

EFFECT OF MULTIMEDIA INSTRUCTION ON STUDENTS' ACHIEVEMENT IN BIOLOGY IN PUBLIC SENIOR SECONDARY SCHOOLS IN AGBANI EDUCATION ZONE OF ENUGU STATE, NIGERIA

Enedo, Achiette Asu and Dr. (Mrs.) V.C. Ude

Department of Science and Computer Education, Faculty of Education, Godfrey Okoye University Enugu, Nigeria

DOI: <https://doi.org/10.5281/zenodo.10682817>

Abstract: The purpose of this work was to examine the effect of multimedia instruction on the achievement of students in Biology in public secondary schools in Agbani Education Zone of Enugu State. Three research questions were formulated to guide the study. Quasi-experimental non-randomized control group design involving intact classes was the research design used for the study. The population of the study comprised all SSII students in Agbani Education Zone of Enugu State. Purposive sampling was used to get four co-educational schools, 300 SSII students were used for the study. Biology Achievement Test was used to collect data on students' achievement in essay writing. The instrument was face and content-validated by two experts in the Science Education Departments. Trial testing was carried out using 10 students from two schools from another zone and to test the reliability of the instrument, inter-rater reliability was sought using Kuder Richarlison formula to obtain 0.76. Mean and Standard deviation were used to answer the research questions. Analysis of Covariance was used to test the null hypotheses formulated for the study at 0.05 level of significance. Major findings showed that: multimedia instruction had significant effect on students' mean achievement in Biology. Based on these findings some recommendations were made: that Biology teachers should endeavor to teach Biology using multimedia; government in conjunction with other professional associations should organize workshops, seminars, conferences and in-service training to re-train Biology teachers on the use of multimedias.

Keywords: Multimedia Instruction, Biology Achievement, Public Secondary Schools, Agbani Education Zone, Quasi-Experimental Design

Introduction

Education is a cornerstone of societal development, and within the educational sphere, the integration of science, particularly biology, holds significant promise for advancing societies worldwide. In Nigeria, as in many other countries, efforts to improve educational outcomes, particularly in the sciences, are paramount for economic and

social progress (Quarcoo-Nelson, Buabeng & Osafo, 2012). However, despite the recognition of the importance of science education, challenges persist, hindering the optimal attainment of educational goals.

Among the sciences, biology occupies a central position due to its relevance to various fields such as medicine, agriculture, and environmental conservation (Umar, 2011). Its study encompasses the understanding of life processes, organisms, and their interactions with the environment. In Nigeria, the secondary school biology curriculum aims to deepen students' understanding of biological concepts and their application in real-world contexts (Yeboah, 2014). Yet, despite the curriculum's intentions, academic achievement in biology remains a concern, as evidenced by data from the West African Examination Council (WAEC) (Yeboah, 2014).

Several factors contribute to the challenges faced in biology education. Research by Ofoegbu (2013) and Ige (2019) has identified issues such as time constraints, large class sizes, and inadequate facilities as hindrances to effective teaching and learning. Furthermore, traditional teaching methods, characterized by teacher-centered approaches and rote memorization, have been criticized for their inefficacy in imparting complex biological concepts (Young, 2016). Consequently, there is a growing recognition of the need for innovative instructional strategies to enhance biology education outcomes.

Multimedia instruction has emerged as a promising approach to address the shortcomings of traditional teaching methods. With its ability to integrate various media formats such as text, graphics, videos, and animations, multimedia instruction offers opportunities for interactive and engaging learning experiences (Akude, 2014). According to Heinich, Molenda, Russell, and Smaldino (2012), multimedia instruction stimulates learners' senses and facilitates deeper understanding compared to traditional instructional methods. Moreover, multimedia technology aligns with the cognitive theory of multimedia learning, which posits that learners process information more effectively when presented through multiple sensory channels (Ahmed, 2013).

While the potential benefits of multimedia instruction in biology education are evident, empirical evidence on its effectiveness, particularly in the Nigerian context, is limited. Furthermore, factors such as gender and school location may influence students' response to multimedia instruction (Okeke, 2017; Ezema, 2012). Therefore, there is a need for research that explores the impact of multimedia instruction on students' achievement in biology, considering contextual factors such as gender and school location.

This study aims to investigate the effect of multimedia instruction on students' achievement in biology in public senior secondary schools in the Agbani Education Zone of Enugu State, Nigeria. By examining the relationship between multimedia instruction and academic achievement, as well as the moderating effects of gender and school location, this research seeks to contribute to the existing body of knowledge on effective instructional strategies in biology education. Through rigorous empirical analysis, this study endeavors to provide insights that can inform educational policies and practices aimed at enhancing biology education outcomes in Nigeria.

Statement of the Problem

Even though biology is a crucial science subject, the way it is now taught in schools leaves much to be desired. In secondary schools in Nigeria, student performance in biology has remained persistently low throughout time. Students' lack of interest, bad teaching techniques, and their propensity to remember knowledge rather than understand it are a few variables that contribute to this low success. The underperformance of rural children in biology may also be caused by an imbalance in the allocation of teaching and learning resources, which appears to favor urban schools over their rural counterparts. Another reason is the difference in gender roles, where men

are more likely to pursue difficult courses like biology while women are more likely to pick occupations that support marriage and family.

By employing efficient teaching strategies and running educational campaigns to pique students' interests and aid learning, educators have been working to increase students' biology success. However, despite these initiatives, students still have difficulty with the topic. This condition emphasizes the need for more efficient teaching strategies that can raise students' biology achievement. As a result, the study's research question is: How beneficial is the employment of a multimedia package as an instructional method in raising students' biology achievement? The study will also look into how the achievement of learners in biology utilizing multimedia instruction is influenced by gender and school location.

