



## Impact of Interactive Multimedia Instruction on Achievement in Photosynthesis among Secondary School Students in Zaria

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### ABSTRACT

The research examined the impact of interactive multimedia instruction on academic achievement in photosynthesis among secondary school students in Zaria, Kaduna State, Nigeria. A quasi-experimental design was employed, utilizing an interactive multimedia approach to teaching photosynthesis. The total population of Senior Secondary 2 (SS2) students in 2024 was 8,439, comprising 4,853 males and 3,586 females across 29 schools. From this population, two schools were purposively selected based on gender inclusiveness and the availability of multimedia facilities. The treatment group was exposed to photosynthesis instruction using Microsoft PowerPoint, a courseware package (resources and tools supporting learning in online and blended classroom settings), and YouTube videos. The educational software package and YouTube videos were retrieved online, while the slideshow presentation was prepared by the researchers involved in the study. The comparison group was taught using traditional lesson plans and textbooks. Data collection was conducted using the Students' Achievement in Photosynthesis Test (SAPT). Both selected schools underwent pretesting with the SAPT, and the results were analyzed using Analysis of Variance (ANOVA) at a significance level of 0.05, which yielded no significant difference. Consequently, one school was designated as the Experimental Group (EG), while the other served as the Control Group (CG). Students from two intact classes formed the sample for the study, with 95 students (55 females and 40 males) in the intervention group and 88 students (42 males and 46 females) in the baseline group. The findings revealed a significant difference between students' scores in the post-treatment group compared to those in the post-non-treatment group, with a t-value of -11.741, a mean difference of 20.17, and a p-value of 0.00. However, no significant difference was found between male and female students' scores in the post-treatment group, with a t-value of 0.43, a mean difference of -1.23, and a p-value of 0.41. The study recommends that state governments incorporate multimedia teaching methods into the secondary school curriculum to enhance students' academic performance.

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### INTRODUCTION

Teaching photosynthesis in biology classrooms faces both evolving trends and persistent challenges. Recent educational strategies emphasize active learning and use of

innovative resources to address common misconceptions and enhance student engagement. However, significant hurdles remain, particularly in ensuring conceptual understanding and addressing the complexity of

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the topic. Teachers are adopting inquiry-based approaches, such as the floating leaf disk assay, which allows students to design experiments and analyse environmental impacts on photosynthesis (Paullier, 2024). Multimedia in biology education encompasses a range of innovative content delivery methods that foster enhanced student engagement and comprehension. By seamlessly integrating text, audio, images, animations and interactive elements. Multimedia elements includes text, audio, still images, animations and videos which can be linear or non-linear (Bilek et al., 2012, and Bursjöö, 2022). Studies have shown that students taught through hybrid methods outperform those in conventional settings, highlighting the effectiveness of integrating technology into education (Paramguru, 2024). According to Galope (2013), students taught with multimedia tools most often outperform those receiving traditional instruction with significant improvement in achievement scores. The integration of multimedia in teaching biology in Nigeria is crucial for enhancing students' engagement, motivation and educational attainment. The use of 3D games based on augmented reality actively engaged students allowing them to experience the photosynthesis process interactively which improved their learning outcomes (Zikky et al., 2020). Alternative animations and 3D models significantly enhanced students' academic success in understanding photosynthesis compared to traditional 2D models. Alternative animations and 3D models significantly enhanced students' academic accomplishment in understanding photosynthesis compared to traditional 2D models (Capuno, 2016).

Biology is a prerequisite for numerous disciplines, including botany, anatomy, microbiology and more. These are vital for national development. It supports technological advancements by providing a scientific basis for innovations, medicine, agriculture and biotechnology (Malshe et al., 2023). The teaching of biology enhances scientific literacy, enabling students make informed decisions as active citizens (Tzovla & Kedraka, 2020 & Kuta et al. 2024). This approach not only addresses the

