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# COMPUTER-ASSISTED INSTRUCTION AND ACADEMIC PERFORMANCE OF SENIOR SECONDARY SCHOOL STUDENTS IN BIOLOGY IN EAST SENATORIAL DISTRICT OF RIVERS STATE

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## Abstract
This study examined the effect of computer-assisted instruction (CAI) using recorded video clips and the conventional discussion method on students' academic performance and retention in Biology in Rivers East Senatorial District of Rivers State. Anchored in Mayer's Cognitive Theory of Multimedia Learning and the Engagement Theory, the study employed a quasi-experimental, pre-test post-test non-equivalent control group design. A purposive sampling technique was used to select 120 Senior Secondary School II students from two intact classes. The Biology Performance Test (BPT), validated and tested for reliability, served as the data collection instrument. Data were analysed using mean, standard deviation, and Analysis of Covariance (ANCOVA) at a 0.05 level of significance. Results revealed that students taught using CAI significantly outperformed their counterparts taught with the discussion method in both academic performance and retention tests. The study further showed that the multimedia and self-paced features of CAI enhanced students' comprehension, engagement, and long-term memory of Biology concepts. These findings support the view that CAI promotes more effective and sustained learning than conventional methods, particularly in content-heavy science subjects. The study concludes that integrating computer-assisted instructional strategies into Biology teaching enhances both achievement and retention, offering a viable approach to improving science education outcomes. It recommends the widespread adoption of CAI across secondary schools to support active learning, strengthen digital competence, and close performance gaps in Biology.
**Keywords:** Computer-assisted instruction, Discussion method, Academic performance, Retention, Multimedia learning

## Introduction

Education remains the most powerful lever for societal transformation. In today's globalized and technology-driven world, the landscape of education is rapidly evolving from teacher-centered instruction to learner-centered, technology-enhanced experiences. This transition reflects the growing recognition that digital tools, when thoughtfully

integrated into instruction, can enrich learning environments, foster engagement, and deepen understanding (UNESCO, 2023; Voogt *et al*., 2020).

Among all disciplines, science education holds a pivotal role in equipping learners with the cognitive and problem-solving skills needed to navigate modern life and contribute meaningfully to national development. In countries like Nigeria, science education is particularly important for nurturing innovation and addressing pressing challenges such as health crises, environmental sustainability, and technological advancement (Jegede & Okebukola, 2021). Yet despite its importance, science subjects especially Biology continue to yield poor student outcomes in national assessments, often due to traditional pedagogical methods that fail to inspire or sustain learner interest (Adeyemo & Bello, 2022).

Biology, as a core science subject, introduces students to the complexity and interconnectedness of life. It provides foundational knowledge for careers in medicine, agriculture, and environmental science. However, many secondary school students in Nigeria find it difficult to comprehend and retain Biology concepts, leading to widespread underperformance (WAEC Chief Examiner's Report, 2021). A significant contributing factor is the continued use of conventional discussion methods, which often rely heavily on verbal explanation and rote memorization, offering limited visual or experiential support (Agogo & Oyelekan, 2022). In contrast, computer-assisted instruction (CAI) particularly when delivered through recorded video clips offers a powerful alternative. By combining audio narration, visual animations, and dynamic illustrations, CAI provides a multimodal learning experience that caters to diverse learning styles (Mayer, 2021). It allows students to visualize complex biological processes, replay difficult segments, and control the pace of their learning features that promote deeper engagement and long-term retention (Kurt & Yıldırım, 2022). More importantly, it transforms passive learners into active participants in the learning process, which is a core tenet of 21st-century education.

As the global education community continues to embrace digital innovation, it is essential to examine whether these technologies are truly effective in enhancing learning outcomes within contextually constrained environments such as Nigerian public schools.

This study was therefore designed to evaluate the effectiveness of computer-assisted instruction using recorded video clips on students' academic performance and retention in Biology, compared to the conventional discussion method. The goal is to offer evidence-based insights into how CAI can be effectively adopted to address the persistent learning challenges in Nigerian secondary schools and beyond.

In the contemporary classroom, particularly in science education, technology has emerged as a vital tool for addressing long-standing pedagogical challenges. One such innovation is Computer-Assisted Instruction (CAI), an interactive learning technique where the computer serves as both instructor and facilitator. CAI includes instructional strategies such as simulations, tutorials, problem-solving tasks, video clips, and educational games, all designed to promote active learner engagement and immediate feedback (Kurt & Yıldırım, 2022). These tools are particularly effective in subjects like Biology, where visualizing complex processes such as cell division or ecological cycles can significantly enhance comprehension and retention.