Purpose of the study

The main objective of this research is to examine the effect of using multimedia instruction on students' academic achievement in Biology in public secondary schools within the Agbani Education Zone. The study specifically aimed to determine the following:

1. The mean achievement scores of students who were taught Biology topics using multimedia instruction compared to those taught through the traditional lecture method.
2. The mean achievement scores of students from rural and urban areas who were taught Biology topics using multimedia instruction.
3. The interaction effects of the instructional method and the location of the school on students' achievement in Biology.

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of students taught Biology topics using multimedia instruction and those taught using lecture method?
2. What are the mean achievement scores of rural and urban students taught Biology topics using multimedia instruction?
3. What are the interaction effects of method and location on students' achievement in Biology?

Hypotheses

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

1. There is no significant difference in the mean achievement scores of students taught Biology topics using multimedia instruction and those taught with lecture method.
2. There is no significant difference in the mean achievement scores of rural and urban students taught Biology topics using multimedia instruction
3. There is no significant interaction effect of methodology and location on students' achievement scores in Biology.

REVIEW OF RELATED LITERATURE

This study reviewed related literature which throws more light on the problem under investigation.

Conceptual framework

1. Teaching and Learning Biology in Nigerian Secondary Schools: Teaching and learning biology in Nigerian secondary schools is pivotal for nurturing scientifically literate individuals and fostering societal progress. The dynamic and objective nature of science emphasizes the exploration of natural phenomena through active inquiry

and investigation (Nwosu, 2011). Biology, as a branch of science, plays a significant role in understanding life forms, their structures, functions, and interactions with the environment. It offers foundational knowledge and skills in life sciences, promoting economic development, poverty reduction, and social welfare (Nwagbo, 2015). Despite its broad scope, biology shares fundamental concepts such as the cell as the basic unit of life, genes as the unit of heredity, and evolution as the driving force behind species diversity (Magna, 2012). Moreover, it emphasizes energy transformation and homeostasis as essential processes for organism survival.

Effective biology education in Nigerian secondary schools necessitates knowledgeable teachers and student-centered approaches. Teachers must possess a deep understanding of biological concepts and current research to deliver accurate information (Nwosu, 2011). Interactive teaching methods, including demonstrations, experiments, and multimedia resources, engage students actively in the learning process, fostering critical thinking and problem-solving skills (Yusuf & Afolabi, 2010). Integration of educational technologies such as computer simulations and virtual labs enhances learning experiences and facilitates complex concept comprehension (Nwosu, 2011). However, challenges like poor academic performance, inadequate infrastructure, and limited teacher competence hinder effective biology education (Bramoh & Okadeyi, 2011). Addressing these challenges and promoting a positive learning environment are crucial for enriching biology education and inspiring student interest in the life sciences.

Quality teaching in biology not only imparts subject knowledge but also cultivates scientific literacy and drives economic productivity for sustainable development (Oriahi, 2010). Effective teachers possess a strong knowledge base, employ student-centered approaches, and create supportive learning environments where students are encouraged to actively participate and inquire (Nwosu, 2011). Moreover, they integrate technology, utilize appropriate assessment strategies, and provide access to resources to enhance student learning experiences (Bramoh & Okadeyi, 2011). Professional development opportunities for teachers ensure continuous improvement and alignment with evolving educational practices (Oriahi, 2010). Additionally, addressing factors affecting academic achievement, such as socioeconomic status and parental involvement, contributes to improving biology education outcomes (Yusuf & Afolabi, 2010). Overall, fostering a positive learning environment and employing effective teaching strategies are essential for enhancing biology education in Nigerian secondary schools and nurturing the next generation of scientists and informed citizens.

2. Academic Achievement in Nigerian Secondary Schools: Academic achievement in Nigerian secondary schools is a multifaceted concept encompassing students' attainment of educational goals, knowledge, skills, and competencies across various subjects and disciplines (Cole & Baker, 2013). It reflects the effectiveness of teaching and learning processes, as well as the overall educational outcomes of students, teachers, and educational institutions. Academic achievement extends beyond grades or scores to include critical thinking skills, problem-solving abilities, creativity, and analytical thinking (Cole & Baker, 2013). Factors influencing academic achievement range from socioeconomic status and parental involvement to effective teaching methods and student motivation (Jimoh, 2014). Addressing these factors is crucial for improving academic outcomes and fostering a positive learning environment.

Poor academic achievement among students in Nigerian secondary schools can be attributed to various factors, including socioeconomic status, inadequate school resources, ineffective teaching methods, and lack of student engagement (Jimoh, 2014). Socioeconomic status influences access to resources, healthcare, and home environments, impacting students' academic performance (Jimoh, 2014). Insufficient school resources, such as

outdated textbooks and facilities, hinder students' learning experiences and impede academic progress (Jimoh, 2014). Additionally, ineffective teaching methods and a lack of student engagement contribute to low academic achievement, emphasizing the importance of student-centered approaches and interactive learning strategies (Jimoh, 2014). Addressing these factors requires collaborative efforts from educators, policymakers, and parents to create supportive learning environments and provide equal opportunities for all students.

