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ORIGINAL RESEARCH ARTICLE

Effectiveness of Media Animation on Academic Achievement in Ecology Among Secondary School Students in Municipal Education Zone, Kano State, Nigeria

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ABSTRACT
This study investigated the effectiveness of media animation on the academic achievement of secondary school students in biology within the Kano Municipal Education Zone, Nigeria. Unlike previous studies that broadly explored multimedia learning, this research provides a focused examination of animated media's impact on ecology instruction and its differential effects on male and female students. A quasi-experimental pre-test post-test design was adopted, involving 127 SSII students selected from four purposively sampled public secondary schools. Participants were assigned to either an experimental group (taught using media animation) or a control group (taught using conventional methods). The Ecology Achievement Test (EAT) was developed using past WASCCE biology questions (2016–2020) and validated by four experts. Reliability was established using Pearson Product Moment Correlation Coefficient (PPMC) and Cronbach's Alpha, yielding a coefficient of r = 0.715, ensuring the test's internal consistency. The findings revealed that students exposed to media animation significantly outperformed their counterparts in the control group, demonstrating higher comprehension and retention of ecological concepts. Notably, female students in the experimental group achieved higher mean scores than their male counterparts, suggesting that media animation may be particularly beneficial for female learners in biology. ANCOVA results confirmed the statistical significance of these findings ($p < 0.05$). This study's novel contribution lies in its empirical validation of media animation as an effective pedagogical tool for ecology instruction in Nigerian secondary schools. Its practical implications suggest that biology educators should integrate media animation into their teaching strategies to enhance student engagement, improve academic performance, and bridge gender gaps in science education. Future research should explore long-term retention effects and the integration of animation with hands-on activities to further optimize biology learning outcomes.

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INTRODUCTION
In Nigeria, science education is a cornerstone for developing a scientifically literate populace capable of addressing modern challenges, yet biology performance among secondary school students remains alarmingly poor, particularly in Kano State. Data from the West African Examinations Council (WAEC) between 2017 and 2021 reveal a troubling trend: only 10.44% of students in Kano achieved credit-level passes (A1–C6) in biology in 2021, with failure rates climbing to 55.03% (Kano Educational Resource Department, 2021). This mirrors national concerns highlighted in the National Policy on Education, emphasizing science learning to foster inquiry and innovation (Federal Government of Nigeria, 2013). While studies attribute such underachievement to inadequate teaching strategies and weak foundational knowledge (Nbina & Obomanu, 2011; Sequeira, 2018), the root causes in Nigeria extend beyond pedagogy. Teacher competency is often compromised by limited training in modern instructional methods; and technological limitations hinder access to digital tools, and cultural attitudes—sometimes viewing animated aids as frivolous or misaligned with traditional learning—further complicate adoption (Ajaja, 2016; Umnnunakwe & Isah, 2021; Yusuf & Adigun, 2023). These contextual challenges are underexplored in prior research, which tends to assume the universal applicability of media animation without tailoring it to such constraints.

The integration of media animation into educational settings has been widely explored as a tool to enhance academic achievement, particularly in science subjects like biology, with numerous studies documenting its potential to improve comprehension and engagement (Asiedu, 2022; Lawan, 2024; Anekwe & Opara, 2021; Alex et al.,

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2022). These investigations have demonstrated that animated visuals and dynamic audiovisual aids can simplify complex concepts, making them more accessible to learners. However, despite this extensive body of research, much of the existing work focuses on generalized applications across diverse contexts, often overlooking region-specific educational challenges and the nuanced interplay of local factors such as teacher competency, technological infrastructure, and cultural perceptions of innovative tools. This study seeks to address this knowledge gap by examining the efficacy of media animation within the unique socio-educational landscape of northern Nigeria, a region marked by persistent academic underperformance and systemic barriers.

This study contributes to the field by investigating how media animation can be optimized to improve biology achievement—specifically in ecology—within Kano State's Municipal Education Zone, where overcrowded classrooms and resource scarcity amplify educational disparities. Unlike previous works that broadly endorse animation's benefits (e.g., Lawan, 2024; Asiedu, 2022), this research narrows its lens to assess its effectiveness, feasibility, and reception in a resource-constrained, culturally distinct setting. By doing so, it addresses a critical gap: the lack of localized evidence on how media animation can counteract specific barriers like low teacher digital literacy and skepticism toward technology-driven instruction. Furthermore, it explores potential gender differences in outcomes, a dimension often overlooked in Nigerian studies despite known disparities in educational access and engagement (Adebayo, 2022). Through this focus, the study aims to provide actionable insights for educators and policymakers, offering a context-specific framework to enhance biology education and, by extension, scientific literacy in Nigeria's evolving academic landscape. Specifically, it:

1. Examined the impact of media-animated instruction on students' performance in Ecology in senior secondary schools in the Municipal Education Zone, Kano State.

