INFLUENCE OF COMPUTER ANIMATION INSTRUCTIONAL STRATEGY ON ACADEMIC PERFORMANCE OF BIOLOGY SECONDARY SCHOOL STUDENTS IN SOKOTO STATE, NIGERIA

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Abstract

This study aimed to determine the influence of computer animation instructional strategy on the academic performance of Biology secondary school students in Sokoto Metropolis, Sokoto State, Nigeria. A quasi-experimental design involving pretest and posttest with experimental and control groups was adopted. The population comprised 2,977 Senior Secondary School II (SS II) students from the 2023/2024 academic session. A sample of 96 students (51 males and 43 females) was selected using two intact classes. The Biology Performance Test (BPT) was used for data collection and was validated by three experts. The test-retest method was used to establish the instrument's reliability, yielding a Pearson Product-Moment Correlation Coefficient of 0.88 for the BPT. Two research questions and two null hypotheses guided the study. Descriptive statistics were used to answer the research questions, while an independent t-test was used to test the null hypotheses at a 0.05 level of significance. The findings revealed a significant difference in the mean academic performance scores of students taught Biology using the computer animation strategy compared to those taught using the conventional teaching method, with results favoring the computer animation strategy. It was therefore recommended that the computer animation strategy should be implemented for teaching secondary school students, irrespective of gender.

Keywords: Computer Animation, academic performance, biology, gender.
DOI: **https://doie.org/10.10318/SER.2025591838**

Introduction

Recent innovations in teaching and learning across all educational areas have gained prominence through technology utilization globally. The National Policy on Education (NPE, 2014) emphasizes that to fully achieve educational goals in Nigeria, teaching should be practical, activity-based, experimental, and Information Technology (IT) supported. For the past two decades, animation and other areas like anchored instructions have become prominent aspects of technology-based learning environments (Musa, Ziatdinov, Sozcu, & Griffiths, 2015). The use of animations is confidently seen as a creative, useful, and student-centered alternative to traditional learning approaches in many countries. Computer animations can capture attention and demonstrate concrete or abstract procedures that require memorization, including various animated arrows or highlights (Berney & Bétrancourt, 2016).

Computer animation is a visual medium that includes motion graphics and audio-visual elements, translating content into words for effective and meaningful learning (Matazu & Ismail, 2023). Thus, animation teaching approaches provide extra information and external support for intellectual simulations, enabling learners to engage in higher cognitive processing (Falode, Usman, Ilobeneke, Mohammed, Godwin & Jimoh, 2016b). Gambari, Falode, and Adegbenro (2014) reported a significant difference in

the mean achievement and retention of students taught using animation and geometrical models. Accordingly, if appropriately designed and executed in a natural learning setting, animation packages can effectively improve students' performance and retention in Biology. The use of computer animation is believed to facilitate smooth teaching and learning and improve concept retention, as concepts must be stored and recalled long-term for performance to improve (Faruk, Faruku, & Hassan, 2022).

Numerous studies have demonstrated the significance of innovative approaches such as digital platforms, mobile learning, and computer animation in enhancing students' performance and retention. For instance, Aiyedun (2020) found that animation teaching was viable in upgrading students' performance, retention, and interest in climate change, as the combination of visual and sound sensations in the learning process enhanced the encoding of the learned material. Similarly, Mogbo, Ibrahim, and Tukura (2021), in their research on the effects of animation and concept map visualization elements on performance, retention, and interest in geography among secondary school students in Abuja, Nigeria, found a substantial difference in the performance and retention of students exposed to animation and concept map visualization. Ahmed and Inti (2021) added that a well-designed computer animation can help students learn quicker and with less stress. It also serves as an outstanding aid for teachers in elucidating tough subjects. With computer animation, learning becomes fascinating and attractive, which promotes understanding and improves student-student teamwork through interaction with the computer package to make meaning from the studied content (Teplá, Teplý & Šmejkal, 2020). Moreover, Faruk et al. (2022) also found a significant difference in the performance and retention of students exposed to animation and orthodox methods of teaching, with the difference favoring students exposed to the animation strategy.