Improving academic achievement in Nigerian secondary schools requires targeted interventions and support systems addressing various factors influencing student performance (Jimoh, 2014). Enhancing parental involvement, providing adequate school resources, implementing effective teaching methods, and promoting student engagement are essential strategies for improving academic outcomes (Jimoh, 2014). Additionally, recognizing the diverse needs and backgrounds of students and providing personalized support and interventions can facilitate academic success (Jimoh, 2014). By addressing these factors and fostering a positive learning environment, Nigerian secondary schools can enhance academic achievement and provide students with the knowledge, skills, and

3. Multimedia Instruction as Pedagogy for Teaching Biology: Multimedia instruction offers a versatile and engaging approach to teaching biology, leveraging a combination of text, images, audio, video, and interactive elements to enhance the learning experience (Fenriich, 2017). By incorporating various media formats, multimedia instruction caters to diverse learning styles and preferences, making complex biological concepts more accessible and comprehensible to students (Philips, 2017). This pedagogical approach transforms traditional biology classrooms into dynamic learning environments where students actively engage with multimedia content to deepen their understanding of biological phenomena.

One of the key advantages of multimedia instruction in biology is its ability to make the learning process more goal-oriented, participative, and adaptable to individual needs (Philips, 2017). Students have the flexibility to learn at their own pace and in their preferred learning environment, whether in the classroom or at home. Additionally, multimedia instruction transcends geographical barriers, allowing students to access learning resources regardless of their location. By combining text, images, animations, and videos, multimedia instruction stimulates student interest and motivation, leading to enhanced learning outcomes (Fenriich, 2017). Moreover, the interactive nature of multimedia allows students to take control of their learning experience, promoting active engagement and collaboration with peers and teachers.

Multimedia instruction also facilitates collaborative learning environments in biology classrooms, where students work together to explore and understand complex biological concepts (Philips, 2017). Teachers can utilize multimedia tools to create interactive activities, simulations, and virtual labs that encourage collaborative problem-solving and critical thinking (Fenriich, 2017). Moreover, multimedia instruction empowers teachers to adopt a facilitator role, guiding students through the learning process and providing personalized support as needed. By harnessing the power of multimedia, biology educators can create immersive and interactive learning experiences that inspire curiosity, creativity, and a lifelong passion for science among students.

4. Strengths of Multimedia Usage in Education: Multimedia usage in education offers numerous strengths and benefits for both educators and students. One of the key advantages is its ability to cater to diverse learning styles and preferences, enhancing the accessibility and comprehensibility of educational content (Oshinike & Adekumisi, 2012). By incorporating multiple media formats such as text, images, audio, and video, multimedia instruction provides a rich and dynamic learning experience that engages learners on various levels. This

versatility allows educators to create customized learning experiences tailored to the individual needs and preferences of their students.

Another strength of multimedia usage in education is its capacity to promote active learning and student engagement (Neo & Neo, 2020). Interactive multimedia tools and resources encourage students to actively participate in the learning process, rather than passively consuming information. For example, interactive simulations, virtual labs, and educational games enable students to explore complex concepts through hands-on experimentation and exploration. This active engagement fosters deeper understanding, critical thinking, and problem-solving skills among students.

Furthermore, multimedia usage in education facilitates flexible and personalized learning experiences (Asogwa, 2019). With the advent of digital technologies and online platforms, educational content can be accessed anytime, anywhere, allowing students to learn at their own pace and convenience. Multimedia resources also enable educators to differentiate instruction to meet the diverse needs and abilities of their students. For instance, multimedia presentations can be adapted to accommodate visual, auditory, and kinesthetic learners, ensuring that all students have equal opportunities to succeed. Overall, the strengths of multimedia usage in education lie in its ability to enhance accessibility, engagement, and flexibility, ultimately enriching the teaching and learning experience for all stakeholders.

5. Influence of School Location on Academic Achievement:

The influence of school location on academic achievement, particularly in the context of rural and urban settings, is a topic of significant interest and debate in educational research (Lackney, 2014). School location refers to the geographic placement of a school within its surrounding environment, whether in a rural or urban area, and encompasses various factors such as access to resources, community demographics, and educational opportunities (Igbeyin, 2012). Urban areas typically have more extensive social amenities and educational resources compared to rural areas, which can impact students' academic performance. Research on the relationship between school location and academic achievement has produced mixed findings, with some studies suggesting a positive association between urban school environments and higher academic outcomes, while others highlight the challenges faced by rural schools in providing quality education.

The disparities in academic achievement between rural and urban schools can be attributed to several factors, including differences in resource allocation, teacher quality, infrastructure, and community support (Lackney, 2014). Urban schools often have access to more funding, qualified teachers, advanced technology, and extracurricular opportunities compared to their rural counterparts. These advantages contribute to a more conducive learning environment and better academic outcomes for students in urban schools. In contrast, rural schools may struggle with limited resources, teacher shortages, inadequate infrastructure, and isolation, which can negatively impact student performance.

However, it is essential to recognize that the influence of school location on academic achievement is complex and multifaceted. While urban schools may have certain advantages, such as access to more resources and opportunities, they also face challenges such as larger class sizes, cultural diversity, and socioeconomic disparities among students (Igbeyin, 2012). In contrast, rural schools may offer a more close-knit community environment, personalized attention, and a slower pace of life, which can have positive effects on student well-being and engagement. Thus, the relationship between school location and academic achievement is influenced by a combination of factors that vary depending on the context.

Understanding the impact of school location on academic achievement is crucial for policymakers, educators, and stakeholders in education to develop targeted interventions and allocate resources effectively. By addressing the unique needs and challenges faced by schools in both rural and urban areas, policymakers can work towards promoting equitable access to quality education for all students, regardless of their geographical location.

