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EFFECT OF COMPUTER-ASSISTED INSTRUCTIONS ON SENIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN GENETICS IN KARU, NASARAWA STATE, NIGERIA

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Abstract

This study investigated the Effect of computer-assisted instructions on Secondary School Students' Achievement in Genetics in Karu, Nasarawa State, Nigeria. Two research questions were posed to guide the study, and two null hypotheses were formulated and tested at the 0.05 level of significance. The study adopted a quasi-experimental research design with a pretest and post-test and non-randomised control groups. The study population comprises 2,275 SS3 students in Karu, Nasarawa State, Nigeria, during the 24/2025 academic session. Simple random sampling technique was used to select sample for the study. Genetics Achievement Test (GAT) items were used to collect data. The instruments were validated by three experts, and Kuder-Richardson 21 (K-R21) was used to assess the GAT's internal consistency, yielding an efficiency of 0.88. Descriptive statistics of mean and standard deviation were used to answer research questions, while Inferential Statistics of Analysis of

Covariance (ANCOVA) were used to test the null hypotheses at 0.05 level of significance. The findings of the study revealed that exposure to Computer Assisted Instruction enhanced students' Achievement in Genetics; there was also no significant gender difference in students' achievement when exposed to Computer Assisted Instruction. It was however, recommended among others that, Teachers of Biology should be encouraged to adopt Computer Assisted Instruction to teach Genetics Concepts, State government should organize seminars, conferences, and workshops for Biology Teachers on the new innovations in teaching and learning, students should be placed at the Centre state in learning and through practical as recommended in the curriculum to improve their creative thinking skills in Biology among others.

Keywords: Effects, Computer-Assisted Instruction Strategy, Achievement, and Genetics.

Introduction

The integration of technology in teaching and learning has been a topic of global interest, as

educators and policymakers seek innovative ways to enhance students' learning and engagement. Computer-assisted instruction

has gained significant attention as a tool for teaching complex scientific concepts, such as genetics. Genetics, a fundamental aspect of biology, explores the intricate mechanisms of inheritance, variation and the transfer of traits across generations. However, Tamim, Bernard, Borokhovski, Abrami, and Schmid (2017) asserted that the abstract nature of genetic concepts presents a formidable challenge for students, often leading to difficulties in comprehension and knowledge retention in genetics. Mayer (2018) postulated that computer-assisted instruction offers a powerful solution to these challenges by providing interactive, visually engaging environments. Mayer (2018) further stated that these assisted instructions allow students to actively explore and manipulate genetic models, processes, and concepts in ways that conventional methods cannot replicate. By enabling hands-on experimentation and observation, computer-instructions align with multimedia learning theories, which emphasize the importance of active engagement in building understanding. The ability to visualize abstract genetic processes through animations, illustrations, and interactive models has been shown to reinforce conceptual understanding and support diverse learning styles, ultimately improving students' achievement. (Herrington, Oliver & Reeves, 2018).

Globally, several studies, such as Kim and Hannafin (2016) and Akhibge (2020), have investigated the effectiveness of computer simulations in teaching genetics and other complex scientific topics. In Nigeria, Folorunso, Ajeigbe, and Falola (2017) postulated that there has been a concerted effort to promote the use of educational technology, including computer simulations, across various subjects in primary and secondary education levels. Recognizing the potential benefits of integrating technology into the classroom, the Nigerian government launched initiatives to equip schools with computer facilities. These efforts aim to provide students with access to innovative learning tools and resources that enhance their understanding and engagement with complex subjects (Folorunso, Ajeigbe & Falola, 2017). Ahmad, Aziz, and Hassan (2018) posited that the government's initiatives have also focused on providing teacher training to ensure the effective use of technology in the classroom. By equipping educators with the necessary skills and pedagogical approaches, these training programs have sought to empower teachers to seamlessly incorporate computer simulations and other digital tools into their teaching practices. This comprehensive approach acknowledges the crucial role that well-trained and technologically proficient teachers play in maximizing the impact of

educational technology on students' learning outcomes (Ahmad, Aziz, & Hassan, 2018).