2. Investigated whether gender differences exist in students' performance when taught Ecology using media-animated instruction.

Research Questions

The following research questions guided the study:

1. What is the difference in the mean score of Biology students taught Ecology media animated strategy and those taught using conventional strategies in Senior Secondary Schools of the Municipal Education Zone Kano State?

2. What is the difference in the Mean score of male and female students taught Ecology using media-animated strategy in Senior Secondary Schools in the Municipal Education Zone, Kano State?

Hypotheses

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

H01: The mean of students taught Ecology using media-animated strategy does not differ significantly from those taught using conventional methods for Biology Senior Secondary Schools in the Municipal Education Zone, Kano State.

H02: No significant difference exists in the mean academic achievement scores of males and females taught Ecology using media-animated strategy in Senior Secondary Schools in the Municipal Education Zone, Kano State.

Theoretical Framework

The theoretical framework for this study is grounded in two key learning theories: Cognitive Load Theory (CLT) and Multimedia Learning Theory (MLT). These theories provide a foundation for understanding how media animation can enhance students' academic achievement by improving engagement, comprehension, and retention of ecological concepts in Biology.

Cognitive Load Theory, proposed by Sweller (1988), posits that learning is most effective when instructional materials are designed to optimize cognitive processing. It distinguishes between three types of cognitive load: intrinsic (complexity of the material), extraneous (inefficient instructional design), and germane (effort devoted to learning and schema development). Traditional teacher-centered methods often impose a high extraneous cognitive load, making it difficult for students to grasp complex ecological concepts. Media animation, on the other hand, helps reduce extraneous load by presenting information in a more structured, visually appealing, and interactive manner. This facilitates better understanding and retention of knowledge, particularly in subjects like Ecology, where abstract and dynamic processes are involved.

The Multimedia Learning Theory, developed by Mayer (2001), emphasizes that learning is enhanced when information is presented using a combination of visual and auditory modalities. According to this theory, students learn more effectively when instructional materials integrate images, animations, and narration rather than relying solely on text or verbal explanations. This is based on the dual-channel assumption, which suggests that humans process visual and auditory information separately, and the limited capacity assumption, which states that cognitive resources are finite. By utilizing animated media, students can engage with content in a way that reduces cognitive overload, promotes active learning, and enhances memory retention. Research has demonstrated that multimedia instructional strategies improve students' ability to understand scientific concepts, making them particularly useful for teaching

Ecology, which involves complex interactions and dynamic environmental processes (Mayer, 2005).

This study explores media animation's impact on secondary school students' academic achievement in Ecology within the Municipal Education Zone of Kano State, Nigeria. By aligning with CLT and MLT, the study assumes that media animation reduces cognitive overload and enhances learning by presenting ecological concepts in a more digestible format. Given that previous research has shown positive correlations between multimedia-based instruction and improved academic performance (Anekwe & Opara, 2021; Alex et al., 2022), this study seeks to determine whether similar benefits can be observed in Nigerian secondary schools.

METHODOLOGY

Study Area and Study Design

This study was conducted in the Municipal Education Zone of Kano State, Nigeria, focusing on public secondary schools. The research adopted a quasi-experimental, pretest-posttest, non-equivalent control group design to determine the effects of media-animated strategies on students' academic achievement in Ecology. Two groups were established: an experimental group, which received instruction using media animation, and a control group, which was taught using conventional methods. The academic achievement test in Ecology was administered to both groups as a pre-test and post-test to assess learning outcomes.

Sample Size Calculation

The study targeted SSII Biology students from the Kano Municipal Education Zone public schools. A stratified random sampling technique was used to select four public secondary schools within the Kano Municipal Education Zone. The selected schools were randomly assigned to either the experimental or control group. Two of the schools were boys only, and the other two were girls only. In each of the schools, one intact class was selected. Thus, in the boys schools, one class was assigned to experimental group, and the other was assigned control group. Similarly, to the girls' schools, one intact class was assigned to experimental group and the other to the control group. The experimental group had a total of 60 participants, while the control group had a total of 67 participants, bringing the total to 127 participants

Development and Validation of the Academic Achievement Test in Ecology (EAT)

The Ecology Achievement Test (EAT) was developed using past questions from the West African Senior School Certificate Examination (WASSCE) Biology papers (2016-2020). The test consisted of 30 multiple-choice items covering key Ecology concepts.