6. Ways of Promoting Balanced Learning in Science among Schools in Rural and Urban Areas: Promoting balanced learning in science among schools in both rural and urban areas requires a strategic approach that addresses the specific challenges and opportunities present in each context. Here are some effective strategies for promoting balanced learning in science:

Promoting Balanced Learning in Rural Schools:

1. **Access to Resources:** Ensure that rural schools have access to basic infrastructure and resources necessary for science education, such as laboratories, textbooks, and scientific equipment. Collaborate with local communities and organizations to bridge resource gaps and provide necessary support.
2. **Practical Application:** Emphasize hands-on and practical learning experiences in rural schools by utilizing locally available resources and examples. Engage students in fieldwork and outdoor activities to explore scientific concepts in their natural environment.
3. **Community Engagement:** Foster community involvement in science education by inviting local experts and professionals to share their knowledge and experiences with students. Establish partnerships with local organizations to support science-related initiatives and activities.
4. **Teacher Training:** Provide professional development opportunities for science teachers in rural schools to enhance their teaching skills and subject knowledge. Offer training workshops, mentoring programs, and access to resources to support effective science instruction.
5. **Technology Integration:** Leverage technology to enhance science education in rural schools by utilizing online resources, educational software, and virtual laboratories. Provide students with access to digital tools and platforms to supplement their learning experiences.

Promoting Balanced Learning in Urban Schools:

1. **Real-World Connections:** Emphasize the relevance of science to students' everyday lives by connecting scientific concepts to urban issues and challenges. Encourage students to explore local environmental issues and propose solutions through scientific inquiry and investigation.
2. **Inquiry-Based Learning:** Promote inquiry-based learning approaches that encourage students to ask questions, design experiments, and explore scientific phenomena independently. Provide opportunities for hands-on experimentation and exploration in urban school settings.
3. **Collaboration and Partnerships:** Foster collaborations with local universities, research institutions, and industries to provide students with access to mentorship, internships, and experiential learning opportunities. Engage experts from various scientific fields to support student learning and exploration.
4. **STEM Programs:** Establish STEM programs, clubs, and competitions in urban schools to promote student engagement and interest in science, technology, engineering, and mathematics. Provide opportunities for students to participate in hands-on projects, competitions, and innovation challenges.
5. **Digital Resources:** Utilize digital resources and online platforms to enhance science instruction in urban schools. Incorporate multimedia resources, virtual simulations, and interactive tools to supplement classroom learning and provide students with access to diverse learning experiences

Theoretical Framework

The study's theoretical framework was based on the cognitive theory of multimedia learning, which was popularized by Mayer. This theory posits that multimedia enhances the learning process by leveraging how the human brain learns. According to Mayer, individuals gain a deeper understanding when information is presented in a combination of words and pictures, as opposed to words alone. This phenomenon is known as the multimedia principle (Mayer, 2005). Scholars in the field generally define multimedia as the integration of text and visual elements. The process of multimedia learning involves constructing mental representations based on these words and pictures (Mayer, 2005). The words can be presented orally or in written form, while the pictures can encompass various graphical formats, such as illustrations, photographs, animations, or videos. By drawing from cognitive research, multimedia instructional design aims to effectively combine words and pictures to optimize the learning experience.

According to Mayer's cognitive theory of multimedia, learning is an active process that involves the integration of information from different sensory channels, such as visual and auditory. The theory proposes several principles or guidelines for designing effective multimedia learning materials:

1. **Multimedia Principle:** People learn better from words and pictures combined than from words alone. Presenting information in a multimedia format that includes relevant visuals (e.g., images, diagrams, animations) alongside spoken or written explanations can enhance learning and retention.
2. **Modality Principle:** People learn better when information is presented in their preferred mode of representation. For example, presenting information visually for spatial learners or using spoken explanations for auditory learners can improve learning outcomes.
3. **Coherence Principle:** People learn better when extraneous or irrelevant material is excluded from multimedia presentations. Eliminating unnecessary or distracting elements helps learners focus on the essential content and promotes cognitive processing.
4. **Redundancy Principle:** People learn better when information is presented in a complementary manner rather than duplicating it across multiple channels. Avoiding redundant presentation of information reduces cognitive load and prevents cognitive overload.
5. **Signaling Principle:** People learn better when important information is highlighted or signaled. Using cues, such as arrows or highlighting, to draw attention to essential concepts or relationships can aid learners' understanding and retention.
6. **Personalization Principle:** People learn better when multimedia materials are presented in conversational style or with a human voice rather than a formal style. Adding a personal touch to instructional materials can enhance learners' engagement and motivation.

These principles are grounded in cognitive theories of learning and memory, such as cognitive load theory and dual-coding theory. The cognitive theory of multimedia learning provides valuable insights for instructional designers, educators, and multimedia developers to create effective multimedia learning experiences that optimize learning outcomes.

The cognitive theory of multimedia learning developed by Mayer can have implications for the utilization of multimedia in teaching biology to improve students' academic achievement. This theory emphasizes the

importance of incorporating both words and visuals in multimedia presentations to enhance learning outcomes. When applied to the teaching of biology, the cognitive theory of multimedia learning suggests that combining textual explanations with relevant visuals, such as diagrams, illustrations, animations, and videos, can facilitate deeper understanding of biological concepts. By presenting information through multiple channels, learners can build mental connections and create coherent mental representations of the subject matter.

Multimedia presentations in biology can leverage the multimedia principle, which posits that learners gain a deeper understanding when information is presented in a combination of words and pictures. By integrating textual explanations with visually rich content, students can better grasp complex biological processes, structures, and relationships. Moreover, the cognitive theory of multimedia learning highlights the importance of reducing extraneous or irrelevant material to minimize cognitive load. In the context of teaching biology, this means focusing on essential content and avoiding unnecessary visual or textual elements that may distract or overload students' working memory. By streamlining multimedia presentations, educators can help students concentrate on the most important aspects of biological concepts.