Furthermore, researchers argue that the conventional lecture method does not help students construct their own understanding and assert that teaching methods adopted by science teachers lead not only to low academic performance in science but also incapacitate students from developing required skills for creative thinking (Achor & Kalu, 2014; Bichi, Hafiz & Abdullahi, 2017; Ahmad, 2019). The conventional lecture method is a teaching approach where the teacher presents a verbal discourse on a particular subject, theme, or concept to learners, delivering preplanned lessons with little or no instructional aids (Bichi et al., 2017).

In a related development, Jirgba, Eriba, and Achor (2018) noted that the conventional lecture method is an ineffective teaching method that does not yield positive outcomes on students' academic performance at the secondary school level. Therefore, teachers need to employ different learning strategies to ensure students' comprehension of scientific concepts. Technology has become a teaching strategy in all educational institutions at all levels with the increased availability of the internet, computers, smartphones, television, videotapes, and other educational applications. A considerable number of researches have been conducted on various educational contributions of technological media and devices on how they improve the teaching and learning of science in schools. Ahmed and Inti (2021) revealed a substantial difference in academic performance in favor of students exposed to animation than those exposed to the lecture method.

Biology imparts science skills such as observation, identification, analysis, and evaluation of data, which are necessary for day-to-day living. Biology holds a significant position in the secondary school education curriculum due to its importance as a life science. However, several recent studies have noted the decline in the performance of learners in science subjects, including Biology (Ugwuanyi, Agah, Onah, Ugwuanyi, Elochukwu, Agnes, Ene, & Oguguo, 2019a; Ugwuanyi & Okeke, 2020; Onah, Ugwuanyi, Okeke, Nworgu, Agwagah, Ugwuanyi, Obe, Nwoye, & Okeke, 2020; Njoku, Nwagbo, & Ugwuanyi, 2020; Benson, Nwagbo, Ugwuanyi, & Chinedu, 2020). Research has also shown that student-centered instructional approaches foster meaningful learning of Biology and consequently influence students' achievement in the subject (Nzewi & Ibenemi, 2011).

According to Gambari, Yaki, Gana, and Ughovwa (2014), ineffective instructional approaches used by teachers at the senior secondary school level in Nigeria have been described as one of the major factors leading to students' poor performance in Biology examinations. Although students' achievement improved in 2016 and 2017, WAEC Chief Examiners Reports of 2018 and 2019 observed a decline in student achievement in Biology in external examinations. Chukwu and Arokoyu (2019) reported that the underperformance of Biology students in the West African Senior School Certificate Examination (WASSCE) in Nigeria has become a worrisome situation that calls for urgent attention. More research on students' Biology academic performance is required due to the gap created by students' inconsistent performance. It is against this background that this study investigated the influence of computer animation instructional strategy on the academic performance of Biology secondary school students in Sokoto Metropolis, Sokoto State, Nigeria.

Theoretical Background of the Study

This study is based on Richard Mayer's (1947) cognitive theory of multimedia learning. Mayer, a Professor of Psychology, developed this theory, which states that learning becomes effective when it stems from words and pictures rather than words alone. Mayer emphasized that the brain processes information through multiple channels, depending on how that information is presented. The first channel is for visually represented material, and the second is for auditory represented material. When a learner is presented with visual information, including pictures, videos, charts, or printed words, all that information enters the visual channel and is processed there. According to Matazu and Ismail (2023), auditory information, including spoken words in a narration and other non-verbal sounds, is processed separately by the brain from visual information. As a learner acquires new material, it first enters their sensory memory; the image is captured in its entirety, or the spoken words are logged in their entirety. After that moment, the learner begins to work with the information to process and learn it; this occurs in the working memory (McGraw Hill, 2019).

The implication of this theory is that students learn more deeply from sounds and images. Mayer stipulated that auditory and visual channels are important for processing information, and learning is an active process of filtering, selecting, organizing, and integrating information based on prior knowledge. This theory assumes that auditory and visual processes influence sensory, working, and long-term memory. This theory is relevant to the present study because the animation strategy consists of both visual and audio channels, which can help students understand abstract concepts in Biology.