To ensure validity, the test was reviewed by experts in Science Education (Biology) from Bayero University, Kano. A pilot test was conducted, and the test-retest reliability coefficient was established at $r = 0.715$, indicating a reliable instrument for assessing students' performance.

Types of Media Animations Used and Their Administration

The experimental group was taught using various media animations designed to enhance the understanding of Ecology concepts. The animations used in this study included:

1. **PhET Interactive Simulations** – Used for demonstrating energy flow in ecosystems.
2. **EcoBeaker® Software** – Simulated predator-prey relationships and population dynamics.
3. **Bioman Biology Animations** – Explained food chains, food webs, and nutrient cycling.
4. **YouTube Educational Animations** (CrashCourse Biology) – Provided visual explanations of ecological succession, biomes, and environmental changes.

Administration of Media Animations

The experimental group received instruction over a six-week period using the animations integrated into lessons. The control group was taught the same topics using traditional methods such as lectures, textbooks, and chalkboard illustrations.

Data Collection and Analysis

The **EAT** was administered as a **pre-test** before the instructional period to assess students' baseline knowledge. After the six-week intervention, the **post-test** was conducted to measure learning gains.

For data analysis:

- **Descriptive statistics** (mean and standard deviation) were used to answer research questions.
- **Inferential statistics** (Analysis of Covariance – ANCOVA) were employed to test hypotheses and control for initial differences between groups.

ANCOVA was used to measure the effect of the independent variable (media animation strategy) on the dependent variable (academic achievement in Ecology) while statistically controlling for pre-test scores.

RESULTS

Research Question One: What is the difference in the mean score of Biology students taught Ecology media animated strategy and those taught using conventional

strategies in Senior Secondary Schools of the Municipal Education Zone Kano State?

To address this research question, the pre-test and post-test scores of students in the experimental and control groups were analyzed using descriptive statistics (Mean and Standard Deviation). The results are presented in Table 1.

Table 1 shows the mean scores, standard deviations, and mean gains of the experimental and control groups' pre-test and post-test. The experimental group attained a pre-test mean of 45.25 (SD=10.23) and a post-test mean of 65.72 (SD=11.56), which show a mean gain of 20.47. On the other hand, the control group was assessed to have a pre-test mean of 44.18 (SD= 9.77) while the post- test mean was 46.37 (SD = 10.66), representing a mean gain of only 2.19.

The **bar chart with error bars** below in Figure 1 further illustrates the post-test performance of students in the experimental and control groups.

Table 1: Mean and Standard Deviation of Academic Achievement of Students of the Pre-test and Post–test Experimental and Control Groups

Variables	Group	N	Pre-Test Mean	Pre-Test Std. Dev.	Post-Test Mean	Post-Test Std. Dev.	Mean Gain
MAS	Experimental	67	45.25	10.234	65.72	11.562	20.47
CLM	Control	60	44.18	9.765	46.37	10.659	2.19