The theory also emphasizes the active processing assumption, suggesting that students construct knowledge by actively engaging with the presented material. In biology education, this can be achieved by incorporating interactive multimedia elements that allow students to manipulate virtual models, conduct virtual experiments, or engage in problem-solving activities. Such interactive multimedia can promote active learning, critical thinking, and the application of biological concepts. By aligning instructional design in biology with the cognitive theory of multimedia learning, educators can create engaging and effective multimedia resources that promote students' understanding, retention, and application of biological knowledge. However, it is important to consider individual differences and adapt instructional strategies to meet diverse learning needs and preferences.

Empirical Studies

Effect of Multimedia Instruction on Achievement

A study conducted by Athanassios and Vassillis (2011) examined the impact of computer animation on students' academic achievements in core sciences. In order to do this, a study with two equal groups was created, each with twenty female students: the group participating in the experiment and the control group. While the second group received the identical lecture using the conventional approach, which employs the dialog & discussion technique, they were considered as the control group. The first group received the lecture using a computer presentation application that incorporates multimedia as an experimental group. Pre- and post-tests were given to both groups on the lecture's topic. No statistically significant differences were found in the study of the pretest results, demonstrating the equality of the two groups. At the same time, the post-test analysis result revealed the following: At a significance level of 0.05, differences between the experimental group and the control group are statistically significant in favor of the experimental group. This research is comparable to the current work in that both looked at the impact of multimedia on students' academic performance, but it is distinct from the current work in terms of study area and emphasis.

In a similar vein, Akpınar and Errgin (2018) studied the use of interactive multimedia to improve primary school pupils' comprehension of cells and related concepts. The pretest posttest groups design was the one employed for the investigation. Lower Basic 2 (JSII) pupils made up the population. 2216 JSII mathematics students made up the population during the 2017–2018 school year. The sample consisted of 92 JSII pupils from two different schools who were chosen at random from their complete classrooms. The study's equipment included a math

aptitude test and an interest survey. The instruments' validity was established by specialists, and their reliability was evaluated using the test-retest approach. At a significance level of 0.05, the obtained data were analyzed using the mean, standard deviation, and analysis of covariance. The outcomes showed that students who were taught via multimedia had much greater performance than their counterparts. It's worth noting that this study focused on primary school students, while the current research pertains to secondary school students, distinguishing the two in terms of the level and scope of investigation.

In research published in 2010, Channg, Quintana, and Krajcik investigated how middle school students' comprehension of the particulate nature of matter was affected by the creation and assessing of multimedia molecular animations. A quasi-experimental approach with pretest and posttest evaluations was used in the investigation. Three treatment groups were randomly allocated to eight classrooms, totaling 271 pupils. Students in the first group created, analyzed, and evaluated animations using Chemation. The third group saw and analyzed teacher-made animations, while the second group solely created and understood animations. Seventh-grade students were given the opportunity to make straightforward flipbook-like movies of chemical models and dynamic processes using Chemation, a learner-centered animation platform. The effects of the interventions on students' posttest performance as well as their created animations and interpretations during class were examined using a two-factor analysis of covariance. To account for potential biases relating to students' past knowledge and its impact on their learning results, pretest data was utilized as a covariate. The findings showed that using instructional animation to improve student learning was successful when done in conjunction with peer review. However, compared to letting them see animations, it was unsure how effective it would be to only let them develop animations without peer review. In comparison to the present study, the previous research involved students in the construction of the animations used, which differs from the current study.

In a related research, Miri and Yehudit (2011) looked at the incorporation of a web-based animated mouse into the scientific curriculum for elementary schools and its effects on the learning results of the children. The research strategy for the study used a quasi-experimental pretest-posttest format. In all, 1,010 Turkish students in grades four and five made up the sample, which also included fifteen instructors. Oral interviews were done in addition to informal chats with the 1010 students and fifteen instructors to gather data. The data were analyzed using analysis of covariance. The participants were split into two groups: control and experimental. The experimental group used animated movies and supplemental exercises at least once a week, while the control group learned science via textbooks and still images. According to the research, animated films encouraged the employment of a variety of teaching methodologies and learning techniques while also encouraging students to apply a range of thinking abilities. The animations were found to promote scientific thinking, improve scientific language learning, and increase scientific interest. It is important to note that while the present study included secondary school children, the previous research concentrated on pupils in elementary schools. However, a pretest-posttest study approach was used in both investigations.

Studies on School Location

The location of the school has been identified as one of the factors that affect learning. Owwoeye and Yara (2010) conducted a study to investigate the impact of school location on the academic achievement of secondary school students in Ekiti State. The study utilized the previous results of the students, specifically the 1990-1997 West African School Certificate Examinations (WASCE) results from senior secondary schools in both rural and urban areas as the population for the study. A Student Location Questionnaire (SLQ) was used as the data collection

instrument. The findings of the study revealed significant differences in academic achievement between rural and urban secondary schools in the senior school certificate examinations. Based on the reviewed results, the study demonstrated that students in urban areas outperformed their rural counterparts academically. The present study is interested in Owoeye and Yara's work because it aims to explore the effect of location on academic achievement.