Moreover, when computer animation is employed in the teaching and learning process, students can use their sensory memory (a short-term memory) to observe the skills involved in solving Biology problems, process the observed information to create mental constructs, and implement the acquired skills to solve Biology problems. This theory has been successfully utilized by Ejimonye, Eneogu, and Ugwuanyi (2020), Hamzat, Bello, and Abimbola (2017), and Edo (2017) in similar studies.

Review of Related Literature

Several studies have explored the effectiveness of computer animation on students' performance and retention. Ugwuanyi et al. (2020) found that animated PowerPoint presentations (PPT) significantly enhanced the academic performance of students in Physics compared to non-animated PPT presentations. Falode and Mohammed (2023) revealed that computer simulation (mean gain=41.70) and computer animation (mean gain=38.32) instructional packages in flipped classroom settings improved students' performance and retention of geography concepts. Also, no significant difference was found in the mean achievement (t=.05, df=124, p=0.63) and retention (t=2.04, df=124, p=0.82) scores of the two groups. Ritonga, Safrida, Huda, & Sarong (2020) revealed that problem-based video animation instruction can improve students' critical thinking skills. Ritonga et al. (2020) showed a pretest score of 30.39, and the average posttest score was 84.27, indicating an increase of 53.88. The findings of this study showed that animated videos can improve critical thinking skills. Nnorom and Emeka-ifeanyi (2021) revealed, among other findings, that students taught Biology using computer animation yielded a greater achievement mean gain score than those taught using the expository method. It was also reported that there is a significant difference in the mean achievement scores of students taught Biology using computer animation compared to those taught using the expository method, favoring computer animation.

Strømme and Mork (2020) demonstrated that students in the animated condition outperformed students in the static condition. Their interaction analysis indicated that students' conceptual understanding develops at the juncture of animation and text segmentation and through students' collaborative conceptual sense-making. Hamzat et al. (2017) conducted a study on the effect of a computer animation instructional package on students' achievement in practical Biology in Ilorin, Nigeria. The result revealed that students in the experimental group, exposed to the package, had higher achievement scores than students in the control group who were taught without the package. Falode et al. (2016) found that students taught Agricultural Science through a computer animation instructional package performed better than their counterparts taught the same concept with the lecture method. Beichumila, Bahati, and Kafanabo (2022) found that students taught with computer simulations and animations improved Science Process Skills in formulating hypotheses, identifying variables, operational definitions, planning experiments, making interpretations, and drawing conclusions in learning chemical kinetics and equilibrium. While some studies found a positive effect of animation and animated materials, others found otherwise. It is on the strength of these inconsistencies that this present study investigated the influence of computer animation instructional strategy on the academic performance of Biology secondary school students in Sokoto Metropolis, Sokoto State, Nigeria.

Statement of the Problem

Despite the value of Biology as one of the science subjects critical for pursuing medical, paramedical, and other science-related disciplines at tertiary institutions, researchers continue to report students' poor academic performance in the subject. This is confirmed by Biology results reported by WAEC's Chief Examiners from 2018-2020, which show inadequate academic accomplishment in Biology and other science subjects in Nigeria. This poor academic performance in Biology at the senior secondary school level has become worrisome to all education stakeholders. Numerous works by researchers in Nigeria have shown that the predominant method of instruction used by secondary school teachers is the conventional teaching method (lecture), which could be one of the reasons for this decline, among others. The conventional lecture method of teaching is deficient in promoting active student participation in science, likely leading to their poor academic performance in Biology. It is against this backdrop that this study investigated the influence of computer animation strategy on academic performance in Biology of secondary school students in Sokoto Metropolis, Sokoto State, Nigeria.

Objectives of the Study

The overall objective of the study is to investigate the effect of animation as a teaching strategy on secondary school students' performance on genetics concepts in Sokoto State. Specifically, the objectives of the study are to:

i. Determine the differences in the mean performance scores of students taught Biology with computer animation strategy and those taught with the conventional teaching method.
ii. Determine the gender differences in the mean performance scores of male and female students taught Biology with computer animation strategy.

Research Questions

The study was guided by the following research questions:

What is the difference in the mean performance scores of students taught Biology with computer animation strategy and those taught with the conventional teaching method?
What is the gender difference in the mean performance scores of male and female students taught Biology with Computer Animation Strategy?

