# EFFECTS OF COMPUTER-ASSISTED INSTRUCTIONAL STRATEGY ON THE RETENTION OF BIOLOGY CONCEPTS AMONG SECONDARY SCHOOL STUDENTS IN DELTA STATE, NIGERIA

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**Abstract**
*The study is on the effects of computer-assisted instructional strategy on the retention of biology concepts among secondary school students in Delta State, Nigeria. The study used a pre-test and post-test non-randomized quasi-experimental design. The participants were 42,811 second-grade seniors from all public secondary schools. A simple of 230 biology students was used through the simple random sampling method by replacement and withdrawal. The Biology Attainment Test (BAT) was the data collection tool. Its reliability was assessed determined using the Kuder-Richardson Formula 21 (KR-21) which yielded a reliability index of 0.78, which confirmed the tool's trustworthiness. Data were analyzed using ANOVA, t-test, variance, mean, and standard deviation. The results showed that students taught with a computer-assisted teaching strategy scored higher on average than those taught with traditional lectures. There was no correlation between teaching methods and gender in terms of retention. It was recommended that biology teachers should use computer-assisted teaching strategy to enhance student retention in biology and therefore should be trained.*

**Keywords:** Computer-Assisted Instructional, Retention, Biology

## Introduction

Science is the foundation upon which any technological breakthrough is built hence for any nation to experience growth, there should be meaningful teaching and learning. According to Oyovwi (2019), the study of science yield both theoretical and practical knowledge about the environment. This can be used to manipulate and harness the force and resources of nature for human development and well-being and pointed out science literacy is indispensable in achieving technological development of any nation. Therefore, a sound science educational system is accepted world over as the bed rock of human development and progress and should be taught both theoretically and practically. The study and practice of science is felt in all part of the world including developing nation like Nigeria which has been in high demand for scientific skills and manpower, the more reason it determines to a high level the standard of living of its citizens (Oyovwi & Iroriteraye-Adjekpovu, 2021). Biology is a science subject that teaches students about the basics of life and living organisms in high-school. It covers topics like structure, function, growth, classification, and other biological ideas (Green, Heyner, & Rogers, 2023). According to the Federal Government of Nigeria (FGN, 2013), teaching biology has several goals. These include teaching students the scientific method, helping them understand science, applying biological concepts to real-life situations such as agriculture and health, preparing them to live successfully in a scientific and technological world, and encouraging them to be responsible citizens who embrace technological progress for economic growth. Because Biology is so important, biology teachers need to use innovative teaching methods to ensure that biology education is thorough, practical, relevant, engaging, and up-to-date. The method used to teach biology can significantly impact students' academic performance. Research by Akpan and Olagunju (2019) and others shows that teaching strategies directly affect students' attainment, performance, retention, and interest in biology. They noted that a teacher's use of advanced technology influences their teaching methods,

which greatly affects students' learning outcomes. Therefore, teachers should adopt effective instructional strategies to help students understand and engage with the material. However, observations and experiences show that most teachers still use traditional lecture methods for teaching biology in senior secondary schools (Izunna & Osuafor, 2021).

Exploiting technology in biology classrooms is essential for giving students various tools and resources to help them understand complex biological concepts better. It is crucial to balance and ensure that technology supports biology education goals. One of the aims of studying biology is to prepare students for success in a scientifically and technologically advanced society. To attain this, biology teaching should incorporate problem-solving, hands-on activities, practical experiences, and IT-supported strategies. One innovative teaching method that meets this need is computer-aided instruction. How biology is instructed can either enhance or diminish students' academic success. Researchers like Akpan and Olagunju (2019) discovered that teaching methods impact students' low grades, poor performance, low retention, and lack of interest in biology. They argued that when teachers creatively use technology, it influences their teaching methods and significantly affects students' learning outcomes.

If the method a teacher chooses affects how well students grasp concepts and engage meaningfully, it's crucial to adopt instructional strategies that support learning and help students attain specific learning goals in the subject. This study recommended incorporating computer-assisted instruction (CAI) into the biology curriculum to enhance student retention. CAI involves Exploiting a computer during teaching and learning to present instructional materials and monitor student progress. It aims to improve and facilitate instruction by integrating computer technology into the process. Nazimuddin (2015) outlines several benefits of Exploiting computer-assisted instruction (CAI).