Similarly, Omachonu (2018) conducted a study to examine the influence of school location on students' achievement. The study was guided by one research question and two null hypotheses. A quasi-experimental research design with a nonequivalent control group was employed. The sample consisted of 304 Junior Secondary School (JS III) students selected from eight intact classes in the Idah Education Zone of Kogi State, Nigeria. Pre-test and post-test assessments were administered to both the treatment and control groups. An Oral English Achievement Test (OEAT) comprising 60 items was used to collect the data. Mean, standard deviation, and Analysis of Covariance (ANCOVA) at a significance level of 0.05 were employed to analyze the collected data. The findings of the study indicated that school location had an influence on students' achievement. This study is relevant to the present research due to its findings on the relationship between teaching method, location, and achievement, as these variables are also of interest in the present study

Research Methodology

Research Design: The study employed a quasi-experimental research design, specifically utilizing a non-equivalent control-group design. This design was chosen because random assignment of subjects to experimental and control groups was not feasible, and intact groups were utilized instead.

Study Area: The research was conducted in Agbani Education Zone, located in Enugu State, Nigeria. This zone comprises urban and rural areas and is equipped with modern amenities, making it suitable for the study.

Population of the Study: The study population consisted of 2,927 Biology students in their second year of senior secondary school (SS 2) across 45 public secondary schools in Agbani Education Zone.

Sample and Sampling Technique: A total of 300 respondents were selected as the sample for the study using multi-stage sampling. Four schools were purposively selected, and intact classes were utilized without further sampling. Random sampling was used to assign schools to the experimental and control groups.

Instrument for Data Collection: The data collection instrument was the Biology Achievement Test (BAT), consisting of 30 multiple-choice items. The test was developed by the researcher and underwent validation by specialists.

Validation of the Instrument: The BAT underwent validation by three specialists who assessed its face and content validity. Suggestions for improvement were implemented, and the revised version was used in the study.

Reliability of the Instrument: The reliability of the BAT was estimated using the Kuder Richardson Formula (KR-20) and found to be 0.72, indicating reliability.

Experimental Procedure: The experimental group received multimedia instruction, while the control group received conventional teaching. Training was provided to research assistants, and treatments were administered over three weeks following the school's regular timetable.

Control of Extraneous Variables: Strategies such as avoiding experimenter bias, addressing non-randomization effects using ANCOVA, minimizing the testing effect, avoiding Hawthorne effects, and controlling the teacher variable were implemented to control extraneous variables.

Method of Data Collection: The BAT was administered as a pretest and posttest to both experimental and control groups by their respective Biology teachers.

Method of Data Analysis: Mean and standard deviation scores were calculated to address research questions, while two-way Analysis of Covariance (ANCOVA) was used to test hypotheses at a significance level of 0.05. A p-value less than 0.05 indicated rejection of the null hypothesis.

RESULTS

Research Question One: What are the mean achievement scores of students taught Biology topics using multimedia instruction and those taught using lecture method?

Table 1:

Mean and standard deviation of achievement scores of students taught Biology topics with multimedia instruction and those taught with lecture method

Group	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
Multimedia Instruction	155	13.02	7.08	64.15	14.39	51.13
Lecture method	145	10.21	5.05	26.49	9.78	16.28

According to Table 1, the students who received Biology instruction using multimedia achieved a mean score of 64.15 with a standard deviation of 14.39 on the post-test. In contrast, the students taught using the lecture method obtained a mean score of 26.49 with a standard deviation of 9.78. The mean gain scores for the two groups were 51.13 and 16.28, respectively. These results indicate that students who were taught Biology topics with multimedia instruction performed better than their counterparts in the lecture method group.

Research Question two: What are the mean achievement scores of rural and urban students taught Biology topics using multimedia instruction?

Table 2: Mean and standard deviation of achievement scores of rural and urban students taught Biology topics using multimedia instruction

Gender	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
Rural	135	9.51	7.10	42.81	21.53	33.30
Female	165	13.54	4.28	48.33	21.88	34.79

67

Table 2 reveals the achievement mean scores of rural and urban students taught Biology topics. It shows that rural students had post-test mean achievement score of 42.81 with a standard deviation of 21.53 while their urban counterparts had post-test mean achievement score of 48.33 with a standard deviation of 21.88. Mean gain scores of 33.30 and 34.79 for the rural and urban students respectively indicated that urban students achieved higher than their rural counterparts.

Research Question 3: What are the interaction effects of method and location on students’ achievement in Biology?

Table 3 Mean and standard deviation of students according to method and school location on students’ scores in Biology topics.

Method	School location	Mean	SD
Conventional method	Urban	22.78	9.63
	Rural	20.71	9.47
Project-based method	Urban	27.06	10.65
	Rural	26.74	10.03

Table 3 shows that in the conventional group, both the urban and rural mean scores were different (22.78 and 20.71) for urban and rural students respectively. Their standard deviation also differed slightly from each other. The results also show that in the multimedia instruction groups, students in urban schools had a mean score of 27.06 with a standard deviation of 10.65 while their rural counterparts scored 26.74 with a standard deviation of 10.05. This indicate that students in urban schools scored higher in Biology topics when taught using lecture or multimedia instruction. The values of the standard deviation further showed that the scores of the students in urban schools were less homogenous when compared to standard deviation of the rural school counterparts.

Test of Hypothesis

H₀₁: There is no significant difference in the mean achievement scores of students taught Biology topics using multimedia instruction and those taught with lecture method.

Table 4: Analysis of Covariance of the effect of multimedia instruction on students’ achievement in Biology topics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	35337.604 ^a	2	17668.802	110.736	.000
Intercept	46426.887	1	46426.887	290.971	.000
PRETEST	5.391	1	5.391	.034	.855
EXPERIMENT	33806.669	1	33806.669	211.877	.000
Error	15477.146	145	159.558		
Total	266575.000	154			
Corrected Total	50814.750	299			

a. R Squared = .695 (Adjusted R Squared = .689)

The analysis of data in Table 4 shows that the probability associated with the calculated value of F (211.877) for the effect of multimedia instruction on students’ achievement in Biology topics is 0.000. Since the probability value of .000 is less than the .05 level of significance ($p < .05$), the null hypothesis was rejected. Thus, there is a significant difference between the mean achievement scores of the students taught Biology with multimedia instruction and those that are taught with the lecture method in favour of the experimental group.