Genetics is a branch of biology concerned with the study of inheritance, including the interplay among genes, DNA variation, and environmental factors. Genetics is a crucial component of the secondary school biology curriculum because it covers key areas such as chromosomes, the basis of heredity, probability in genetics, application of the principles of heredity, genetics terms, and hereditary traits in organisms. Atuboke and Idowu (2017) stated that students often struggle to grasp these abstract genetic principles due to their complexity and the lack of concrete visualization tools to simplify the concepts. This difficulty in

comprehending genetics has reportedly led to poor student achievement and retention. Consequently, the abstract nature of genetic concepts has led to poor achievement and retention in both internal and external biology examinations. The Chief Examiner's Report for WAEC (2015 - 2025) states that most students do not attempt questions on genetics, and even those who do often fail. This report, therefore, led to the student's poor achievement and retention in biology. The trends in students' achievement in Nasarawa State can also be seen in WAEC (2025) and Eshi (2025), as presented in Table 1.

Table 1: West African Secondary School Certificate Examination Results in Nasarawa State from 2015 -2023

Year	Reg. Cand	No. Pass A1- C6	% Pass A1- C6	No. pass D7- E8	% Pass D7- E8	No. Fail F9	% Fail F9
2015	7421	2611	40.68%	3810	59.32%	1000	15%
2016	8212	2815	40.17%	4197	59.83%	1200	17%
2017	9019	3019	39.67%	4600	60.33%	1400	18%
2018	9815	3310	40.31%	4905	59.69%	1600	19%
2019	9034	3110	41.28%	4424	58.72%	1500	20%
2020	12815	4901	45.32%	5914	54.68%	2000	25%
2021	14018	4507	39.13%	7011	60.87%	2500	30%
2022	13152	4110	39.01%	6424	60.98%	2800	35%
2023	11518	3507	44.19%	5011	55.81%	3000	40%
2024	10239	3018	42.48%	5211	50.00%	2010	43%
2025	12336	4016	32.56%	6012	48.00%	2308	18.71%

Source: (ERC, Nasarawa State Ministry of Education, Lafia, 2025).

Table 1.1 shows a fluctuating trend in candidates' achievement over the years. While the number of registered candidates has been increasing, the pass rates at credit levels A1-C6 have been inconsistent, with a

high of 45.32% in 2020 and a low of 39.01% in 2022. The percentage of passes at D7-E8 level has been steadily increasing, indicating a growing number of candidates who are passing, but not at the higher credit levels.

Meanwhile, the figures for the F9 level shows the number of candidates failing, with a significant jump from 20% in 2019 to 43% in 2024 indicating that, something urgently needed to be done to address this situation from the data presented in the Table 1.1 is so glaring that the students' level of achievement in biology has been very unsteady due to the poor achievement and retention in genetics in particular and biology in general. The conventional method relies heavily on textbooks and charts, which may not effectively facilitate students' understanding of genetic concepts and their practical applications.

Technology fosters a culture of effective teaching among teachers. When using technology, teachers are encouraged to broaden their knowledge, make use of more problem-solving examples, and utilize an inquiry-based approach to learning. Technology has been used to help students cope with genetics concepts in senior secondary Biology, which students believed were difficult to teach. In the conventional classrooms, teachers are often unable to make use of appropriate tools to simplify the topic and foster students' understanding. Technology also enables teachers to make use of learning aids that are designed to exploit the students' visualization and modelling power to solve problems. Computer simulation Packages, such as Computer-Aided Design, assist teachers in

developing simplified and engaging ways to teach these difficult topics in Biology. Teaching Biology with technology gives the teacher more tools to offer instruction to students. A critical role of the teacher is to explain concepts to students and ensure they understand the material being presented. Unlike the conventional setting where the teacher was confirmed to relying on drawings and handmade models, technology offers a wide variety of teaching aids (Barak & Dori, 2015). Technology enables teachers to use simulations to better illustrate certain biology concepts. In essence, the teacher's ability to explain genetic concepts is facilitated by technology. The use of technology has been shown to enhance teaching by enabling teachers to model abstract ideas and concepts. Technology is linked to genetics in that it plays a critical role in advancing students' understanding of genetics, as technological tools enable it. Genetics research includes DNA sequencing machines and bioinformatics software, which allow students to read, analyse, and manipulate genetic materials at high speed.

Computer-Assisted Instruction is a computer simulation package model on genetics concepts to simulate real-life situations by allowing students to interact with the simulation package and explore virtually different scenarios in the genetics concepts. This computer simulation package is

prepared by the researcher in line with genetics concepts, so that students can see these concepts in their simplest terms, which may lead to strong academic achievement and retention in biology. Odedele and Ayodele (2016) posit that computer simulations incorporate multimedia elements, such as animations, illustrations, and interactive models, which reinforce genetics concepts through multiple sensory channels. This approach suggests that combining different modes of information presentation can enhance learning by leveraging the dual channels of human information processing.