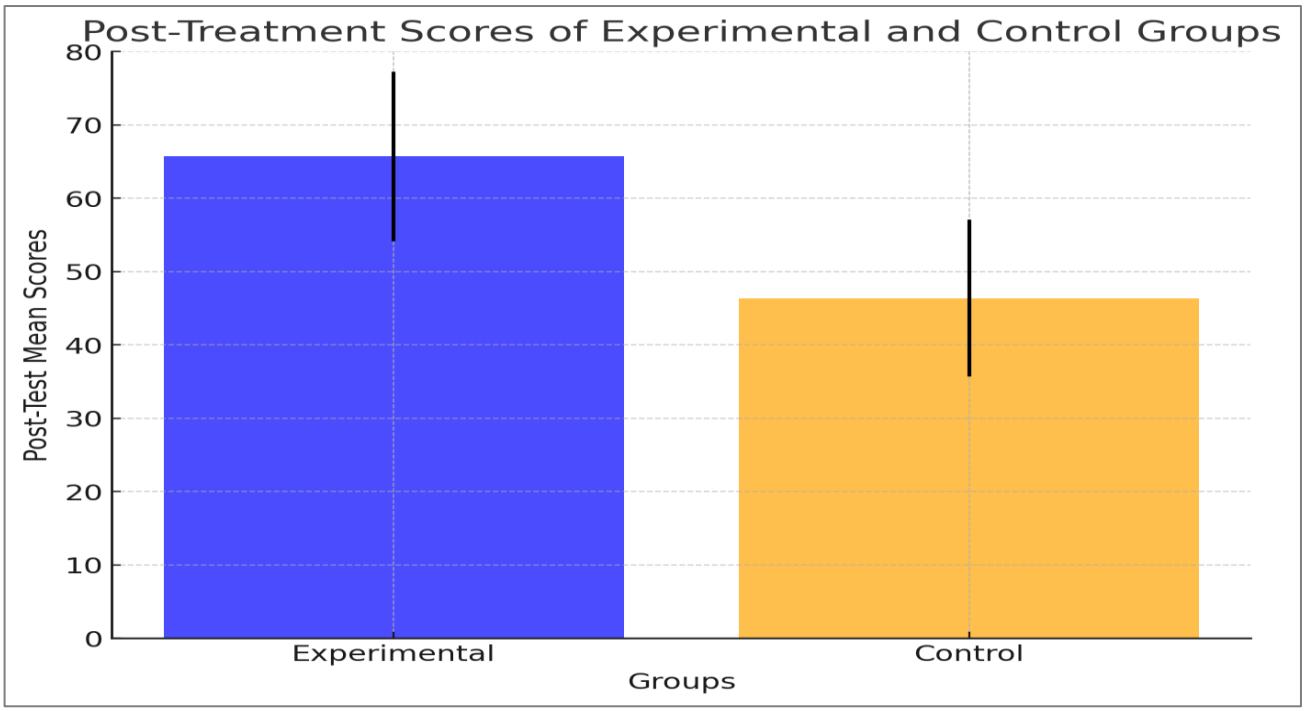

Figure 1: Post-Test Mean Scores of Experimental and Control Groups

The bar chart above shows that students in the experimental group (media-animated strategy) outperformed those in the control group (conventional method). The error bars represent the standard deviations, indicating the variation within each group.

Null Hypothesis One: The mean of students taught Ecology using a media-animated strategy does not differ significantly from those taught using conventional methods for Biology Senior Secondary Schools in the Municipal Education Zone, Kano State.

To test null hypothesis one, the post-test scores of the experimental and control groups were analyzed using Analysis of Covariance (ANCOVA). A summary of the analysis is presented in Table 2.

The results, summarized in Table 2, indicate that the F calculated value for the achievement group is 28.712, with a significance level of p = 0.000. Since this p-value is less than the alpha level of 0.05, we reject the null hypothesis. This finding implies that there is a significant difference in the mean academic achievement scores of biology students exposed to media-animated strategies in the teaching of ecology and those taught using the conventional approach in Senior Secondary Schools within the Municipal Education Zone of Kano State (F-cal = 28.712, p = 0.000).

Research Question Two: What is the difference in the Mean score of male and female students taught Ecology using media-animated strategy in Senior Secondary Schools in the Municipal Education Zone, Kano State?

Descriptive statistics, including mean and standard deviation, were used to answer the research question, as shown in Table 3.

Table 3 presents the pre-test and post-test mean academic achievement scores, standard deviations, and mean gains for male and female students in the experimental group. Male students had a mean pre-test response of 14.25 (SD = 2.50) with a post-test mean response of 16.64 (SD = 3.76), which gave a mean gain of 2.39. Female students scored 18.50 (SD = 1.20) on the pre-test and 20.25 (SD = 1.64) on the post-test, with a mean gain of 1.75. Based on these findings, the study revealed that Male students' overall academic performance improved and had a slightly higher mean gain of 2.39 as compared to the female students who also gained an average of 1.75. This implies that the media animated strategy might have had a slightly greater influence on the males' students' academic performance in ecology than their female counterparts.

The bar chart with error bars below in Figure 2 visually represents the post-test performance of male and female students.

The bar chart in Figure 2 shows that both male and female students improved after being taught using the media-animated strategy, but male students had a slightly higher mean gain (2.39) compared to female students (1.75). The error bars indicate the variation within each group.