CAI serves as a strong motivator because users can explore various options and receive immediate feedback on their responses. Since computer-based instruction lets students to learn at their own pace, it benefits shy and slower learners by providing more personalized attention from teachers. In essence, it promotes customized teaching and accelerates students' mastery over the subject. The benefits of a multisensory approach are undeniable. Multimedia content helps students grasp challenging concepts more easily. With self-directed learning, students have the freedom to choose when, where, and what they study. CAI significantly enriches the resources available to students. CAI enhances the intensity of personalized instruction students receive. Many students appreciate the private, self-paced learning environment and the immediate feedback provided through computer interactions. Engaging in computer-assisted instruction often sparks students' curiosity, motivates them to learn, fosters independence, and encourages them to take responsibility for their education.

Eravwoke (2016) defines retention as the capability to recall and use newly acquired information long after it was learned. Retention happens as knowledge is acquired and concepts are understood deeply. Agboro (2019) argues that true understanding of concepts is necessary for effective retention. Experimentation is highlighted as the optimal method for remembering concepts. Halpern (2003) asserts that genuine learning goes beyond passive activities like reading or listening; it involves active implementation where mistakes are made, fostering real learning opportunities.

Retention refers to the ability of students to remember and apply the information and skills they have learned over time. It involves the ability to apply knowledge in similar situations and maintain what has been learned over time. It is crucial in learning as it lets students to build upon their knowledge and apply it in new contexts. Educators need to be aware of the teaching

methods used for concept instruction and strive to enhance them to promote retention (Agboro, 2019). According to Jensen (2011), retention is an important consideration in education and its impact on overall well-being. In biology education, retention specifically refers to the ability to comprehend and recall biological concepts over time. This can be attained by presenting information clearly, concisely, and in an engaging manner. When educators utilize various teaching approaches, particularly those integrating technology, students can acquire and retain new knowledge. Active learning strategies, such as those involving computer-assisted learning, have been shown to enhance retention by enabling the application of learned concepts to real-world scenarios (Freeman *et al.,* 2014).

**Statement of the Problem**

The nation's educational system is plagued with varied challenges which have either cause or causing the standard of education to dwindle. This could be attributed to instructional strategies applied by the teachers. The instructional strategies play a critical role in shaping students' active engagement and instructional attainment. However, it has been observed by researchers that science teachers especially in Biology still adhere to teacher-centered instructional strategies in the teaching learning process which makes students passive. Hence, the need to explore strategies that are student centered becomes imperative. These strategies are known to promote active participation in the teaching-learning process. Computer-Assisted Instructional (CAI) strategy is an instructional strategy that uses computer to present instructional materials and track students' progress throughout the course (Orhuakpo; Oyovwi & Kpangban, 2014). It also facilitate active engagement and motivation. Hence, the statement of the problem is "will the adoption of CAI enhance students retention of Biology concepts among secondary school students in Delta state, Nigeria?

**Research Questions**

These research questions were addressed in this study.

1. What is the difference in the mean retention scores between students taught Biology using Computer-Assisted Instruction (CAI) and those taught using the lecture method?
2. What is the variance in mean retention scores between male/female students taught Biology using CAI and lecture method?
3. What is the effect of interaction of teaching methods and gender on students' retention in Biology?

**Hypotheses**

The following null hypotheses guided this study and were tested at a significance intensity of 0.05

**$Ho_1$:** There is no significant difference in the mean retention scores between students taught Biology using CAI and those taught using the lecture method.

**$Ho_2$:** There is no significant difference in mean retention scores between male/female students taught using Computer-Assisted Instruction (CAI) and lecture method in Biology

**$Ho_3$:** There is no significant effect of interaction of teaching methods and gender on students' retention in Biology.