H₀₂: There is no significant difference between the mean achievement scores of rural and urban students taught Biology topics with multimedia instruction

Table 5: Analysis of Covariance of the effect of multimedia instruction on rural and urban students’ achievement in Biology topics

Source	Type Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1814.638 ^a	2	924.238	1.782	.173
Intercept	34878.081	1	34578.81	69.024	.000
PRETEST	1237.244	1	1237.244	2.449	.123
LOCATION	269.710	1	269.710	.541	.458
Error	49210.105	105	505.300		
Total	26565.000	194			
Corrected Total	50814.750	299			

a. R Squared = .045 (Adjusted R Squared = .018)

Table 5 shows that the probability associated with the calculated value of F (.541) for the mean achievement scores of the rural and urban students taught Biology topics with multimedia instruction is 0.458. Since the probability value of 0.381 is greater than 0.05 level of significance ($p > .05$), the null hypothesis was accepted. Thus, location has no significant influence on the achievement of students in Biology topics.

H₀₃: There is no significant interaction effect of method and school location (urban and rural) on mean achievement scores of students in Biology.

Table 6: ANCOVA of interaction effect of method and school location on the mean Achievement scores of students in Biology.

Source	Type II sum of squares	Df	Mean Square	F	Sig
Corrected	6964.90	4	1733.91	20.71	0.00
Intercept	16115.93	1	16370.15	195.49	0.00
Pretest	4636.80	1	4854.40	57.97	0.00
Location	10.73	1	1997.91	23.85	0.00
Method	1601.57	1	71.09	0.85	0.36
Location x method	751.44	1	68.82	0.82	0.37
Error	24673.77	295	83.74		
Total	211224.00	300			
Corrected total	31638.67	299			

The results of table 6 show that the probability value for the calculated F (0.82) is 0.37. The probability value is greater than the 0.05 level of significance. Thus, the null hypothesis is accepted this implies that there is no significant interaction effect of method and school location on students' achievement in Biology.

Discussion of Findings

The discussion of finding was organized under the specific purposes of the study as follows:

Achievement Scores of Students taught Biology with Multimedia Instruction and lecture method

Table 1 displays the results indicating that students who were taught Biology using multimedia instruction achieved higher mean scores in the post-test compared to students taught through lecture method. The significant difference in achievement between the experimental and control groups, as confirmed by table 5, demonstrates that the use of multimedia instruction had a notable impact on students' Biology achievement. This finding aligns with Usman & Esaduha (2017), who emphasized the use of e-learning to enhance learning and improve student performance. Similarly, Ezome (2013) stated that subsets of e-learning, such as ICT, have greatly improved and facilitated the development of instructional materials for teaching and learning. The effective presentation of information through computers, particularly in a PowerPoint environment, has been beneficial. Kadiri (2012) also asserted the importance of ICT in today's world and its instructional roles, including providing various multimedia resources for learners, making learning more engaging, and incorporating technology into the learning process. Therefore, the adoption of multimedia instruction in teaching and learning is highly recommended. Additionally, Fakae (2014) stated that computer applications are widely used in education at all levels and extensively employed in scientific research for solving biological problems. The use of multimedia instruction can address the issue of poor achievement in Biology among students. Furthermore, Etukudo (2012) demonstrated that students exposed to computer software packages outperformed those exposed to traditional classroom instruction, highlighting the value of incorporating software packages in teaching.

The findings of this study are particularly valuable for Biology teachers, as they align with the views of Okeke & Anakpue (2010) who emphasized the importance of Biology in national development. According to these researchers, Biology plays a crucial role in understanding national problems, and encouraging the use of simple biological models can contribute to solving certain national issues.

Effect of multimedia instruction on Achievement of Rural and Urban Students in Biology

The results of this study indicate a significant difference in achievement between urban and rural students, with urban students outperforming their rural counterparts in Biology. This finding is consistent with Alokun's (2013) study, which revealed a significant difference in Biology achievement between rural and urban schools, favoring urban schools. Additionally, Ayub, Yunus, Mahmud, Salim, and Suleiman (2017) also discovered significant differences in Biology achievement between rural and urban schools, with urban schools having the advantage.

The higher achievement observed in urban schools may be attributed to the availability of numerous facilities that are lacking in rural schools. This finding contradicts the conclusions of Genshenson and Langbein (2015), who found no direct impact of school location on Biology achievement between urban and rural students. The superior performance of urban students could be due to factors such as the absence of relevant facilities in rural schools, students' lack of interest and motivation, as many of them spend school hours engaged in farm work or running errands in the local market. Consequently, students from rural schools, who may possess similar learning abilities as their urban counterparts, are hindered by various factors that impede their academic achievement.

Interaction effects of Method and School Location on Students Achievements

The results of this study indicate that there is no significant interaction effect between the teaching method and school location on the mean achievement scores of secondary school students in Biology. These findings suggest that the use of multimedia instruction in teaching Biology improves the achievement of students in both rural and urban areas. The absence of an interaction effect between the method and school location on students' achievement aligns with the findings of Agwu (2014), who similarly reported no significant interaction effect between instructional approach and school location on students' science achievement. This provides evidence that multimedia instruction is superior to the lecture method regardless of whether the school is located in an urban or rural area. It implies that the higher achievement observed in the experimental group cannot be attributed to the school location.