limitations of traditional teaching methods but also adopts to the evolving educational landscape particularly in the post-COVID-19 context (Kuta et al. 2024). Multimedia tools such as animated videos, foster active participation and enthusiasm among students leading to a more dynamic learning environment (Julianti et al. 2022). In Kaduna south, the use of interactive packages in teaching ecological concepts resulted in higher performance and retention scores among students to traditional teaching methods. This approach was particularly effective in engaging students and making abstract concepts more tangible (Musa et al. 2023). Many educational institutions struggle with poor internet access which is crucial for implementing Interactive Multimedia Instruction effectively. The lack of consistent electricity supply further complicates the use of multimedia tools in most of our classrooms (Akaeze & Akaeze, 2024). Gender disparities in educational performance within scientific disciplines are shaped by a multifaceted array of social and cultural influences. Cultural stereotypes portray STEM as a male-dominated field leading to a lack of interest among young girl (Owuundo, 2023).

### Statement of the Problem

The continuous downfall in students' academic success in the discipline of photosynthesis, particularly within secondary educational institutions, constitutes an urgent issue for teachers and educational administrators alike. Photosynthesis, being an important scientific topic in biology, is instrumental in developing scientific knowledge and gearing students towards future occupations in biology and other STEM subjects. Notwithstanding, conventional pedagogical methods, frequently typified by teacher-centered strategies, fall short of incorporating the interactive and engaging components necessary to accommodate the varied learning requirements of students, particularly with respect to intricate biological concepts. Factors such as personal interest, perceived career opportunities and the classroom environment significantly influence student's engagement science education.

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Moreover, gender-based discrepancies in educational performance and engagement within STEM disciplines, including biology, persist as obstacles to realizing equitable educational outcomes. These discrepancies are frequently shaped by elements such as pedagogical approaches, societal perceptions, and educational environments that may not uniformly inspire or assist both male and female students. Multidimensional multimedia teaching, accepted for its strength in integrating text, pictures, sound, and interactive features, could transform the educational framework by raising learners' involvement, supporting active participation, and refining comprehension and memory of sophisticated concepts. Despite the aforementioned potential, there remains a notable scarcity of empirical research concerning the efficiency of interactive multimedia teaching in promoting student outcomes, persistence, and engagement among high school students in Nigeria, particularly when analyzed through a gender-focused perspective. Biological concepts such as meiosis, photosynthesis and natural selection are cited to be hard to teach by teachers due to their abstract nature and the prerequisite knowledge required.

This inquiry, therefore, strives to rectify this issue by delving into the role of interactive multimedia instruction on academic outcomes in biology for secondary school students in Zaria, Nigeria, highlighting gender-related effects. The results from this investigation will offer significant understanding regarding the success of this educational method and its consequences for addressing gender gaps in the realm of biology teaching.

### Objectives of the Study

The study was carried out to ascertain:

- i. To investigate whether the use of multimedia in teaching photosynthesis impacts students' academic attainment.
- ii. Assess the difference in performance on the use of Multimedia between male and female learning photosynthesis.

### Research Questions

The following research questions guided the study:

1. Does the use of Multimedia in teaching photosynthesis have an impact on students' academic attainment?
2. Is there a difference in the performance of male and female students taught photosynthesis concepts with interactive Multimedia?

### Hypotheses

The following hypotheses were examined and validated at 0.05 level of significance

1. There is no significant difference in the academic attainment of students taught with interactive multimedia and those with conventional method.
2. There is no significant difference in the academic attainment of male and female students taught with interactive multimedia only.

### METHODOLOGY

The study employed a non-randomized control trial with a pre-test and post-test non-randomized standard group design. This approach was chosen because intact classes were used to avoid disrupting the normal classroom settings of the sampled schools. The pre-test was conducted to establish the equivalence of the two groups, while the post-test was used to assess the impact of the multimedia teaching method (experimental group) compared to the conventional lecture method (control group).

The focus group of this study comprised all Senior Secondary 2 (SS2) biology students in public schools within the Zaria Education Zone of Kaduna State. As of 2024, the total population of SS2 students was 8,439 (Zaria Education Zone, 2024), consisting of 4,853 males and 3,586 females across 29 schools. From this population, six schools were initially selected and pretested using the Students' Achievement in Photosynthesis Test (SAPT). The results were analyzed using a t-test at a significance level of 0.05, revealing no significant differences between



the schools. Consequently, two schools were randomly selected based on gender inclusiveness and the availability of multimedia facilities. The first school was designated as the Experimental Group (EG), while the second served as the Control Group (CG). Students from two intact classes formed the study sample, with 95 students (55 females and 40 males) in the intervention group and 88 students (42 males and 46 females) in the comparison group.