**Purpose of the Study**

This study examined the effects of a computer-assisted instructional strategy on student retention in the biology curriculum in secondary schools in Delta State. Specifically, the study will:

1. Compare the difference in mean retention scores between students taught Biology using CAI and those taught using the lecture method,
2. Compare the difference in mean retention scores between male/female students taught

using CAI and lecture method in Biology,
3. Determine the effects of interaction of teaching methods and gender on students' retention scores in Biology.

**Research Design**
In this research, the quasi-experimental designs used for the pre-test, post-test, and control groups were non-randomized. The classes were kept intact to prevent disruption of the curriculum or school activities. The study focused on one learning goal, which is retention, and involved two teaching methods and two gender groups (males and females). Retention is considered the dependent variable, while gender (males and females) serves as the moderating variable. The independent variables in this study are the lecture technique and computer-assisted instructional strategy.

**Population for the Study**
The study targeted 42,811 Senior Secondary School two (SS2) Biology students from 846 public secondary schools across the three senatorial districts in Delta State, Nigeria. The biology concepts (Respiration, Excretion, Digestion, Reproduction) chosen were aligned with the SS2 Biology Scheme of Work, and the students had not yet taken external exams such as WASSCE or NECO, ensuring their full attention could be devoted to the study. These criteria guided the selection of SS2 students for the research.

**Sample and Sampling Techniques**
The study's sample consists of 230 biology students in senior secondary school,91 boys and 139 girls from six public coeducational secondary schools in Delta State. These schools were chosen Exploiting Simple Random Sampling Techniques.

**Research Instrument**
The tool used to collect data was the Biology Attainment Test (BAT). The Biology Attainment Test is divided into two parts known as Sections A and B (BAT). Section B consists of 50 multiple-choice questions with four possible answers each. BAT was developed from past WAEC questions. Section A collects biographical information from students at the bottom of the form.

**Validity of the Instrument**
The face and content validity of the instrument was duly established. Specifically, the Biology Attainment Test (BAT) validity was assessed by a panel of three experts: a certified and experienced biology teacher, a measurement and evaluation specialist, and a science education specialist. Each expert was familiar with the research questions, hypotheses, and instrument, and they determined whether the tool could effectively collect data to test the theories and address the research questions. Expert input was incorporated into the final version of the study's instrument. The content validity of BAT was established using table of specification.

**Reliability of the Instruments**
The reliability of the Biology Attainment Test (BAT) was assessed during a pilot study involving fifty biology students from schools not included in the main sample. The Kuder Richardson formula 21 (KR-21) was used to analyze the data, yielding a reliability index of 0.81. According to Wiseman (1999), a reliability score of 0.78 or higher indicates that the test reliably measures the intended traits. Therefore, the BAT is considered reliable for accurately assessing the targeted characteristics.

**Method of Data Analysis**
Data analysis in the study was conducted using mean scores, standard deviation, independent group t-tests, paired sample t-tests, and analysis of variance (ANOVA) statistics to address the

research questions and test hypotheses effectively.

**Presentation of Results**

**Research Question 1:** What is the difference in mean retention scores between students taught Biology using Computer-Assisted Instruction (CAI) and those taught using the lecture method?

**Table 1: Descriptive statistics showing the comparison between the CAI and LM group students' on Biology retention test scores**

| Groups | N | Mean | Mean Diff | SD |
|---|---|---|---|---|
| CAI | 108 | 53.38 | 5.708 | 21.34 |
| LM | 112 | 47.68 | | 17.38 |

Table 1 indicates that students in the CAI group attained an average retention score of 53.38, with a standard deviation of 21.34, while students in the LM group had an average retention score of 47.68, also with a standard deviation of 17.38. The mean difference between these scores was 5.708 points, favoring the CAI group. This demonstrates significant differences in biology outcomes between the two groups.