Table 2: ANCOVA test for the Post-test Scores of Biology Students taught Ecology using Media Animated Strategy and those taught using Conventional Method of Teaching.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Decision
Corrected Model	251.815[a]	2	125.907	17.599	.000	.221	
Intercept	668.717	1	668.717	93.473	.000	.430	
Pretest	21.315	1	21.315	2.979	.087	.023	
Group	205.412	1	205.412	28.712	.000	.188	Rejected
Error	887.114	124	7.154				
Total	46872.000	127					
Corrected Total	1138.929	126					

a. R Squared = .221 (Adjusted R Squared = .209)

Table 3: Pre-Test and Post-Test Mean Academic Achievement and Standard Deviation Scores of Male and Female Students in Experimental Group

Variable	Group	N	Pre-Test Mean	Pre-Test Std. Dev.	Post-Test Mean	Post-Test Std. Dev.	Mean Gain
Gender	Male	28	14.25	2.50	16.64	3.76	2.39
Gender	Female	32	18.50	1.20	20.25	1.64	1.75

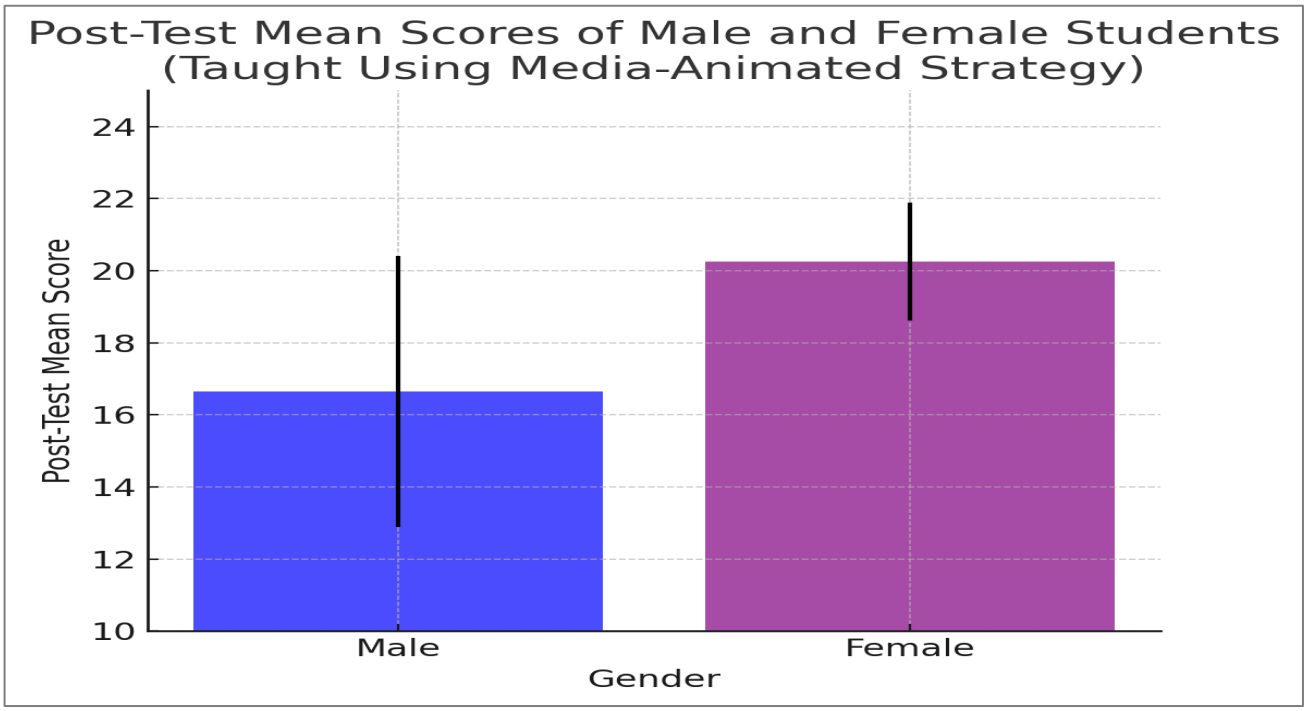

Figure 2: Post-Test Mean Scores of Male and Female Students in the Experimental Group

Table 4:ANCOVA test for the Post-test Scores of Male and Female Biology Students taught Ecology using Media Animated Strategy.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Decision
Corrected Model	194.947[a]	2	97.474	11.928	.000	.295	
Intercept	470.149	1	470.149	57.534	.000	.502	
Pretest	.643	1	.643	.079	.780	.001	
Gender	191.720	1	191.720	23.461	.000	.292	Rejected
Error	465.786	57	8.172				
Total	21344.000	60					
Corrected Total	660.733	59					

a. R Squared = .295 (Adjusted R Squared = .270)

Null Hypothesis Two: There is no significant difference in the mean academic achievement scores of male and female students taught Ecology using media-animated strategy in Senior Secondary Schools in the Municipal Education Zone, Kano State.