Achievement can be defined as the student's overall learning experience resulting in observable, measurable behavior change, including the acquisition of specific ideologies, skills, and techniques at the end of a teaching and learning situation. A number of definitions of achievement exist in the literature, and most of these aim to capture the essence of the concept. Alhassan (2023) defined achievement as the event in which a person has accomplished something, acquired information, or mastered skills, usually as a result of planned instruction or training. Umar (2024) sees academic achievement as an assessment of how students have learned or changed after a learning period. Thus, the degree of a student's learning program is to be

determined by the learner's achievement, that is, the sort of performance that is usually determined through tests. These tests provide a means of evaluating students' performance absolutely, such as percentage, and comparing students' results. Thus, this study will investigate students' achievement using Computer-Assisted Instruction. Students' achievement can be easily enhanced when Biology teachers and educators use student-centred, activity-based strategies. This would go a long way toward improving students' gender achievement and retention in biology and other science subjects.

In view of the foregoing, the study examined gender achievement among students, as gender is one of the variables to be investigated. Therefore, the study examined gender differences in achievement in genetics when taught with Computer-Assisted Instruction.

Statement of the Problem

Many students in post-primary schools today achieve poorly in biology. The current obvious situation in biology is the staggering decline in learners' achievement at all levels of education. This low achievement and retention lies in the fact that most teachers use a deductive teacher-centred approach. The use of teacher-centred and non-activity-oriented approaches to teaching by biology teachers may not have been effective in

providing room for students' participation in classroom activities, making it difficult to stimulate students' interest during instruction. Curriculum delivery using a teacher-centred approach in teaching is no longer sufficient to cope with the present world of the computer and internet age (digital age). The strategies used by most of my biology teachers to teach genetics concepts have led to significant misunderstandings between learners and the concepts they learn. The possible ways that this gap created by the use of conventional methods could be minimized by adopting a computer simulation package by biology teachers. The researcher investigated the effect of computer-assisted instruction on students' achievement to enhance learning and make it more permanent. Therefore, based on the above discussion, the study investigated the effect of Computer-Assisted Instruction on students' achievement and retention in genetics in Karu, Nasarawa State, Nigeria.

Research Objectives

The objective of this study was to investigate the effect of computer-assisted instruction on senior secondary school students' achievement in genetics in Karu Local Government Area, Nasarawa State.

Specifically, the study sought to;

1. Investigate the effect of Computer-Assisted Instruction on students' achievement in genetics
2. Find out the effect of Computer-Assisted Instruction on the achievement of male and female students taught genetics.

Research Questions

To achieve the stated objectives of the study, the following research questions were asked to guide the study

1. What are the mean achievement scores of students taught Genetics using Computer-Assisted Instruction and those taught using the conventional method?
2. What are the mean achievement scores of male and female students taught genetics using Computer-Assisted Instruction?

Statement of Hypotheses

Based on the objectives of the study, the following Null hypotheses were formulated and were tested at a 0.05 level of significance.

H₀₁: There is no significant difference in the mean achievement scores of students taught Genetics using Computer-Assisted Instruction and

those taught using conventional teaching method

H₀₂: There is no significant difference in the mean achievement scores of male and female students taught genetics using Computer-Assisted Instruction.

Methodology

A quasi-experimental research design with a pre-test, post-test, and non-randomized control group was adopted for the study. The population of this study comprised 2,275 students, of whom 1,024 were females and 1,251 were males, SS III students in a public secondary school in Karu, Nasarawa State. The choice of this population is because the concept of genetics is mostly taught in SSIII levels. The sample for this research consists of 124 SSIII students (68 male and 56 female). A simple random sampling technique was used to select one intact class from each of two chosen public senior secondary schools in Karu, Nasarawa State. The two schools were randomized and assigned experimental and control groups, respectively. The experimental group consists of 64 students (35 males & 29

females) who were exposed to Computer-Assisted Instruction, while the control group consists of 60 students (33 males & 27 females) who were exposed to the conventional method.

