

INTEGRATING TECHNOLOGICAL TOOLS IN TEACHING AND LEARNING CELL AS THE BASIC UNIT OF LIFE AMONG SECONDARY SCHOOL STUDENTS IN KATSINA CENTRAL ZONE, KATSINA STATE, NIGERIA

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ABSTRACT

The study investigated the effectiveness of using 3D computer-animated multimedia packages in teaching the cell as the basic unit of life to secondary school students in Katsina Central Zone, Nigeria. Four objectives, research questions and one null hypothesis were set up to guide the study. Using a concurrent mixed-methods design, the research sampled 278 senior secondary II students and all 22 biology teachers from a population of 976 students and 22 biology teaching staff. Data was collected through validated multimedia packages, questionnaires, achievement tests, and focus group discussions guide, achieving a reliability coefficient of 0.86. The researchers were able to retrieve 256 questionnaires which are valid for data analysis. Using SPSS analysis of simple frequency and percentages, mean and standard deviation, one-way t-test and ANOVA revealed that the multimedia packages significantly improved students' understanding, interest, and motivation, as well as positively influenced teachers' perceptions and attitudes. Additionally, there was evidence of long-term retention of cell concepts among students from their post-test scores. Based on these findings, the study recommends integrating interactive computer-animated media and educational videos alongside traditional teaching methods to enhance biology education.

Keywords: Integrating, technological tools, multi-media packages, teaching and learning, cell and cell division.

1. INTRODUCTION

Education is designed to fulfill the needs of society, and as society evolves, education must also adapt. Consequently, educational standards continually shift to address the changing needs of individuals and society, aligning with environmental realities and the modern world (FRN, 2004). Nigeria, like many other countries, is undergoing rapid social, economic, and political reforms, creating a need to align its educational system with current developmental objectives and the demands of globalization (NPE, 2013). In today's era of science and technology, traditional teaching methods often fall short of effectively engaging students and meeting their intellectual, psychological, and emotional needs. Therefore, a new approach to teaching biology is essential (Gracy, 2016).

Each child is unique in terms of needs, interests, abilities, learning style, comprehension capacity, maturity, past experiences, cultural background, readiness, and physical experiences. These differences must be considered to meaningfully impart knowledge, skills, and attitudes to all learners (Amadi, Iwu, and Onyemerekeya, 2001). To ensure that each student understands the content, it is necessary to use a variety of teaching strategies and resources. Additionally, there are variations in the subjects taught, the topics within each subject, and the objectives for each topic and subject. As a result, diverse teaching approaches are needed to achieve these goals effectively.

The International Society of Technology in Education (ISTE, 2024) states that ISTE Standards provide a framework to guide educators, leaders, and coaches in leveraging technology to create impactful, sustainable, scalable, and equitable learning experiences. These standards are widely adopted across the United States and in many countries worldwide. With the growing use of electronic resources in education, traditional textbooks are quickly becoming outdated, and the integration of technological tools is likely to boost students' interest, motivation, and achievement (Abanikannda, 2018). Educators recognize that merely knowing how to use technology is not enough; the key lies in effectively integrating these tools to enhance student learning (Doukakis et al., 2021). This is crucial, as the effective use of technology can significantly enrich the teaching and learning process.

Multimedia or digital learning resources help students build mental representations by using a variety of media elements that support information processing. These resources combine text, images, videos, and audio to present information, which can include content and learning activities. Research on multimedia learning has shown that students who learn

with a combination of images and words achieve better outcomes than those who use text alone (Chen & Liu, 2008; Mayer, 2008). Multimedia tools like animations, simulations, and interactive software have been shown to enhance student engagement and comprehension in cell biology. This was revealed in a study by Nwafor and Chukwu (2020) which found that students using multimedia tools to learn cell biology scored significantly higher on tests than those taught through traditional methods. Using animations to illustrate cellular processes, such as cell division, helps students better visualize and retain information, making complex concepts more accessible

As the cell is the basic structural and functional unit of life, forming the foundation for comprehending the complexities of living organisms, understanding cell in biology is essential for students. A solid grasp of cell as a topic provides students with fundamental knowledge of cell structure, function, and behavior. Olowe and Adekoya (2020) reported that "In Nigerian secondary schools, cell biology is a core component of the biology curriculum, typically introduced at the senior secondary level to prepare students for national exams like the West African Senior School Certificate Examination (WASSCE) and the National Examinations Council (NECO)".