To determine whether the difference is significant, H01 was tested Exploiting an independent samples t-test. The result is shown in Table 2

**Table 2: Independent sample t-test statistics comparing the difference between CAI and LM group students' Biology retention test scores.**

| Groups | N | Mean | Mean Diff | SD | df | tcal | Sig (2-tail |
|---|---|---|---|---|---|---|---|
| **CAI** | 108 | 53.38 | | 21.34 | | | |
| | | | 5.708 | | 218 | 2.708 | 0.00 |
| **LM** | 112 | 47.68 | | 17.38 | | | |

Table 2 indicates a significant difference, as evidenced by the calculated Sig value of 0.00, which is below the critical significance intensity of 0.05. This rejects the hypothesis (H01) that there is no significant difference in average retention scores between students taught biology using computer-assisted instruction (CAI) with animation and those taught using the lecture method.

**Research question 2:** What is the difference in mean retention scores between male/female students taught Biology using Computer-Assisted Instruction (CAI) with animation and lecture method?

To answer the research question, descriptive statistics of the mean and standard deviation were used to compare the retention scores of both the CAI and control LM students.

**Table 3: Descriptive statistics comparing the difference in the retention score of male/female biology students taught with CAI and LM**

| Methods | Sex | N | Mean | Mean Diff. | SD |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **CAI** | Male | 46 | 27.85 | 2.23 | 8.31 |
| | Female | 62 | 25.53 | | 13.01 |
| **LM** | Male | 45 | 24.40 | 1.12 | 9.21 |
| | Female | 67 | 23.28 | | 10.12 |

Table 3 illustrates that male students attained a mean score of 27.85 with a standard deviation of 8.31, while female students scored 25.53 with a standard deviation of 13.01. The mean difference between these scores was 2.23 points in favor of females. For the LM group, male students had a mean score of 24.40 with a standard deviation of 9.21, and female students had a mean score of 23.28 with a standard deviation of 10.12, showing a mean difference of 1.12 points. This indicates a slight advantage for females in post-test results compared to males. To assess the significance of these differences, independent samples t-tests were conducted to test H02, as detailed in Table 4.

**$Ho_2$:** There is no significant difference in mean retention scores between male/female students taught using Computer-Assisted Instruction (CAI) with animation and lecture method in Biology

**Table 4: One-Way ANOVA Comparing Mean Retention Scores by Gender within CAI and LM Groups**

| Methods | Source | SS | df | MS | F | Sig. |
|---|---|---|---|---|---|---|
| **CAI** | Between Groups | 204.13 | 1 | 204.13 | 1.59 | 0.210 |
| | Within Groups | 12988.35 | 106 | 122.53 | | |
| | Total | 13192.48 | 107 | | | |
| | Source | SS | df | MS | F | Sig. |
| **LM** | Between Groups | 70.07 | 1 | 70.07 | 0.32 | 0.572 |
| | Within Groups | 24092.92 | 110 | 219.03 | | |
| | Total | 24162.99 | 111 | | | |

Table 4 shows that the variance is not significant since the calculated Sig values of 0.210 and 0.572 are higher than the critical Sig value of 0.05. Thus, Ho2 is rejected. Therefore, there is no significant difference in mean retention scores between male and female students taught biology exploiting computer-assisted instruction (CAI) with animation and lecture method.
Research Question 3: What will be the effect of interaction of teaching method and sex on students' retention score in Biology?

**Table 5: Descriptive Statistics Comparing Interaction Effects of Method and Sex on Retention Scores**

| Group | Sex | N | Mean | SD |
|---|---|---|---|---|
| **CAI** | Male | 46 | 27.85 | 8.31 |
| | Female | 62 | 25.53 | 13.01 |

| | | | | |
|---|---|---|---|---|
| **Total (CAI)** | | 108 | 26.54 | 11.04 |
| **LM** | Male | 45 | 24.40 | 9.21 |
| | Female | 67 | 23.28 | 10.12 |
| **Total (LM)** | | 112 | 23.75 | 9.69 |

Table 5 shows that, in the CAI group, male students had an average interaction score of 27.85, with a standard deviation of 8.31, whereas female students scored 25.53, with a standard deviation of 13.01. The mean interaction difference between these groups was 2.23 points in favor of females. In the LM group, male students attained an average interaction score of 24.40, with a standard deviation of 9.21, while female students scored 23.28, with a standard deviation of 10.12, resulting in a mean difference of 1.12 points. This suggests a slight bias favoring females in post-test results compared to males.