The intervention group was taught photosynthesis using Microsoft PowerPoint, a courseware package (resources and tools supporting learning in online and blended classroom settings), and YouTube videos. The courseware package and YouTube videos were retrieved online, while the Microsoft PowerPoint

presentation was developed by the researchers. The comparison group received instruction using the conventional teaching method with lesson plans and textbooks.

The primary data collection tool was the Students' Achievement in Photosynthesis Test (SAPT), adapted from Ayittey et al. (2019), and administered at the conclusion of the study. Data collection for both groups was completed over six weeks. The collected data were analyzed using a t-test statistical approach.

## RESULTS

**Research Question 1:** Does the use of Multimedia in teaching photosynthesis have an impact on biology students' academic attainment?

**Table 1:** Descriptive Statistics Showing Post-Test Result on the use of Multimedia in teaching photosynthesis have an impact on biology students' academic attainment?

Group	N	Mean	Sd
Post Experimental	95	60.53	10.95
post Control	88	40.36	11.97

In Table 1, students in post-experimental group have mean performance of 60.53 and standard deviation of 10.95 while the students in the pots-non-treatment group have mean performance of 40.36 and standard deviation of 11.97. The average difference between the post groups is about 20.17

This result reveals that the post groups revealed the difference is so high, this study found

that Multimedia in teaching photosynthesis increases students' performance in prediction of answers related to photosynthesis.

**Research Question 2:** Is there a difference in the performance of male and female students taught photosynthesis concepts with interactive Multimedia?

**Table 2:** Post-Test Result on the use of performance of male and female students Multimedia between male and female biology students learning photosynthesis

Group	N	Mean	Sd
Male Post Experimental	55	59.87	10.95
Female Post Experimental	40	61.1	10.97

Table 2 shows the computation mean scores and standard deviation of the male and female in post treatment instruction. The male students performance in post-intervention group have mean performance of 59.87 and standard deviation of 10.95 while the female students in the post-intervention group have mean performance of 61.1 and standard deviation of 10.97. The

average score difference between the post groups is about 1.23.

This result reveals that the post groups revealed almost the same performance, the result revealed Multimedia in teaching photosynthesis does not affect gender in terms of students' performance in prediction of answers related to photosynthesis.

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### Hypotheses Testing

Two null hypotheses were verified through the utilization of t-test as statistical tools at 0.05 levels of significance as follows:

H<sub>01</sub>: The use of multimedia in teaching photosynthesis has no notable impact on students' educational attainment.

**Table 3:** Independent T-test for Posttest Performance of Students on the use of multimedia in teaching photosynthesis has no notable impact on students' learning outcomes

Group	N	X	St. div	t	df	p-value	Mean differences	Decision
Experimental	95	60.53	10.95					
				-11.74	185	0.00	20.17	significant at p < 0.1 reject H <sub>01</sub>
Control	88	40.36	11.97					

Alpha value =0.05

Table 3 reveals the t-test analysis of significant difference for post-treatment and control group performance. The significance value of the statistic is 0.00. Considering this value is less than 0.05, here the study assumes that the groups have unequal variances. This means that there is significant difference between students'

scores in the post-intervention group compared to the scores of students in the post- non-treatment group.

H<sub>02</sub>: There is no substantial distinction in the use of Multimedia between male and female biology students

**Table 4:** Independent t-test for Post gender student assessment outcomes on the use of multimedia in teaching photosynthesis impact on students' academic attainment.