Statement of the Problem

The widespread use of technological gadgets among adolescents has increased due to their affordability and easy access, making them highly popular. However, this trend has led many students to become distracted from their academic goals, as they spend more time on social media and entertainment platforms instead of focusing on their studies. The integration of technological tools in understanding cell at the secondary school level is necessary due to the limitations of traditional teaching methods, which often rely on static diagrams, textbooks, and limited laboratory experiments. These methods can make complex cellular concepts difficult for students to grasp fully, leading to a lack of engagement and a superficial understanding of the subject. Different students learn in different ways, while some may excel with traditional textbooks and lectures, others may benefit more from visual or hands-on approaches. Technology can cater to a variety of learning styles, offering personalized experiences that improve learning outcomes for diverse student groups.

With the rapid advancements in biological research, students require exposure to modern technologies, such as multimedia packages, computer animations, interactive simulations, 3D modeling, virtual labs, and digital microscopy, to better visualize and understand cellular structures and processes. However, schools often face challenges like limited access to such tools, lack of teacher training, and inadequate infrastructure, creating a gap between current scientific practices and classroom learning. Bridging this gap is essential for fostering a deeper understanding of cell biology, improving scientific literacy, and preparing students for future studies in life sciences. Therefore this study intends to identify the effectiveness of integrating technological tools in teaching and learning cell division topic as the basics for understanding cell biology concept among secondary school students in Katsina Central Zone, Katsina State, Nigeria.

Aim and Objective of the Study

This research is primarily aimed at integrating technological tools i.e. multimedia packages in teaching and learning of cell as the basics of understanding the general concept of cell biology among Students of Secondary Schools in Katsina Central Zone, Katsina State, Nigeria.

Research Questions

This study intends to answer the following research questions:

1. How effective does multimedia packages increase students' understanding of cell as the basic unit of life?
2. How do multimedia packages influence students' motivation and interest in biology subject?
3. How do teachers perceive the benefits of using technology in teaching of cell as the basic unit of life?
4. What are the long-term effects of technology-enhanced learning tools on students' achievement?

Research Hypothesis

Based on the research questions stated, one null hypothesis was formulated for testing at $p \leq 0.05$

H₀₁: The use of Multimedia packages in teaching cell as the basic unit of life has no significant effect on students' understanding and long-term retention of the concept based on their achievement scores.

2. RESEARCH METHODOLOGY

This study utilized a concurrent mixed methods design, combining quantitative and qualitative data to thoroughly examine the research problem (Creswell, 2009). The target population included 976 senior secondary school students and 22 biology teachers from four Local Government Areas within the Katsina Zonal Education Quality Assurance (ZEQA): Katsina, Jibia, Kaita, and Kankia. Using the Research Advisors (2006) sample size table, a sample of 278 students and all 22 biology teachers was selected for statistical significance. A multi-stage cluster sampling technique was applied, with four local government areas purposively chosen, followed by simple random sampling of one female senior secondary school per area, ultimately selecting four schools and various SSII classes.

Quantitative instruments included a 3D multimedia package app (with videos, simulations, and animations) to aid students in understanding cell structures and division. Students then completed a 5-point Likert-scale questionnaire titled "Computer Animated Media Packages for Learning Cell (CAMPLC)" and a 20-question post-test Biology Achievement Test. Qualitative data was collected through focus group discussions with biology teachers to gather their perspectives on multimedia use. Ethical consent was obtained from relevant authorities. A copies of 278 were distributed to the respondents with the help of research assistants and a total of 256 questionnaires were retrieved and valid for data analysis. Then the data was analyzed using SPSS version 23.0. Descriptive and inferential statistics of simple frequency and percentages, one-sample t-tests and ANOVA were applied to quantitative data, while thematic analysis was used for qualitative data from focus group discussions. Results were presented in tables below.