Despite its advantages, the implementation of CAI in Nigerian schools faces persistent challenges. These include poor electricity supply, limited access to quality educational software, and inadequate teacher training (Aderibigbe, 2020). Nonetheless, when properly deployed, CAI helps to overcome the limitations of traditional methods by engaging students with visual and auditory stimuli, allowing for repetition, and providing individualized learning experiences. In contrast, the discussion method, although widely practiced, is typically teacher-centered and relies heavily on verbal explanation. While it allows for dialogue and clarification, it often fails to stimulate deep learning or sustain retention especially among students who benefit more from visual or experiential input.

Retention itself refers to the learner's ability to transfer information from short-term to long-term memory. In science education, retention is crucial because it underpins performance in cumulative assessments and real-life application of concepts. However, various factors can influence retention and performance, including instructional strategy, students' study habits, and access to supportive learning environments. This study is grounded in Mayer's Cognitive Theory of Multimedia Learning and the Engagement

Theory, both of which offer valuable insights into how students learn more effectively through technology-enhanced instruction.

Mayer's Cognitive Theory of Multimedia Learning (Mayer, 2021) posits that people learn better from a combination of words and pictures than from words alone. The theory is based on three major assumptions: the dual-channel assumption (visual and auditory processing), the limited capacity assumption (each channel has a finite load), and the active processing assumption (learners must actively integrate information). When applied to the teaching of Biology, Mayer's theory implies that video-based instruction which combines narration, images, and animation can reduce cognitive overload and foster deeper understanding. For instance, students are more likely to grasp the stages of photosynthesis or mitosis when shown animated visuals synchronized with audio explanations. The theory supports the use of CAI video clips in this study by reinforcing the idea that multimedia instruction enhances comprehension and retention more than text or speech alone.

On the other hand, the Engagement Theory (Kearsley & Shneiderman, 1998) emphasizes that students learn best when they are meaningfully engaged in learning tasks, particularly those involving interaction and collaboration. In a CAI context, engagement occurs when students control the pace of learning, interact with content, and make decisions during simulations or tutorials. For Biology students, this could mean engaging with a self-paced video on the human circulatory system, where they can pause, replay, or test themselves at intervals. The theory suggests that active engagement rather than passive reception is key to sustained interest, concept retention, and academic success.

Together, these theories validate the use of computer-assisted video clips as a pedagogical strategy in Biology classrooms. They provide the theoretical justification for expecting students who learn via CAI to perform better and retain concepts longer than those taught through conventional discussion methods. Empirical studies over the past decade have consistently shown that computer-assisted instruction (CAI), particularly when delivered through video-based materials, enhances students' academic performance and supports long-term retention. This is especially true in science education, where

visualizations and interactive experiences can simplify abstract content and sustain learner engagement. For instance, Alasoluyi (2015) demonstrated that students taught with CAI outperformed their peers taught with conventional methods in science comprehension tests. The study attributed this improvement to CAI's ability to present complex ideas in visually enriched and sequential formats, which deepened understanding and improved recall. In a similar study, Okonkwo and Eze (2021) found that secondary school students who were exposed to animated Biology lessons using CAI retained information longer than those taught through textbook-based discussion. The delayed post-test results showed a significant retention gap favoring the CAI group, underscoring the value of multimedia learning in reinforcing memory. Ibrahim and Yusuf (2020) also highlighted that video-based instruction promotes deeper cognitive engagement by combining auditory and visual stimuli, which helps learners form strong mental representations. Their findings support the idea that multimedia instruction leads to better retention of concepts, especially in abstract science topics like cell structure, respiration, and photosynthesis.

Furthermore, Lawal and Bello (2022) examined the use of video clips in teaching human anatomy and concluded that students not only performed better immediately after instruction but retained more content after two weeks, compared to those in traditional lecture-based settings. These findings reinforce the premise of this study: that CAI using video clips can lead to significantly better academic performance and higher retention of Biology concepts compared to conventional discussion methods. However, despite growing interest in educational technologies, the application of CAI specifically to secondary school Biology instruction remains underexplored in the Nigerian context. This study addresses that gap by empirically testing the effectiveness of video-based CAI in improving both performance and retention in Biology among secondary school students.