Null Hypotheses

The following null hypotheses were formulated for testing at a 0.05 level of significance:

H01: There is no significant difference in the mean performance scores of students taught Biology with computer animation strategy and those taught with the conventional teaching method.
H02: There is no significant gender difference in the mean performance scores of male and female students taught Biology with computer animation strategy.

Methodology

The study employed a non-randomized pre-test post-test quasi-experimental design. This design was adopted because the researcher used intact classes for the study. The population of the study involved 2,977 public Senior Secondary School II (SS II) students in Sokoto Metropolis, Sokoto State. Two schools were randomly selected for data collection. A pre-Biology Performance Test (BPT) was administered to students as a pretest in the two selected schools to determine the equivalence of academic performance between them. The results of the pre-BPT were subjected to t-test analysis at $p \leq 0.05$, and the result obtained showed no significant difference, indicating that the subjects were homogenous and suitable for the study. Two intact classes of SSII were selected from each school. Furthermore, a simple random sampling technique of "Hat and Draw" was used to assign each class to the experimental and control groups. Two intact classes, comprising 94 students (51 male, 43 female), were used for the study from two co-educational public senior secondary schools that had been in existence for more than ten years, had well-experienced and qualified teachers, and possessed ICT facilities.

Instrumentation

The Biology Performance Test (BPT) was developed by the researcher for data collection from the participants. The BPT consisted of 30 multiple-choice items with options A, B, C, and D, with each item carrying one mark. The test items were developed using the SSS II Biology textbook based on the curriculum and content taught in the lesson. The BPT was used to evaluate the academic performance of SSS II students both before and at the end of the instructional processes (pretest and posttest).

Validation of the Instrument

The items in the Biology Performance Test (BPT) were subjected to content and face validations. The content validation of BPT was ensured by strictly following the test Blueprint. Face validation was conducted by three Biology teachers from the Department of Biology in three different senior secondary schools in Sokoto Metropolis, which were part of the study's population but not involved in the study itself. These Biology teachers were requested to validate the content of the instrument and vet the animation package for the lesson. Their suggestions helped in deleting, adjusting, and selecting a set of twenty-five (25) test items for the study.

Reliability of the Instrument

The Biology Performance Test (BPT) items were subjected to trial testing to ascertain the reliability of the instrument. One intact class consisting of 30 SSS II students was used for the BPT pilot-testing. The school used for the pilot testing was not part of the study sample but exhibited similarities in terms of staffing, infrastructure, teacher and student competencies, and administrative setup. This school was chosen to avoid experimental contamination of the subjects. The test-retest method was used in pilot testing the test items for the reliability coefficient. The data obtained from the pilot testing were subjected to statistical analysis using the Pearson Product-Moment

Correlation Coefficient. A reliability coefficient of 0.88 was obtained, which indicated that the instrument is valid and reliable.

The Biology Performance Test (BPT) was administered to the experimental and control groups before the commencement of the experiment. The BPT items were reshuffled for the posttest after the treatment, which lasted for six (6) weeks. The reshuffled BPT was administered to the experimental group. Both the pre-BPT and post-BPT were marked by the researcher according to the marking scheme. The research questions were answered using descriptive statistics (mean and standard deviation). The null hypotheses formulated were tested at a $p \leq 0.05$ level of significance using inferential statistics (independent t-test).

Data Analysis and Result Presentation

Answering Research Questions:

Research Question 1: What is the difference in the mean performance scores of students taught Biology with computer animation strategy and those taught with the conventional teaching method?

Table 1: Mean and Standard Deviation of Academic Performance scores of students in Experimental and Control Groups

Groups	N	Mean	Standard Deviation	Mean Difference
Experimental Group	45	17.46	4.05	5.82
Control Group	49	11.64	4.99	

Source: Field work 2023

The results in Table 1 indicate that students in the experimental group, who were taught genetics using a computer-animated strategy, achieved a mean performance score of 17.46 (standard deviation = 4.05). In contrast, students taught biology using a conventional teaching method had a mean performance score of 11.64 (standard deviation = 4.99). This reveals a 5.82-point difference in mean performance scores, favoring the students who received instruction via the computer-animated strategy. This suggests a significant difference in posttest mean scores between the experimental and control groups, with the computer-animated strategy proving more effective.