Presentation of Results and Data Analysis

Results: The data collected from the five selected senior secondary schools in Katsina Central Zone will be presented below.

Table 1: Distribution of Respondents by schools

School	Frequency	Percentage
Government Girl College Katsina (snr)	151	58.98
Government Girls Unity Sec Sch Jibia (snr)	20	7.81
Government Girls Sec Sch Dutsin Safe (snr)	38	14.84
Government Girls Sec Sch Rimaye (snr)	20	7.81
Government Girls Sec Sch Shema (snr)	29	11.4
Total	256	100.00

Source: Field Survey, 2024.

Table1 presents a sample of 256 questionnaires successfully retrieved and found valid for data presentation and analysis. The table highlights variations in respondent numbers across different institutions. Dominance of Government Girl College Katsina with 151 respondents (representing 58.98%), Government Girl College Katsina (Senior) is the largest group among the schools surveyed because of it's largest population, followed by moderate representation by Government Girls Secondary School Dutsin Safe with 38 respondents (14.84%). Considering the minimal representation of three schools namely; Government Girls Unity Secondary School Jibia, Government Girls Secondary School Rimaye, and Government Girls Secondary School Shema each have lower respondent numbers, with 20 (7.81%), 20 (7.81%), and 29 (11.4%) respondents, respectively. Their lower participation is due to smaller sample sizes.

Table 2: Demographic Data of the Respondents

Bio Data	Frequency	Percentage
Gender	256	100.00
All Females	20	7.81
Age	126	49.22
13-14 years	110	42.97
15-16 years	256	100.00
17 years and above	114	44.53
Total	142	55.47
Nature of School	256	100.00
Day	182	71.09
Boarding	45	17.58
Total	29	11.33
Class of Students	256	100.00
Science		
Arts		
Commerce		
Total		

Source: Field Survey, 2024.

The data in Table 2 outlines gender, age distribution, nature of school and class of the respondents, presenting insights into the demographics of the surveyed group. Based on gender, all the 256 respondents were females with a percentage of 100. Based on age group the largest distribution was 15-16 years with 126 respondents, representing 49.22% of the total. This almost half-and-half distribution reflect the typical age range for senior secondary school students II, aligning with their educational stage. Additionally, the table shows that 114; students representing 44.53% were day students while 142 students representing 55.47% were boarding students. However, the table also shows that 182 respondents representing 71.09% were science students, 45 respondents representing 17.53% were art students while 29 respondents representing 11.33% were commerce students.

Data presentation

RQ1: How effective does multimedia packages increase students' understanding of cell as the basic unit of life?

Table 3: find the technology-enhanced learning tools easy to use in understanding cell as the basic unit of life

Response	Frequency	Percentage	
Strongly disagreed	0	0.00	
Disagreed	2	0.00	
Neutral	2	0.78	
Agreed	10	3.91	
Strongly agreed	244	95.31	
Total	256	100.00	

Results in Table 3 presents respondents' views on the ease of using technology-enhanced learning tools for understanding the concept of the cell as the basic unit of life. A striking 244 respondents (95.31%) strongly agreed that technology-enhanced learning tools were easy to use in understanding the cell concept. This high percentage reflects widespread satisfaction with the usability and effectiveness of these tools, suggesting that students find them accessible and helpful for grasping fundamental biology concepts. Such a positive reception indicates that the technology-enhanced approach is likely well-designed, user-friendly, and aligned with students' learning preferences.

RQ 2: How do multimedia packages influence students' motivation and interest in biology subject?

Table 4: I am curious and motivated during learning when CAMPLC is used in teaching cell concepts

Option	Frequency	Percentage
Strongly disagreed	6	2.34
Disagreed	8	3.13
Neutral	44	17.19
Agreed	21	8.20
Strongly agreed	177	69.14
Total	256	100.00

Table 4 shows that a large number of respondents 177 representing 69.14% strongly agreed and 21(8.20%) respondents agreed that they are curious and motivated during learning when CAMPLC is used in teaching cell concepts. Moreover, 44 respondents representing 17.19 were neutral, 8 respondents representing 3.13% disagreed while 6 respondents representing 2.34% strongly disagreed that they were curious and motivated during learning when CAMPLC is used in teaching cell concepts. In conclusion, the data indicates a strong positive impact of CAMPLC on students' interest in biology, with a significant majority of students expressing enthusiasm about pursuing the subject as a future course of study.