**Statement of the Problem**

In recent years, there has been growing concern over the continuous decline in students' performance in Biology at the senior secondary school level in Nigeria. Despite national emphasis on science education and the adoption of various curriculum reforms,

examination outcomes in Biology have remained below expectations. Analysis of results from the West African Senior School Certificate Examination (WASSCE) between 2017 and 2023 shows that less than half of the candidates consistently attain credit-level passes in Biology. Official records from the Rivers State Examination Development Centre further reveal a persistent trend of poor academic performance in Biology among secondary school students. This trend raises important questions about the effectiveness of existing instructional approaches in delivering Biology content and promoting understanding among learners. Several factors have been suggested as possible contributors to this performance gap, including large class sizes, limited laboratory facilities, and a general disconnect between teaching methods and students' learning needs. However, the extent to which the method of instruction influences students' academic performance and retention in Biology remains unclear. It is in view of this persistent performance crisis and the uncertainty surrounding the instructional factors involved that this study becomes necessary. The central concern is to determine whether the method of instruction significantly impacts students' learning outcomes in Biology, particularly in terms of academic achievement and retention.

## Purpose of the Study

The purpose of this study is to investigate the effects of computer-assisted instruction (using recorded video clips) and discussion method on the academic performance and retention of senior secondary school students in Biology in Rivers East Senatorial District of Rivers State. Specifically, the study aims to:

1. ascertain the difference in the academic performance of students taught Biology using computer-assisted instruction (video clips) and those taught using the discussion method.
2. examine the difference in the retention scores of students taught Biology using computer-assisted instruction (video clips) and those taught using the discussion method.

## Research Questions

This study is guided by the following research questions:

1. What are the differences in the mean academic performance scores of students taught Biology using computer-assisted instruction (video clips) and those taught using the discussion method?
2. What are the differences in the mean retention scores of students taught Biology using computer-assisted instruction (video clips) and those taught using the discussion method?

## Hypotheses

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

**$H_{01}$:** There is no significant difference in the academic performance mean scores of students taught Biology using computer-assisted instruction and those taught using the discussion method.

**$H_{02}$:** There is no significant difference in the retention scores of students taught Biology using computer-assisted instruction and those taught using the discussion method.

## Methods

This study adopted a quasi-experimental design incorporating non-randomized pre-test, post-test, and retention test formats within a non-equivalent control group structure. The population consisted of 31,235 SS2 Biology students enrolled in 127 public secondary schools across Rivers East Senatorial District as recorded by the Rivers State Senior Secondary Schools Board (December 2023). The sample comprised 120 SS2 students selected through a purposive sampling technique. Out of the 127 co-educational public secondary schools in the district, two schools were purposefully chosen. Intact classes from the selected schools were used to form the study groups, with one class serving as the experimental group and the other as the control group.

Data were collected using a researcher-designed Biology Performance Test (BPT) consisting of 20 multiple-choice questions each derived from the SS2 Biology topic "Classification of Plants." The instrument covered various cognitive levels and was structured to assess both academic performance and retention. Each correct response was scored at 5 marks, totaling 100 marks per test. The BPT was administered as a pre-test, post-test, and retention test. To ensure content and face validity, the BPT and lesson plans

were reviewed by the research supervisor and two experts in science education and curriculum design. Revisions were made based on their recommendations to ensure alignment with the objectives of the study.

The reliability of the BPT was established using the test-retest method with 20 SS2 students outside the study sample. The scores from both tests, spaced two weeks apart, were correlated using the Pearson Product Moment Correlation Coefficient, yielding a reliability index of 0.893 indicating strong internal consistency. The study was conducted in three phases. First, a pre-test was administered to both experimental and control groups. This was followed by a three-week instructional phase, during which the experimental group was taught using video-based computer-assisted instruction in the school's ICT lab, while the control group received instruction via the discussion method. After instruction, a post-test was administered to assess academic performance. Two weeks later, a retention test using a reshuffled version of the same BPT was administered to both groups to measure knowledge retention. Instructional fidelity was ensured through prior training of assisting teachers. Descriptive statistics (mean and standard deviation) were used to answer the research questions. Analysis of Covariance (ANCOVA) was employed to test the hypotheses at a 0.05 level of significance. Pre-test scores served as covariates to control for baseline differences between the groups.

