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EFFECTIVENESS OF MULTIMEDIA IN ENHANCING BIOLOGY LEARNING OUTCOMES IN SABON GARI, KADUNA STATE

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ABSTRACT

The persistent underperformance in biology among secondary school students has been linked to the ineffective teaching of difficult concepts and the reliance on a teacher-centered approach. The use of multimedia has been put forward as an alternative strategy to enhance student engagement and academic performance. The investigation focused on the Effectiveness of Multimedia in Enhancing Biology Learning Outcomes, the extent of its utilization in high schools, the types of multimedia tools, and the challenges associated with the utilization of multimedia in Sabon Gari, Kaduna State. Three research goals, three separate questions, and three null hypotheses led the research. A mixed-methods approach involving a quasi-experimental design with intact classes and a survey design was utilized. A total of 260 students were selected using a simple random sampling technique. Data were collected through a questionnaire developed by the researchers and achievement tests. Instrument validity was established through expert review, and reliability yielded a coefficient of 0.70 using Pearson's correlation. Data were analyzed using descriptive statistics, paired-sample t-tests, and Chi-square tests at a 0.05 level of significance. The data collected was analyzed using descriptive statistics. The results revealed that incorporating multimedia into biology teaching has a significant impact on students' academic achievement. The reasons being that the calculated p-value of 0.001 is lower than the 0.05 alpha level of significance, and its t-computed value of 26.199 is greater than the 1.96 t-critical value at df = 259. Multimedia is significantly and widely utilized in teaching biology in senior secondary schools. This is because the X^2 *computed value of 109.86 is above the 21.026* X^2 *critical value at df 12. The p-value of 0.002 is lower than the 0.05 alpha level of significance, indicating significant differences in the types of multimedia tools used in teaching biology in senior secondary schools. There are significant challenges associated with the utilization of multimedia in senior secondary schools. Multimedia enhances learning performance in biology, and it is increasingly utilized in most schools, although infrastructural and pedagogical hurdles limit its full consolidation. Finally, the researchers recommend that government and educational stakeholders should invest in infrastructural development by improving electricity supply and internet connectivity in secondary schools, particularly in underserved areas like Zaria, alongside others.*

Keywords: Effectiveness; Multimedia; Biology Learning; Outcomes

Introduction

Biology, a core branch of the natural sciences, is central to understanding life, its origins, organization, evolution, and interactions with the environment. Beyond its theoretical foundations, Biology is

foundational to applied disciplines such as medicine, agriculture, biotechnology, pharmacy, and environmental conservation (Ahmad, 2018). In Nigeria, Biology is one of the compulsory science subjects in the secondary school curriculum, designed to equip learners with problem-solving, critical thinking, communication, and analytical skills required for success in the 21st century. However, despite its relevance, students' performance in Biology at the secondary school level has remained persistently poor (Nwuba et al., 2022).

Research has consistently shown that this underachievement is linked to the dominance of traditional, teacher-centered instructional methods, which often fail to address the abstract and invisible nature of many biological concepts (Agboghoroma & Oyovwi, 2015; Cimer, 2012; Etobro & Fabinu, 2017). Consequently, students frequently perceive Biology as boring and difficult, which undermines motivation and learning outcomes. The implications of this learning crisis are far-reaching, as weak performance in Biology obstructs the realization of national educational goals (FME, 2009) and threatens Nigeria's capacity to meet its developmental aspirations in science and technology (Inegbenebor et al., 2018).

To address this challenge, scholars have emphasized the need for innovative pedagogies that shift instruction from passive, teacher-centered delivery to more interactive, student-centered learning environments (Pirker & Gütl, 2015). Multimedia instruction, which integrates text, graphics, audio, video, and interactive elements, has been identified as a powerful tool for enhancing the visualization of abstract concepts and improving student engagement and retention (Mukherjee, 2020; Yukiko, 2016). Evidence from developed countries suggests that multimedia-based teaching has a significant impact on improving comprehension and achievement, particularly in science-related subjects. However, in developing contexts such as Nigeria, the integration of computer-based multimedia into secondary school classrooms remains limited, often due to infrastructural challenges, inadequate teacher training, and resistance to pedagogical change.