RQ3: To identify the perception of teachers towards the use of technology in teaching and learning of cell as the basic unit of life

Table 5: Summary of Teachers' perspectives on the use of Computer Animated Media Packages for Teaching Cell (CAMPLC) from Focus Group Discussion Guide

Discussion Guide	Summary of Discussion	Remarks
Did you find the technology-enhanced learning tools appropriate for use in teaching cell?	Appropriate, easier and user friendly	Good for use

Do you think the package would aid teaching cell concepts in biology	Yes, it will help a lot in teaching and learning the concept	Excellent in academic outcomes
Do you intend using the package when introduced?	Yes, ofcourse	Satisfactory
Do you think the package would aid the students performance in Biology?	Yes, it is highly effective as a teaching aid	Excellent
Do you have any contribution to add? If no; please rate the package	No, it is appropriate. Almost rated 5 *****	Excellent

Table 5 presents the qualitative analysis of data collected from focus group discussions with 18 biology teachers from the sampled schools, as well as interviews with 5 Heads of Biology Units, based on the provided questions. All 22 teachers evaluated the multimedia package as excellent for teaching and learning the cell concepts.

RQ4: What are the long-term effects of technology-enhanced learning tools on students' achievement?

Table 6: Analysis of Post-test Scores From the Biology Achievement Test of the Respondents

	Scores	Frequency	Percentage
	0-5	00	0.00
	5-10	08	3.12
	10-15	62	24.22
	15-20	186	72.66
	Total	256	100.00

Table 6 shows the post-test achievement scores of the respondents. The majority, 186 out of 256 students (72.66%), scored between 15 and 20, while 62 students scored between 10 and 15. Only 8 students scored between 5 and 10 (3.12%), and no students scored between 0 and 5. These results indicates the effectiveness of the multimedia packages in teaching and learning about the cell as the basic unit of life among the students.

HO1: The use of Multimedia packages in teaching cell as the basic unit of life has no significant effect on students' understanding and long-term retainion of the concept based on their achievement scores.

Table 7: Analysis of Variance for Hypothesis Test

N Mean SD T Sig. (2- F Sig. Remark tailed)

SCORES	256	8.82	1.54	93.52	0.001	93.52	.000	Significant (both)
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Table 7 reports a mean score of approximately 8.82 with a standard deviation of 1.54, indicating that most scores are close to this average, with a typical variation of about 1.54 points. The one-sample t-test shows a t-statistic of about 93.52 and a p-value near zero ($p < 0.05$), indicating the mean score is significantly different from zero.

The one-way ANOVA test, used to compare mean scores across five schools, yields an F-statistic of approximately 9.98 and a p-value of 0.000, which is well below the 0.05 significance threshold. This result suggests a statistically significant difference in mean scores among the schools, implying that at least one school's average score differs from the others. These findings indicate that using multimedia packages for teaching about the cell as the basic unit of life has a significant positive effect on students' understanding and long-term retention and comprehension of the concept, as reflected in their achievement scores.

3. DISCUSSION OF FINDINGS

The study's results indicate that all research questions and the null hypothesis were addressed. Tables 1 and 2 provide a detailed breakdown of respondent distribution by school and demographic information, while Table 3 presents findings on the effectiveness of multimedia packages in enhancing students' understanding of cell biology. These findings align with prior research, such as the work of Olowe and Adekoya (2020), which demonstrated that multimedia tools—animations and interactive simulations—significantly improved comprehension of complex biological concepts like cell division among Nigerian secondary students compared to traditional lectures. Another study by Akinbadewa and Sofowora (2020) further supports this, showing that 80.3% of students in experimental groups responded positively to multimedia instruction. They reported greater confidence in answering biology questions (mean = 3.43) and rated multimedia as highly effective for individualized learning (mean = 3.48), fostering positive attitudes (mean = 3.21), and

promoting creativity in teaching (mean = 3.65). Students also found multimedia packages engaging (mean = 3.13) and believed they would improve biology performance (mean = 2.98).