The instruments for data collection were Genetics Achievement Test (GAT). The GAT items consist of 40 multiple-choice questions. The instruments were validated, and a logical validity index of $r = 0.88$ was found using Pearson Product-Moment Correlation Coefficient (r). A pre-test was administered to both the experimental and Control groups to assess their prior academic achievement in genetics concepts before treatment. Genetics concepts were taught to the experimental group using Computer-Assisted Instruction, while the control group was taught using the lecture method. Lesson plans were designed for both the experimental and control groups. The two groups received treatment for 4 weeks during the second term of the 2024/2025 academic session to determine significant differences in academic achievement between the groups and gender differences.

Results

Research Question One: What are the mean achievement scores of students taught Genetics using Computer-Assisted Instruction and those taught using the conventional method.

Table 2: Mean and Standard Deviation of Achievement of Students Taught Genetics Using Computer-Assisted Instruction and Conventional Method

Teaching Method	Type of Tests	N	Mean	Std. Div.	Mean Gain
Experimental (CAI)	Pre-Test	64	25.06	9.29	41.25
	Post-Test	64	66.31	6.30	
Control (CM)	Pre-Test	60	20.48	9.15	12.04
	Post-Test	60	32.52	10.23	

Table 2 shows the pre-test and post-test mean and standard deviation of achievement scores of students taught genetics using Computer Assisted Instructions means are 25.06 and 66.31 with standard deviation of 9.29 and 6.30, respectively. The pre-test and post-test mean and standard deviation of achievement scores of students taught genetics using the conventional method, the mean are 20.48 and 32.52, with standard deviations of 9.15 and 10.23, respectively.

Null Hypothesis One

There is no significant difference in the mean achievement scores of students taught Genetics using Computer-Assisted Instruction and those taught using the conventional method.

Table 3: Results of ANCOVA on Achievement Scores of Students Taught Genetics Using Computer-Assisted Instruction and Conventional Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	35809.508 ^a	2	17904.754	263.328	0.000	0.813
Intercept	50450.130	1	50450.130	741.978	0.000	0.860
Pretestachiev	439.442	1	439.442	6.463	0.012	0.051
Methods	35170.073	1	35170.073	517.252	0.000	0.810
Error	8227.291	121	67.994			
Total	353537.000	124				
Corrected Total	44036.798	123				

a. R Squared = .813 (Adjusted R Squared = 0.810)

b. Computed using alpha = 0.05

Table 3 shows a significant difference in the mean achievement scores between students in the Computer-Assisted Instruction and Conventional Groups. The value of $F_{(1, 121)} = 517.252$ was obtained with an associated p-value of 0.000. Since the associated probability 0.000 is less than 0.05 level of significance, the null hypothesis one is hereby rejected. The results

implied that, the Computer-Assisted Instruction produced a significant effect on the post-test achievement scores of students when covariate effect (pre-test) is controlled. Hence, there is a significant difference between the Computer-Assisted Instruction Group and the Conventional Group.

Research Questions Two

What are the mean achievement scores of male and female students taught genetics using Computer-Assisted Instruction?

Table 4: Mean and Standard Deviation of Achievement Scores of Male and Female Students' Taught Genetics Using Computer-Assisted Instruction

Gender	Type of Test	N	Mean	Std. Div
Male	Pre-test	35	24.60	7.84
	Post-test	35	66.09	6.59
Female	Pre-test	29	25.62	10.91
	Post-test	29	66.59	6.03

Table 4 shows the results of pre-test and post-test mean and standard deviation of achievement scores of male students taught Genetics using Computer Assisted Instructions means are 24.60 and 66.09 with standard deviation of 7.84 and 6.59,

respectively, while pre-test and post-test mean and standard deviation of achievement scores of female students taught Genetics using Computer Assisted Instructions means are 25.62 and 66.59 with standard deviation of 10.91 and 6.03) respectively.

Null Hypothesis Two

There is no significant difference in the mean achievement scores of male and female Students taught genetics using computer-assisted instruction.

Table 5: Results of ANCOVA on Achievement Scores of Male and Female Students' Taught Using Computer-Assisted Instruction

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	50.119 ^a	2	25.059	0.625	0.539	0.020
Intercept	35709.061	1	35709.061	889.943	0.000	0.936
EXPPRET	46.146	1	46.146	1.150	0.288	0.019
Gender	5.591	1	5.591	0.139	0.710	0.002
Error	2447.631	61	40.125			
Total	283928.000	64				
Corrected Total	2497.750	63				

a. R Squared = 0.020 (Adjusted R Squared = -0.012)

b. Computed using alpha = 0.05

Table 5 shows no significant difference in the mean achievement scores between male and female students exposed to Computer-Assisted Instruction. The value of $F_{(1, 61)} = 0.139$ yields an associated exact probability of 0.710, which exceeds the 0.05 level of

significance; the null hypothesis is retained. The result indicated that male and female students achieved equally well when taught genetics using computer-assisted instruction, suggesting that the method is gender-neutral.