Given these challenges, this study examines the effectiveness of multimedia instructional packages in improving biology learning outcomes among secondary school students in Sabon Gari, Kaduna State. Specifically, it aims to investigate whether computer-based multimedia can enhance students' academic performance, bridge gender disparities, and offer a viable alternative to conventional teaching methods in the Nigerian context. By doing so, the study contributes to the broader discourse on innovative pedagogy, equity in STEM education, and the integration of digital tools into classrooms in developing countries.

Statement of the Problem

Despite growing global recognition of the pedagogical benefits of multimedia instructional resources, their integration into Nigeria's secondary school classrooms, particularly in science education, remains limited. Traditional teacher-centered

methods continue to dominate biology instruction, despite the subject's inherent emphasis on abstract concepts that require visual and interactive reinforcement. Consequently, many students struggle to grasp fundamental biology principles, leading to persistent underachievement in both internal and external examinations. This trend contributes to declining interest and enrollment in science disciplines, as students often perceive biology as complex and inaccessible.

Research has consistently shown that conventional lecture-based teaching strategies contribute significantly to students' poor academic outcomes in biology (Sola & Ojo, 2017). However, most teachers in Nigeria still rely on outdated methods, despite the era in which multimedia tools have the potential to transform science instruction. The continued use of non-interactive approaches in a digital generation highlights a critical gap in classroom practice and a missed opportunity to enhance learning.

In light of these challenges, this study examines the impact of multimedia instruction on the academic achievement of secondary school students in biology within the Sabon Gari Local Government Area, Kaduna State, with a particular focus on the challenges associated with using multimedia. The findings are expected to provide empirical insight into the effectiveness of multimedia as an instructional alternative and its potential to bridge gender gaps and enhance science learning outcomes.

Objectives of the Study

The following are the objectives outlined to be achieved by this study:

1. To determine the impact of multimedia instructional strategies on students' academic achievement in biology.
2. To examine the extent of multimedia utilization in teaching biology in secondary schools.
3. Identify differences in the types of multimedia tools utilized in teaching biology in secondary schools.
4. To investigate the challenges associated with the use of multimedia in teaching biology in senior secondary schools

Research Questions

1. What is the impact of the use of multimedia instruction on students' academic achievement in biology?
2. To what extent is multimedia utilized in biology instruction?
3. What are the differences in the types of multimedia tools used in teaching biology?
4. What are the challenges associated with the use of multimedia in teaching biology?

Research Hypotheses

1. H_1: The use of multimedia in teaching biology has no significant impact on students' academic achievement
2. H2: Multimedia is not widely utilized in teaching biology in senior secondary schools.
3. H3: There are no significant differences in the types of

multimedia tools used in teaching biology in senior secondary schools.

4. H4: There are no significant challenges associated with using multimedia in teaching biology in secondary schools.

Methodology

This study was conducted to investigate the use of multimedia in teaching biology in selected secondary schools. Selected Biology teachers and students of secondary schools in Sabon Gari Local Government Area of Kaduna State form the population of the study. To assess student achievement, a mixed-methods approach involving a quasi-experimental research design was explored, utilizing intact classes to evaluate performance and a survey design. The researcher employed Krejcie and Morgan's table to determine the sample size. Out of all the Biology teachers and students in secondary schools of Sabon Gari Local Government Area, Kaduna State, the researcher selected 260 as the sample size for this study. The research instrument used in this study is the questionnaire. An instrument survey containing a series of questions was administered to the enrolled participants. The questionnaire was divided into two sections. The first section collected the respondents' demographic and personal data, while the second section aligned with the study objectives, aiming to provide answers to the research questions. Participants were required to respond by placing a tick in the appropriate column. The researchers personally administered the questionnaire. The primary source was the use of questionnaires. The responses were analysed using the mean and standard deviation, which provided answers to the research questions. The researchers developed the questionnaire for the study and submitted it to the project supervisor, who will use his intellectual knowledge to critically, analytically, and logically examine the relevance of the contents and statements, ensuring the instrument is valid for the study. The reliability of the research instruments was determined using the Pearson Correlation Coefficient. A coefficient value of 0.70 indicated that the research instrument was relatively reliable. Ethical clearance was sought from the Kaduna State Ministry of Education.