The findings for the second research question reveal that multimedia packages significantly boost students' motivation and interest in cell biology. This aligns with Yusuf and Balogun's (2019) study, which showed that interactive simulations improved problem-solving skills and long-term retention among 150 Nigerian secondary students by helping visualize abstract concepts that traditional teaching methods struggle to convey. Similarly, Ajayi and Falade (2018) found that multimedia-enhanced lessons—using videos, animations, and 3D models—led to increased engagement, question-asking, and active participation among 120 students. Their study emphasized that multimedia encourages students to take ownership of their learning, leading to a deeper understanding. Additionally, Tunde and Adeyemi (2021) found that students rated multimedia as more interesting and motivating than traditional methods, with the visual and auditory elements being particularly effective at maintaining attention. These studies collectively suggest that multimedia not only improves comprehension but also makes challenging topics like cell biology more engaging and appealing.

The results for the third research question indicate that teachers recognize the benefits of using technology in teaching cell biology and are willing to adopt multimedia packages when available. Similarly, a study by Ibrahim and Sani (2017) surveyed 50 schools in northern Nigeria and found that while teachers were enthusiastic about incorporating multimedia tools, access to modern equipment was limited. The study recommended stronger government and private sector support to provide necessary tools and training, aiming to enhance the quality of biology education. This reverts with the findings of Adebayo (2021) that the adoption of multimedia tools in Nigerian schools faces significant challenges, especially in rural areas with limited access to technological infrastructure and reliable electricity. Many teachers also need proper training to effectively integrate these tools into their lessons, as digital literacy is often lacking. Nonetheless, there is increasing awareness of the potential for multimedia to enhance the teaching of cell biology and other sciences in Nigeria, particularly in urban centers where infrastructure is more advanced.

The findings for the fourth research question indicate that technology-enhanced learning tools have a significant long-term positive impact on students' achievement in cell biology, as reflected in their post-test scores compared to their initial understanding. Supporting this, Adekunle (2020) conducted a comparative study with 180 students, showing that those taught with multimedia tools performed better on tests covering cellular processes like photosynthesis and respiration, suggesting multimedia may be a superior alternative to traditional lectures for complex scientific topics. Additionally, a longitudinal study by Okeke and Olatunji (2022) tracked 300 students over three years and found that those taught with multimedia tools consistently outperformed peers in biology assessments. The study highlighted sustained benefits, including improved critical thinking and analytical skills, reinforcing the effectiveness of multimedia in fostering long-term academic success in biology.

4. CONCLUSIONS

Based on the findings of the study, the stated objectives were all achieved. Thus, It is concluded that:

1. The use of multimedia packages has significant effect on students' interest in understanding cell biology.
2. Multimedia packages have significant influence on students' motivation and interest in learning cell biology concepts.
3. Teachers perceive significant benefits associated with the use of technology in teaching of cell as the basic unit of life.
4. Technology-enhanced learning tools has significant long-term effect on students' achievement i. e comprehension.

5. RECOMMENDATIONS

The following recommendations were made based on the study's findings:

1. There is a need to incorporate interactive computer-animated media packages and other educational videos to supplement traditional teaching methods.
2. It is also necessary to implement virtual labs for hands-on practicals, as many laboratories lack equipment and reagents.
3. Educators and curriculum planners should prioritize revising the curriculum to integrate technology-enhanced learning methods and tools that meet students' needs.
4. Regular sensitization exercises, seminars, workshops, and interactive sessions should be conducted to train teachers in multimedia integration.
5. Educational administrators and planners should improve the monitoring, evaluation, and continual updating of technology-enhanced learning tools to ensure their effectiveness.

6. Ministries of education at all levels should make provisions for infrastructure development, such as computer labs and internet connectivity.

Recommendation for further research

While the study focuses on Katsina Central Zone, Ministry of Basic and Secondary Education, Zonal Education Quality Assurance, Katsina State, the findings may have broader implications for similar regions facing comparable challenges. The conclusion acknowledges the potential for further research to explore similar dynamics in different level of education across the world due to the fact that cell is the basic unit of life and a foundational topic in biology.

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