biology teachers should adopt Computer - Based Instructional Strategy in teaching Biology in secondary schools in Katsina State.
2. The Katsina State Ministry of Education, in coordination with the Nigerian Educational Research and Development Council (NERDC), should systematically integrate interactive computer-based instructional software into the official secondary school biology curriculum.
3. The State Government should prioritize equipping public schools with reliable computer laboratories, stable alternative energy sources (such as solar power arrays), and up-to-date science tutorial packages to ensure consistent access for all students.
4. Regular professional development workshops and ICT-focused seminars should be organized for secondary school science teachers. These programs should focus on training educators to design, manage, and use computer-based tutorials alongside traditional teaching methods.

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