Results

Answering research questions

Question One: What is the impact of multimedia in teaching biology on students' academic achievement?

Table 1: Descriptive Mean statistics on the difference between the pre-test and post-test on the impact of multimedia on biology students' performance

Variables	N	Mean	Std	Mean difference
Pretest	260	8.7038	1.23682	
				5.207
Posttest	260	13.9115	3.38231	

The outcome of the above descriptive statistics revealed that Multimedia in teaching biology has a high positive impact on students' academic achievement. Their mean performance scores were 8.703 and 13.911 at their pre-test and post-test,

respectively, indicating a mean performance increase of 5.207 at the post-test value. This implies a positive impact of multimedia on academic performance.

Question Two: To what extent is Multimedia utilized in teaching biology in senior secondary schools?

Table 2: Extent of multimedia utilization in teaching biology in senior secondary schools

S.NO	ITEMS	SA	A	D	SD	Mean	STD
1	Computers are regularly used in the labs department	**90**	**90**	**50**	**30**	2.923	**0.751**
2	There are smart board systems in classes for teaching and learning	**30**	**70**	**70**	**90**	**2.154**	**1.031**
3	The school readily uses power PowerPoint presentation application during teaching	**60**	**90**	**70**	**40**	2.654	**0.622**
4	They readily use video tutorials, such as YouTube educational channels	**50**	**90**	**70**	**50**	2.538	**0.600**
5	They use eBooks such as children's storybooks	**80**	**60**	**90**	**30**	2.731	**0.914**
	Decision Mean					**2.600**	

Decision/threshold mean=2.500

The above shows the extent of multimedia utilization in teaching biology in senior secondary schools, which is moderately above average. This is because the cumulative or grand mean response of 2.600 is above the 2.500 decision threshold mean. Specifically, there are computers usage in the schools, as this vie has the highest mean of 2.923 as details showed that while 90 strongly agreed, another 90 agreed as against 50 that disagreed and the rest 30 strongly disagreed, also they readily use some eBooks such as storytelling as this view had the second highest, mean of 2.731 with details showing that while 80 strongly agreed, 60 agreed as against 90 disagreed and the rest 30 strongly disagreed, in summary, Multimedia utilization in teaching biology in senior secondary schools which is moderately above average especially there moderate utilization of computers and eBooks.

Question Three: What are the different types of multimedia tools used in teaching biology in senior secondary schools?

Table 3: The different types of Multimedia tools used in teaching biology in senior secondary schools.

Types of Multimedia	Frequency	Percentage
Computers	72	27.7
Smart boards	42	16.2
PowerPoint presentation application	36	13.8
video tutorials, such as YouTube educational channels	44	16.9
eBooks such as children's story books	66	25.4
Total	260	100.0

The above shows the different types of multimedia tools used in teaching biology in senior secondary schools. It showed that computers had the highest representation, with 72, representing 27.7% of those who can use them. In comparison, 42, representing 16.2%, can use Smartboards, and 36, or 13.8%, can use PowerPoint presentations, as opposed to 44, or 16.9%, who can use Video tutorials, and the rest, 66, representing 25.4%, can use eBooks. Therefore, more people can utilize computers among the multimedia facilities in senior secondary schools.

Question Four: What are the challenges associated with using multimedia in teaching biology in secondary schools?