Discussion

The findings of this study revealed the effects of Computer-Assisted Instruction on the enhancement of teaching and learning in Genetics in biology.

The results revealed a significant difference in achievement between students exposed to Computer-Assisted Instruction and those exposed to the Conventional Method. The findings on students' achievement in Computer-Assisted Instruction are compared to those using the conventional method. The results also indicated a significant difference in the mean achievement scores of students

exposed to Computer-Assisted Instruction, in favour of the experimental group. Based on the established difference in the achievement scores of the groups, which is in agreement with the earlier findings of Samuel (2018), Ado, Isah and Idris (2024), and Onah and Abraham (2023), who jointly found out that students taught genetics concepts and other science subjects using experimental strategies had better achievement than those taught genetics concepts using the conventional method. This also agrees with the findings of Okolo and Oluwasegun (2020), who reported that students taught

genetics topics using Computer-Assisted Instruction have a significant effect on thinking than those taught using the Conventional Method. The trend of improved achievement in the treatment group could be a result of the enabling learning environment provided when students use Computer-Assisted Instruction, which helps motivate them and enables them to benefit greatly from using computers to solve biology problems. Another reason for the better achievement observed in the treatment group could be that the students were captivated, more focused, attentive, and interested in what they were doing, since what was to be learned was projected on PowerPoint. There is no doubt that slow learners are given the opportunity to catch up with fast learners. The students' achievement in Genetics could be greatly improved if they were allowed to take charge of their learning. In-depth participation in classroom interaction and problem-solving provides students with a better opportunity to achieve higher levels of cognition. As postulated by Uche, Muhammad, Asogwa and Ofoegbu (2016), the internal processes of a person's own judgement are in regard to the relation within a communicated message. And also, Mayer's (1997) Multimedia Learning Theory holds that students learn better when learning activities are both visual and pictorial, because they are engaged in hands-on manipulation.

The results indicated that, there is no significant difference in achievement of male and female students in the experimental groups. This finding is in disagreement with the findings of Reddy and Mint (2017) and Zumyil and Antip (2022), who reported that gender has significant effects on students' achievement. Male students' achievement differed from that of their female counterparts when exposed to Computer-Assisted Instruction and the Conventional Method, probably because males explore their learning environment more than female students. The female finds it difficult to do practical activities like their male counterparts. This could have improved their achievement.

The trend of improved achievement by the treatment groups could be a result of the enabling learning environment provided, where students were exposed to Computer and package interaction, which motivated them to work as a team member who tuned to benefit through sharing, helping one another, explaining and encouraging one another to learn genetics using a computer package. Another reason for the better achievement observed in the treatment groups could be that the students were exposed to an innovative biology package that addressed difficult genetics concepts, which enabled them to be more captivated, more dedicated, more focused, more attentive, and more interactive in their work. There is no doubt

that slow learners are offered opportunities to catch up with the fast learners. Genetics students could greatly improve if they were allowed to take charge of their learning through a computer. Interaction (student-centred) among the students provides a better opportunity for cognitive and affective domain development. As outlined by Goal Achievement Theory, an effective plan, working toward it, and evaluating the conclusion by students motivates students and helps them achieve higher in biology.

Conclusion

Based on the findings of this study, Computer-Assisted Instruction enhanced and improved students' achievement in genetics more than the conventional method. Computer-assisted instruction improved students' understanding of genetics; the method is also gender-friendly, as both males and females benefited from it.

Recommendations

The following recommendations are made based on the findings of the study:

1. Biology teachers should be encouraged to adopt Computer-Assisted Instruction in teaching Genetics concepts.
2. Students should be encouraged to use Computer-Assisted Instruction in heterogeneous (male and female)

groups so as to help reduce the gender gap.

3. Biology teachers should be trained on how to employ the use of Computer Assisted Instructions to teach Genetics and Biology in general.
4. Biology Teachers should limit the use of the conventional method, as they promote rote learning.
5. Biology Teachers should use a student-centred approach, like Computer-Assisted Instruction, in teaching and learning of genetics.
6. The state government should organize Seminars, Conferences, and workshops for Biology teachers to train them on the use of computer-assisted instruction.

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