## Results and Discussion

The results of this study are presented in this chapter according to the research questions and hypotheses that guided the study.

**Research Question One:** What are the differences in mean performance scores of students taught Biology using computer-assisted instruction (video clip) and those taught using discussion methods?

**Table 4.1: Mean and Standard Deviation of Students' Academic Performance Score in Biology**

| Groups | | Pre-test | | Post-test | | Mean Scores | Gain | Mean Gain Difference |
|---|---|---|---|---|---|---|---|---|
| | n | Mean | SD | Mean | SD | | | |
| **CAI(video clip)** | 62 | 21.26 | 7.00 | 55.24 | 4.32 | 33.98 | | |
| | | | | | | | | 2.39 |
| **Discussion Method** | 58 | 15.34 | 7.31 | 46.93 | 5.93 | 31.59 | | |
| Total | 120 | | | | | | | |

Result in Table 4.1 shows the mean performance scores of students who were taught Biology using computer assisted instruction and those taught using the discussion method. Students exposed to computer assisted instruction had a mean performance score of 21.26 with standard deviation of 7.00 at pre-test and 55.24 with standard deviation of 4.32 at post-test. The mean gain difference in favour of students exposed to computer assisted instruction was 33.98 On the other hand, students who were exposed to the discussion method had a mean performance score of 15.34 with standard deviation of 7.31 at pre-test and 46.93 with standard deviation of 5.93 at post-test. The mean gain scores of the students exposed to the discussion method was 31.59. The mean gain difference of 2.39 was recorded for the two groups in favour of students exposed to computer assisted instruction. This indicates that the experimental groups, students taught with Computer-assisted instruction (video clip) package performed higher than the control group that is students taught with the discussion method. In other words, CAI has more effect on the mean performance score of students in Biology. However, the obtained standard deviation from students in both the groups was relatively small, indicating that the variation from the mean was small.

**Research Question Two:** What are the differences in mean retention scores of students taught Biology using computer-assisted instruction (video clip) and those taught using discussion methods?

**Table 4.2: Mean and Standard Deviation of Students' Retention Score in Biology**

| Groups | | Post-test | | Retention-test | | Mean Gain Scores | Mean Gain Difference |
|---|---|---|---|---|---|---|---|
| | n | Mean | SD | Mean | SD | | |
| **CAI(video clip)** | 62 | 55.24 | 4.33 | 80.29 | 4.88 | 25.05 | 2.1 |
| **Discussion Method** | 58 | 46.93 | 5.93 | 69.88 | 4.30 | 22.95 | |
| Total | 120 | | | | | | |

Result in Table 4.2 shows the mean retention scores of students who were taught Biology using computer assisted instruction and those taught using the discussion method. The Table shows that students exposed to computer assisted instruction had a mean post-test score of 55.24with standard deviation of 4.33and mean Retention-test score of 80.29 with standard deviation of 4.88. The mean gain score of students exposed to computer assisted instruction was 25.05. On the other hand, students exposed to discussion methods had a mean post-test score of 46.93 with standard deviation of 5.93and Retention-test score of 69.88 with standard deviation of 4.32. The mean gain scores of the students exposed to the discussion method was 22.95. However, a mean gain difference of 2.1 was recorded for the two groups in favour of students exposed to computer assisted instruction. However, the obtained standard deviation from students in both the groups was relatively small, indicating that the variation from the mean was small.

**Hypothesis One:** There is no significant difference in the mean performance scores of students taught Biology using computer-assisted instruction and those taught with discussion methods.

**Table 4.5: Summary of Analysis of Covariance (ANCOVA) of Students' Performance in Biology when taught using Computer-Assisted Instruction and Discussion Method**

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 2116.068[a] | 2 | 1058.034 | 39.921 | .000 | .406 |
| Intercept | 38389.780 | 1 | 38389.780 | 1448.504 | .000 | .925 |
| Pre-test | 46.238 | 1 | 46.238 | 1.745 | .189 | .015 |
| Methods | 1551.120 | 1 | 1551.120 | 58.526 | .000 | .333 |
| Error | 3100.857 | 117 | 26.503 | | | |
| Total | 320097.000 | 120 | | | | |
| Corrected Total | 5216.925 | 119 | | | | |

a. R Squared = .406 (Adjusted R Squared = .395)

Result of the analysis in Table 5.5 shows that teaching methods is a significant factor on students' performance in Biology; F (1, 117) = 58.52, P = .000. Thus, the null hypothesis of no significant difference in the mean performance scores of students taught Biology using computer-assisted instruction and those taught with discussion methods was rejected. This is because the exact probability value of .000 is less than the level of significance at 0.05. Therefore, the researcher concludes that there is a significant difference in the mean performance scores of students taught Biology using computer-assisted instruction and those taught with discussion methods.