Table 4: Challenges associated with using multimedia in teaching biology in secondary schools

S.NO	ITEMS	SA	A	D	SD	Mean	STD
1	Lack of adequate infrastructural facilities for multimedia, such as internet, facilities	84	100	48	28	2.922	0.651
2	High cost of multimedia facilities	63	93	68	36	2.704	1.021
3	Lack of adequate technical knowledge by the teachers on the use of multimedia	46	93	67	54	2.504	0.612
4	Licensing fees for multimedia tools and facilities	90	57	83	30	2.796	0.141
5	Inability to change or adapt to new and modern technologies	95	55	80	30	2.827	0.341
	Cumulative/grand mean					2.75	

Decision/threshold mean =2.500

The above illustrates the significant challenges associated with incorporating multimedia into biology teaching in secondary schools. This is because the cumulative or grand mean response of 2.750 is above the 2.500 decision threshold mean. Specifically, there are computers usage in the schools Lack of adequate infrastructural facilities for multimedia such as internet, facilities, as this vie has the highest mean of 2.922 as details showed that while 84 strongly agreed, another 100 agreed as against 48 that disagreed and the rest 28 strongly disagreed, another challenge is the Inability to change or adapt to new and modern technologies as this view had the second highest, mean of 2.827 with details showing that while 95 strongly agreed, 55 agreed as against 80 disagreed. The rest 30 strongly disagreed. In summary, the challenges associated with using multimedia in teaching biology in secondary schools are considerable, particularly the lack of adequate infrastructural facilities for multimedia, such as internet access, and the Inability to adapt to new and modern technologies.

Testing null hypotheses

Null Hypothesis one: The use of multimedia in teaching biology has no significant impact on students' academic achievement.

Table 5: Paired sample t-test on the difference between the pre-test and post-test performance of SS II students taught phonetics using an audio-visual package in Kaduna State

Variables	N	Mean	Std	Mean difference	Df	t-computed	t-critical	p-value
Pretest	260	8.70	1.23					
				5.207	259	26.199	1.96	0.001
Posttest	260	13.91	3.38					

p-value =0.001 < 0.05, t-computed = 26.19 > 1.96 at df 259

The outcome of the paired sample test revealed that incorporating multimedia into biology teaching has a significant impact on students' academic achievement. Reasons being that the calculated p-value of 0.001 is lower than the 0.05 alpha level of significance, and its t-computed value of 26.199 is greater than the 1.96 t-critical value at df 259. Their mean performance scores were 8.703 and 13.911 at their pre-test and post-test, respectively, indicating a mean performance increase of 5.207 at the post-test value. This implies a positive impact of multimedia on academic performance. Therefore, the null hypothesis, which states that the use of multimedia in teaching biology has no significant impact on students' academic achievement, is consequently rejected.

Hypothesis Two: Multimedia is not widely utilized in teaching biology in senior secondary schools.

Table 6: Chi-square $\mathbf{X^2}$ statistics on the utilization of multimedia in teaching biology in senior secondary schools.

Ex*pected counts are printed below observed counts*

Variables	SA	A	D	SD	Total	Df	X^2 computed	X^2 critical	p-value
Utilization of	90	90	50	30	260	12	109.869	**21.026**	0.002
Multimedia	62.0	80.0	70.0	48.0					

P= 0.002 < 0.05, X^2 computed = 109.86 > X^2 critical at df 12

The results of the chi-square statistics above show that multimedia is significantly and widely utilized in teaching biology in senior secondary schools. This is because the $\mathbf{X^2}$ computed value of 109.86 is above the 21.026 X^2 critical value at df 12. The p-value of 0.002 is lower than the 0.05 alpha level of significance. Their observed frequencies for strongly agree, agree, disagree, and strongly disagree are 90, 90, 50, and 30, respectively**.** This implies that there is wide utilization of multimedia. Therefore, the null hypothesis, which stated that multimedia is not widely utilized in teaching biology in senior secondary schools, is hereby rejected.

Hypothesis three: There are no significant differences in the types of multimedia tools used in teaching biology in senior secondary schools

Table 7: Differences in the types of multimedia tools used in teaching biology in senior secondary schools

Types of Multimedia	Frequency	Percentage	Ranking
Computers	72	27.7	1st
Smart boards	42	16.2	4th
PowerPoint presentation application	36	13.8	5th
video tutorials, such as YouTube educational channels	44	16.9	3rd
eBooks such as children's story books	66	25.4	2nd
Total	260	100.0	

The above results indicate significant differences in the types of multimedia tools used in teaching biology in senior secondary schools. There are significant differences in the types of multimedia tools used in teaching biology in senior secondary schools. Second is the utilization of eBooks, such as children's storybooks, which is also notable. Next are the video tutorials, such as those found on YouTube educational channels, followed by smartboards. Lastly, in the utilization ranking, is the PowerPoint presentation application. Therefore, the null hypothesis, which states that there are no significant differences in the types of multimedia tools used in teaching biology in senior secondary schools, is hereby rejected.