Group	N	X	Sd	t	df	p-value	Mean differences	Decision
Experimental	55	59.87	10.95					
				.43	94	.41	-1.23	No significant at p <0.1 Accept H <sub>01</sub>

Alpha value =0.05

Table 4 reveals the t-independent assessment evaluation of no distinction for post-gender treatment group performance. The significance value of the statistic is 0.41. Due to this value is more than 0.05, here the study assumes that the groups have equal variances. This means that no notable gender effect was observed in the post-treatment group.

intervention group compared to those in the post-baseline group. This finding implies that students who received instruction through multimedia-based teaching methods demonstrated better academic outcomes than those taught using conventional approaches. The effectiveness of multimedia teaching is supported by previous studies, such as Kassa et al. (2024), who found that students exposed to multimedia instruction showed statistically significant improvements in academic performance compared to those taught using traditional methods. Similarly, Utami et al. (2023) highlighted the effectiveness of 3D

### DISCUSSION OF FINDINGS

The results indicate that the groups have unequal variances, suggesting a significant difference between students' scores in the post-

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animated videos in correcting misconceptions about photosynthesis among elementary students, leading to a 72% reduction in misunderstandings. These findings reinforce the notion that multimedia-based instruction enhances students' comprehension and retention of complex scientific concepts.

Moreover, the results further indicate no significant difference in post-treatment scores between male and female students. This finding aligns with the research of Hajer and Sarsam (2021), who demonstrated that multimedia courseware is equally effective for both genders, as male and female students exhibited comparable learning performance when exposed to digital instructional tools. Likewise, Joseph and Syman (2013) reported no gender-based differences in mathematics scores, suggesting that technology-integrated learning environments help bridge traditional gender gaps in education. Furthermore, Dada and Ahmed (2023) noted that while students exhibited varied achievement patterns in hypermedia learning environments, the overall levels of engagement and interest were positively influenced for both male and female students. These findings collectively suggest that multimedia instruction fosters an inclusive learning experience, ensuring equitable academic opportunities regardless of gender.

Given these results, the study underscores the need for educational stakeholders to integrate multimedia teaching approaches into science curricula, as such methods have been shown to enhance student comprehension and engagement across diverse learning groups. Future research could further explore the long-term effects of multimedia instruction on students' conceptual understanding and retention, particularly in other subject areas where misconceptions are prevalent.

## CONCLUSION

The post-primary stage of education plays a crucial role in shaping the academic foundation and cognitive development of every Nigerian student. At this stage, students transition from basic education to more specialized learning, where they are introduced to complex scientific concepts that require critical thinking and

analytical skills. Given the significance of this stage, it is essential to adopt teaching approaches that not only enhance understanding but also sustain students' interest and engagement in learning.

One such approach is the use of multimedia instruction, which has proven to be an effective method for teaching photosynthesis. By incorporating interactive elements such as animations, simulations, videos, and digital courseware, multimedia instruction enhances students' comprehension by providing visual and auditory stimuli that reinforce theoretical concepts. Unlike conventional lecture-based methods, multimedia instruction allows students to interact with content dynamically, making learning more engaging and memorable.

The success of multimedia teaching in photosynthesis suggests that this method could be extended to other biological concepts, such as genetics, human anatomy, and ecology, where students often struggle with abstract ideas. Beyond biology, the use of multimedia can also be beneficial in other sciences, including chemistry and physics, by illustrating complex reactions, molecular structures, and physical phenomena in a visually appealing manner. Additionally, integrating multimedia resources can accommodate diverse learning styles, ensuring that visual, auditory, and kinesthetic learners all benefit from an enriched educational experience.

Given these advantages, educational policymakers, school administrators, and teachers should consider incorporating multimedia-based instruction into science curricula to improve students' academic performance and foster a deeper understanding of scientific principles. Further research could explore the long-term impact of multimedia teaching on students' retention rates and problem-solving abilities, as well as its effectiveness in addressing learning disparities among students with different cognitive abilities.

## RECOMMENDATIONS

1. Kaduna State Government should incorporate multimedia teaching into the secondary school curriculum

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2. Kaduna State Government and other stakeholders should ensure access to interactive multimedia resources for both male and female students to maintain gender-neutral learning environments
3. Ministry of education in Kaduna State should train teachers on the effective use multimedia technology in order to maximize the educational impact on students learning achievement.
4. Teachers should promote the use of interactive multimedia instruction across diverse subject areas.

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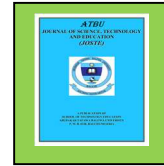


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