**Hypothesis Two:** There is no significant difference in the mean retention scores of students taught Biology using computer-assisted instruction and those taught with discussion methods.

**Table 4.6: Summary of Analysis of Covariance (ANCOVA) of mean retention score of Students In Biology when taught using Computer-Assisted Instruction and Discussion Method**

**Dependent Variable: PostPost-test**

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 3324.405a | 2 | 1662.203 | 79.947 | .000 | .577 |
| Intercept | 5379.709 | 1 | 5379.709 | 258.748 | .000 | .689 |
| Post-test | 76.343 | 1 | 76.343 | 3.672 | .058 | .030 |
| Methods | 1502.443 | 1 | 1502.443 | 72.263 | .000 | .382 |
| Error | 2432.586 | 117 | 20.791 | | | |
| Total | 685415.000 | 120 | | | | |
| Corrected Total | 5756.992 | 119 | | | | |

a. R Squared = .577 (Adjusted R Squared = .570)

Result of the analysis in Table 4.6 shows that teaching method is a significant factor on students' retention in Biology; F (1, 117) 72.263, P = .000. Thus, the null hypothesis of no significant difference in the mean retention scores of students taught Biology using computer-assisted instruction and those taught with discussion methods was rejected. This is because the exact probability value of .000 is less than the level of significance set at 0.05. Therefore, the researcher concludes that there is a significant difference in the mean retention scores of students taught Biology using computer-assisted instruction and those taught with discussion methods.

## Discussion of Findings

The findings of this study revealed that students taught using Computer-Assisted Instruction (CAI) significantly outperformed their peers who were taught using the conventional discussion method in both academic performance and retention tests. This enhancement in learning may be attributed to the interactive, multimodal nature of CAI, which supports visualization, learner engagement, and self-paced exploration key factors that aid knowledge retention and performance. CAI allows for greater conceptual clarity and memory reinforcement through repetitive audio-visual exposure, thereby reducing cognitive overload. This result aligns with the findings of Alaka (2021), who reported

that students taught using CAI retained more information and performed better in post-tests compared to those taught via traditional methods. Similarly, Okeke and Nwachukwu (2020) affirmed that CAI significantly improved students' academic performance and retention in science subjects. The present study further reinforces these findings, highlighting CAI as a potent instructional tool that facilitates long-term learning outcomes. In line with Mayer's Cognitive Theory of Multimedia Learning, and engagement theory, the success of CAI is explained by its ability to engage both verbal and visual cognitive channels, enhancing students' understanding through dual coding.

## Implications of Findings

The results of this study suggest that Biology teachers should leverage CAI to create immersive and engaging learning experiences. Concepts like classification of plants often considered abstract or difficult can be simplified using video-based simulations, animations, and interactive tutorials that offer students a more hands-on understanding. By adopting CAI, educators can cater to diverse learner needs, improve comprehension, and foster independent inquiry. The use of video clips and digital modules helps students construct knowledge actively, thereby increasing their confidence and enthusiasm for science.

## Conclusion

This study concludes that Computer-Assisted Instruction is significantly more effective than the conventional discussion method in improving both academic performance and knowledge retention among senior secondary school Biology students. The multimedia, student-centered approach of CAI facilitates deeper understanding and long-term memory of biological concepts. These findings support the shift towards technologically enhanced education as a strategy to address the persistent underperformance in Biology. Given the current global emphasis on digital learning, CAI offers an innovative and practical solution for improving science education in Nigeria and similar contexts. Its potential to close achievement gaps, especially in critical subjects like Biology, positions it as a transformative tool for instructional delivery.

Biology teachers should be trained and motivated to integrate CAI into classroom teaching to promote conceptual understanding and retention. Education stakeholders should provide the necessary ICT infrastructure, including reliable power supply and multimedia tools, to facilitate CAI implementation in all secondary schools. Curriculum developers should embed CAI principles into Biology syllabi and national education policies to ensure its sustainability. Regular workshops and seminars should be organized to equip teachers with practical skills for developing and using CAI materials.

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