**$Ho_3$:** There is no significant effect of the interaction of teaching method and gender on students' retention scores in Biology.

**Table 6: Two-Way ANOVA on Interaction Effect of Method and Sex on Retention Scores**

| Source | Type III SS | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| **Corrected Model** | 2006.896 | 3 | 668.965 | 2.724 | 0.045 |
| **Intercept** | 707780.576 | 1 | 707780.576 | 2882.113 | 0.000 |
| **Method** | 1580.868 | 1 | 1580.868 | 6.444 | 0.012 |
| **Sex** | 66.365 | 1 | 66.365 | 0.270 | 0.604 |
| **Method * Sex** | 151.055 | 1 | 151.055 | 1.271 | 0.434 |
| **Error** | 53044.632 | 216 | 245.577 | | |
| **Total** | 784498.000 | 220 | | | |
| **Corrected Total** | 55052.527 | 219 | | | |

The interaction effect between teaching method and sex on students' retention scores in Biology was analyzed using a two-way ANOVA as shown in Table 6. The result revealed that the interaction between method and sex was not statistically significant, $F(1, 216) = 1.271$, $p = 0.434$. This indicates that the influence of the teaching method on students' retention scores did not differ significantly between male and female students. In practical terms, both male and female students responded similarly to the respective instructional strategies—whether exposed to Computer-Assisted Instruction (CAI) or the traditional Lecture Method (LM). The lack of a significant interaction effect suggests that the observed differences in retention scores can be attributed more to the teaching method itself rather than to any combined influence of gender and instructional approach. Therefore, while the teaching method plays a significant role in determining academic retention, this effect is consistent across both sexes, implying that CAI enhances retention outcomes in a gender-neutral manner.

## Discussion

This study discovered that biology students taught using CAI attained higher retention scores compared to those taught with the lecture method (LM). This difference was found to be statistically significant. Table 11 demonstrates that the critical significance value of 0.05 was lower than the computed significance value of 0.00, indicating a notable difference in the average retention scores between the LM and CAI groups. This suggests that using CAI had a positive impact on the retention test performance of every student in the CAI group, benefiting them uniformly. This finding aligns with studies conducted by Nwoye and Okeke (2020) as well as Oyovwi (2020), which also observed significant differences between students in CAI and LM groups in physics classrooms, and between those exposed to innovative teaching methods versus traditional methods. This suggests that the use of CAI equally benefited each student

in the CAI group in terms of retention test performance.

Additionally, when comparing the retention scores between the two groups of students, this study found that male students taught using both CAI and LM methods attained higher post-retention scores than their female counterparts. However, it was concluded that this apparent difference was not significant, as the calculated significance values of 0.742 and 0.483 exceeded the critical significance intensity of 0.05. Table 2 illustrates that there was no statistically significant difference in the average scores between male/female students. This suggests that both teaching methods had a similarly positive impact on the post-retention exam scores of all students, regardless of gender. This conclusion is consistent with Oyovwi's (2022 and 2019) findings, which indicate that innovative teaching techniques such as problem-solving and computer-assisted instruction generally benefit both male/female students alike.

The study examined how the interaction between teaching method and gender influenced retention, and it found that this interaction had little to no effect. This suggests that the relationship between gender and teaching method did not influence students' ability to remember biology concepts they were taught. Therefore, the retention of biology knowledge was affected by CAI regardless of whether students were male or female. This conclusion is consistent with Ajaja's (2013) findings, which also indicated that there was no significant interaction between gender and instructional style on biology attainment.

## Conclusion

The results of this study indicate that using CAI improves students' retention, demonstrating their ability to hold material in long-term memory for a considerable amount of time. Thus, it may be said that CAI is appropriate for teaching biology curriculum concepts.

## Recommendations

The study's results and findings informed the recommendations that followed.

1. It is recommended that CAI be employed by biology teachers in teaching biology since the method has proved to enhance students' retention in biology.
2. It is also recommended that students be given the instruction they need to become proficient with CAI and inspired to apply it in the teaching learning process.
3. Curriculum planner should endeavor to include CAI in the curriculum as an instructional strategy.

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