Hypothesis four: There are no significant challenges associated with using multimedia in teaching biology in secondary schools.

Table 8: Chi-square $\mathbf{X^2}$ statistics on the challenges associated with using multimedia in teaching biology

Variables	SA	A	D	SD	Total	Df	X^2 computed	X^2 critical	p-value
Challenges associated with multimedia use	95 75.6	55 79.6	80 69.2	30 35.6	260	3	70.025	**21.026**	0.011

P= 0.002 < 0.05, X^2 computed = 109.86 > X^2 critical at df 3

The results of the Chi-square statistics above showed that there are significant challenges associated with the utilization of multimedia in senior secondary schools. This is because the X^2 computed value of 70.025 is above the 21.026 X^2 critical value at df 12. The p-value of 0.011 is lower than the 0.05 alpha level of significance. Their observed frequencies for strongly agree, agree, disagree, and strongly disagree are 95, 55, 80, and 30, respectively. This implies that there are significant challenges associated with the utilization of multimedia. Therefore, the null hypothesis, which stated that there are no significant

challenges associated with using multimedia in teaching biology in secondary schools, is hereby rejected.

Discussion on Findings

Multimedia in teaching biology has a significant impact on students' academic achievement. This aligns with the work of Kassa et al. (2024), who suggested that multimedia teaching offers better intellectual benefits compared to traditional methods. Similarly, Kassa et al. (2024) found that visual aids have increased students' interest and motivation in biology lessons. According to Ayittey et al. (2019), visual tools make learning engaging and always clarify misconceptions. Multimedia is significantly and widely utilized in teaching biology in senior secondary schools. This finding is similar to that of Eze et al. (2020), who noted notable differences in the scores of students taught using a multimedia instructional package compared to those taught using a conventional method. There are significant differences in the types of multimedia tools used in teaching biology in senior secondary schools**.** This is connected to the findings of Stepanyuk et al. (2024), who noted that platforms such as learningApps.org offer interactive exercises that enhance comprehension of biological concepts, including plant biology. There are significant challenges associated with the use of multimedia in senior secondary schools. This aligns with the findings of Hao (2024), who acknowledges significant challenges in the use of multimedia in education; these obstacles include consistency of achievement, concerns about secrecy, ethical issues, and technical harmony. In a similar vein, Al-Sisi (2022) noted that inadequate training for educators in using multimedia tools effectively poses a significant obstacle to effective learning. Al-Zahrani and Al-Bishri (2024) found in their study that the availability of multimedia resources is often limited, which affects teachers' ability to create engaging lessons.

Conclusion

1. Multimedia in teaching biology has a high positive impact on students' academic achievement, which implies a positive impact of multimedia on academic performance.
2. Multimedia utilization in teaching biology in senior secondary schools, which is moderately above average, especially their moderate utilization of computers and eBooks
3. Therefore, more people can utilize computers among the multimedia facilities in senior secondary schools
4. The challenges associated with using multimedia in teaching biology in secondary schools and these challenges are quite great, especially the challenges of lack of adequate infrastructural facilities for multimedia, such as internet, facilities, and the Inability to change or adapt to new and modern technologies

Recommendations

The researchers put forward the following recommendations

1. Schools should provide an enabling environment and modern infrastructure for multimedia facilities in the schools

2. Teachers should be encouraged through sponsorship to attend courses and in-house training on the proper utilization of these multimedia facilities in secondary schools
3. There should be proper supervision and monitoring of the utilization of these multimedia resources es as most people find it hard to adapt to the use of these modern facilities
4. The state ministry of education should do special training on how to use PowerPoint to deliver lessons.

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