Conclusions

Based on the results of this study, the following conclusions were made.

The use of Multimedia instruction increased students' achievement Biology more than the lecture method. Students taught Biology using the multimedia instruction performed higher than their counterparts taught the same Biology using the lecture method. There was a significant difference in gender on achievement of students in Biology. The achievements of both male and female students were enhanced as a result of the use of the multimedia package. The findings showed that a significant difference did exist between the achievement of Biology students in urban and rural schools in favour of the urban students. The interaction effect was not significant in terms of achievement.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Biology teachers should incorporate the use of multimedia projection software packages in their teaching of Biology topics, as it has been shown to enhance students' achievement in Biology.
2. School principals, as representatives of the government in their respective schools, should prioritize providing and equipping Biology and Computer laboratories. This will facilitate more effective teaching methods that promote students' understanding, particularly through the utilization of multimedia projection and screen viewing.
3. The government should organize in-service training, workshops, and conferences to enable teachers to master the production and use of Computer-Aided Learning (CAL) packages for each concept in Biology. Simply providing computers is not enough, as CAL packages have been proven effective by other researchers. Given the effectiveness of CAL identified in this study, it is crucial to train teachers in the production and implementation of multimedia instruction.
4. Professional bodies such as the Science Teachers Association of Nigeria (STAN), Biological Association of Nigeria (BAN), and Computer Association of Nigeria (CAN) should include e-learning and multimedia instruction in their annual conferences. This will enable teachers to learn and incorporate these techniques into their teaching practices.

References

Adegoke, B. A. (2011). Effect of multimedia instruction on senior secondary school students' achievement in physics, *European Journal of Educational Studies* 3(3), 537

- Ahmed, A. F. (2013). Influence of gender on students learning and academic performance. *Journal of social science*, 5(4) 340-345.
- Ahmed, M. A., & Abimbola, I. O. (2011). Influence of teaching experience and school location on biology teachers' rating of the difficult levels of nutrition concepts in Ilorin, Nigeria. *JOSTMED*, 7(2), 52-61
- Ajayi, D. O. (2018). *Community science: Implications for science teacher*: Proceeding of the 39th Annual Conference of STAN.
- Akude, I. (2014). *A handbook of educational technology*. Owerri: Boma Way Publishers.
- Asogwa, U. (2019). Effect of powerpoint presentations on secondary school students' achievement in Christian religious knowledge. *International Journal of Educational Research*, 11(1)
- Ezema, P.A. (2012). *Strategies for writing effective essays: A guide in essay writing for students on secondary and tertiary institutions*, Enugu; Snaap press.
- Heinich, R., Molenda, M., Russell, J. D. & Smaldino, S. E. (2012). *Instructional media and technologies for learning*. 7th ed., Ohio: Meind Prentice Hall.
- Ige A. (2019): Strategies for improving biology teachers for optimum performance [online] available @ <http://en.oboulo.com/strategies-forimproving-biology-teachersforopt> .
- Lackney, A. (2014). Educational facilities: The impact and role of the physical environment of the school on teaching, learning and educational out Nwagbo, C. & Chikelu, U. (2016). Effect of biology practical activities on students' process skill acquisition. *Journal of the Science Teachers' Association of Nigeria*, 46(1),58 – 70.
- Nwagbo, C.R. (2016). Effect of two teaching methods on the achievement in and attitude to Biology of students of different levels of scientific literacy. *International Journal of Educational Research*. 216 – 229
- comes. *Center for Architecture and Urban Planning Research Books*. 10.
- Ofoegbu, T.O. (2013). Challenges of implementing senior secondary one (SS I) Biology curriculum in Nigeria. *Journal of the Science Teachers Association of Nigeria*, 38(8)
- Okeke, A.C. (2017). *Making science education accessible to all 23rd Inaugural Lecture of the University of Nigeria*. University of Nigeria Press.
- Okoro, A.U. (2011). Effect of interaction patterns on achievement and interest in biology among secondary school students in Enugu State Nigeria. *Unpublished M.Ed Thesis UNN Sc/Ed*.
- Pippert, T.D. & Moore, H. A. (2019). Multiple perspectives on multimedia in the large lecture. *Teaching Sociology*. (27), 92-109.

- Pryor, C. R. & Bitter, G. G. (2018). Using multimedia to teach in-service teachers: impacts on learning, application, and retention. *Computers in Human Behavior* (24), 2668-2681
- Quarcoo - Nelson, R., Buabeng,, I., & Osafo, D. K. (2012). Impact of audio-visual aids on senior high school students' achievement in Physics. *Eurasian Journal of Physics and Chemistry Education*, 4 (11), 46 - 54.
- Umar, A. A. (2011). Effects of biology practical activities on students' process skill acquisition in Minna, Niger State, Nigeria. *JOSTMED*, 7(2), 118–126.
- West African Examination Council. (2011). *Chief Examiners' reports*. Nigeria: WAEC
- Yeboah, A. E. (2014) Applying ict in Biology. *Unpublished project work*. University of Education, Winneba.
- Young, B.C.S (2016). Students' motivational orientations and their association with achievement in Biology. *Brunei International Journal of Science and Mathematics Education*. 1(1), 52 – 64.
- Yu-Hsin C, Ju-Tzu C., Deng-Jyi, C. (2012). The effect of multimedia computer assisted instruction and learning style on learning achievement. *WSEAS Transactions on Information Science and Applications*, 1(9), 24-35
- Yusuf, M. O. & Afolabi, A. O. (2010). Effects of computer assisted instruction (CAI) on secondary School students' performance in biology. *TOJET: The Turkish Online Journal of Educational Technology*.