Research Question 2: What is the gender difference in the mean performance scores of male and female students taught Biology with computer animation strategy?

Table 2: Summary of Mean and Standard Deviation of Academic Performance of male and female Students in Experimental Group

Experimental Group	N	Mean	Standard Deviation	Mean Difference
Male	51	18.11	4.24	1.42
Female	43	16.69	3.77	

The results in Table 2 indicate that male students taught Biology using a computer animation strategy achieved a mean performance score of 18.11 (standard deviation = 4.24), while female students taught with the same strategy had a mean score of 16.69 (standard deviation = 3.77). This demonstrates a 1.42 difference in mean academic performance scores between male and female students, with males performing slightly higher than females.

Hypotheses Testing:

H_{01}: There is no significant difference in the mean performance scores of students taught Biology with computer animation strategy and those taught with conventional teaching method.

Table 3: Posttest Summary of independent t-test on Academic Performance scores of students in Experimental Groups

Groups	N	Mean	SD	df	t-cal	p-value	Remark
Pre-test	45	11.64	4.09				
				44	3.12	0.00	Sig.
Posttest	45	17.46	4.05				

Source Field work 2023 Significant at $p \leq 0.05$

Table 3 shows a calculated t-value of 3.12 and a p-value of 0.00. Since the p-value of 0.00 is less than the significance level of $p \leq 0.05$, the null hypothesis is rejected. This indicates a significant difference in the mean performance scores of students taught Biology using the computer animation strategy compared to those taught with the conventional teaching method, favoring the computer animation strategy. Therefore, the computer animation strategy was more effective than the conventional method for teaching and learning Biology.

H_{02}: There is no significant gender difference in the mean performance scores of male and female students taught Biology using computer animation strategy.

Table 4: Summary of independent t-test of Academic Performance of Male and Female Students of Experimental Group

Experimental Group	N	Mean	SD	df	t-cal	p-value	Remark
Male	24	18.11	4.24				
				42	1.04	0.31	Not Sig.
Female	21	16.69	3.77				

Source: Field work 2023 Significant at $p \leq 0.05$

Table 4 indicates that the calculated t-value is 1.04 and the p-value is 0.31. Since the p-value of 0.31 is greater than the significance level of $p \leq 0.05$, the null hypothesis was retained. This suggests there was no significant difference in the mean academic performance scores of male and female students taught biology using the computer animation strategy, implying that the strategy effectively bridged the gender gap in academic performance.

Discussion

This study found a significant difference in the mean performance scores of students taught Biology using computer animation compared to those taught with conventional methods. Students who learned with computer animation performed better, supporting the findings of Hamzat et al. (2017), Ritonga, Safrida et al. (2020), and Nnorom and Emeka-Ifeanyi (2021). These previous studies also concluded that computer animation leads to improved student performance over traditional lecture methods. This superior outcome is likely due to the ICT-based nature of the computer animation strategy, suggesting its greater effectiveness in the teaching and learning of Biology.

Furthermore, the study revealed no significant gender difference in the academic performance of male and female students taught genetics using the computer animation strategy. This aligns with the findings of Matazu and Ismail (2023), who similarly observed that activity-based learning strategies can enhance secondary school students' academic performance regardless of gender.

Conclusion

The following conclusions were drawn from the findings of the study: it was revealed that computer animation strategy was found to be an effective method in improving academic performance of secondary school students in biology than using conventional teaching method. Computer animation strategy proved to be an effective strategy in enhancing the performance of biology students irrespective of gender.

Recommendations

Based on the findings of the study, it was therefore recommended that;

1. Biology teachers should utilize computer animation strategy in teaching and learning in biology at secondary schools in Sokoto state, Nigeria
2. Computer animation strategy should be used to teach both male and female secondary school students in Sokoto state irrespective of gender, as it is proven to be gender friendly.
3. Government and other stakeholders should make available enabling environment that will allow the application of computer animation strategy in secondary schools

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