To analyze null hypothesis two, a post-test comparison of mean scores of the male and female students was conducted using ANCOVA and the results are summarized as follows in Table 4.

The ANCOVA analysis presented in Table 4 examines the post-test scores of male and female Biology students taught ecology using the media animated strategy. The results indicate a significant difference in academic achievement between the genders. The calculated F-value for gender is 23.461, with a p-value of 0.000, which is less than the significance threshold of 0.05. As a result, the null hypothesis is rejected. This finding confirms that there is a statistically significant difference in the mean academic achievement scores of male and female students taught ecology using the media animated strategy in Senior Secondary Schools in the Municipal Education Zone of Kano State. ($F = 23.461$, $p < 0.05$).

DISCUSSION

The findings of this study revealed that students taught using media-animated instructional strategies had a significantly higher mean achievement score compared to those taught using conventional methods. This suggests that media animation enhances comprehension and retention of ecological concepts, likely due to its interactive and visual nature, which supports cognitive processing and knowledge retention.

These findings align with several previous studies that have established the effectiveness of animated media in enhancing students' academic achievement. For instance, Obinna et al. (2021) and Umezulike & Umezulike (2024) reported that multimedia instruction improves student engagement, comprehension, and achievement across various subjects, including science disciplines. Similarly, Mayer (2022) emphasized that animation-based learning enhances cognitive load processing, leading to better retention and transfer of knowledge than traditional lecture-based methods.

Studies focusing on computer-assisted instruction (CAI) and other multimedia strategies have reported similar findings. Adebayo & Oladele, (2016) found that students who learned biology using interactive animations performed significantly better than those taught with only text-based or traditional approaches.

On the contrary, Ibrahim, (2017) found no significant difference between students taught using animated media and those taught using printed instructional materials, suggesting that other factors, such as instructional design, teacher effectiveness, and students' prior knowledge, may influence learning outcomes. Furthermore, Bello et al. (2016) argued that the effectiveness of multimedia instruction varies depending on the complexity of the subject matter, with some topics requiring additional hands-on practical engagement rather than relying solely on animation.

The study also found a gender difference in achievement among students taught using media animation, where female students performed slightly better than their male counterparts. This aligns with Obinna et al. (2021), who found that female students demonstrated higher interest and engagement in ecological studies when multimedia elements were integrated into instruction. They suggested that females may respond better to visual and narrative-driven learning styles often embedded in animated instructional strategies.

However, these findings contradict the results of Johnson et al. (2024), who reported no significant gender difference in performance when students were taught using multimedia instruction, implying that such strategies are gender-neutral in effectiveness. Similarly, Pius et al. (2023) observed that both male and female students benefitted equally from computer-animated instructional packages, attributing this to equal participation and motivation levels fostered by the technology-based learning approach.

Conversely, Oruakpor & Oyovwi (2024) found that male students benefited more from multimedia instruction than females, arguing that boys tend to be more comfortable with technology-based learning tools, which might explain their higher achievement scores in such settings. Additionally, Nwuba & Osuafor (2021) reported that male students outperformed female students when ecological concepts were taught using a demonstration method,

highlighting the impact of instructional strategies on gender-based performance variations.

Overall, the findings of this study contribute to the growing body of literature supporting the use of media animation as an effective instructional tool in science education. The results emphasize that while media animation improves academic achievement, its impact may vary across gender groups, necessitating further research on how to optimize multimedia instruction for both male and female learners.

CONCLUSION

It can be concluded from the study that animated-media strategy enhances the academic achievement of Biology students in Ecology in Senior Secondary Schools in the Municipal Education Zone, Kano State, Nigeria. All the students in the experimental group –Male and Female– recorded improvement in their academic achievement, with the Male students outperforming the female students with a higher mean gain.

RECOMMENDATIONS

Based on the study, the following recommendations are made:

1. The media-animated strategy should be used in the teaching and learning process so that the teachers of Biology can engage their students more actively. As a result, teachers looking for engaging ways to explain complex ecological concepts to their students can use online animations and game-based learning tools to get students motivated to engage in a collaborative process of explaining the learning material through discussions, stating hypotheses, and working on common projects.
2. Biology teachers should make sure that all the students they teach are taught without discrimination of gender. Such inclusivity can create additional interest and enhance work with the specified subject.

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