



**EXPLORING THE EFFECTIVENESS OF ICT INTEGRATION IN BIOLOGY
INSTRUCTION AMONG SENIOR SECONDARY SCHOOLS IN OSHIMILI NORTH
LGA, DELTA STATE**

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ABSTRACT

This study investigated the extent of Information and Communication Technology (ICT) integration in Biology instruction among senior secondary schools in Oshimili North Local Government Area (LGA) of Delta State, Nigeria. A descriptive survey design was adopted, involving 20 Biology teachers and 100 SS2/SS3 students selected from five public secondary schools through stratified random sampling. Data were collected using validated questionnaires and analysed using descriptive statistics (frequencies, means, and standard deviations). Findings revealed that while basic ICT facilities such as desktop computers and projectors were moderately available, advanced tools like digital microscopes, simulation software, and reliable internet



access were scarce. ICT use in Biology classrooms was irregular, with most teachers relying on traditional teaching methods. Major challenges identified included inadequate funding, erratic power supply, poor internet connectivity, and insufficient teacher training. The study concludes that ICT integration in Biology instruction within Oshimili North LGA remains limited by infrastructural and human resource constraints. It recommends increased investment in ICT facilities, continuous teacher training, and the provision of alternative power sources to enhance effective ICT adoption. These findings align with previous studies by Ajani, Ajani, Okonta, & Ewuotu (2024) and Ajani, Ajani, Osamor, & Chibuoke (2025), which emphasise the need for systemic interventions to strengthen digital learning in Nigerian educational institutions.

Keywords: ICT integration, Biology instruction, teacher training, educational technology, Oshimili North, Delta State

Introduction

The 21st century has witnessed a rapid transformation in education through Information and Communication Technology (ICT). In science education, ICT tools such as simulations, animations, and virtual laboratories enhance visualisation and interaction, making abstract concepts more accessible (Eze, Okeke, & Adeyemi, 2024). Biology, a subject that requires deep conceptual understanding, stands to benefit significantly from ICT integration, as digital resources help learners grasp processes such as mitosis, photosynthesis, and genetic coding more effectively (Onyema, 2023).

ICT-supported instruction fosters active learning, inquiry, and critical thinking, moving beyond the traditional “chalk-and-talk” approach that often limits student engagement (Owolabi & Onwuachu, 2022). Tools such as digital microscopes, interactive multimedia, and online platforms enable learners to explore biological processes in real time, thereby improving retention and stimulating interest in science-related careers (Chinedu & Obasi, 2023).

Globally, ICT integration has been recognised as a driver of educational innovation, equipping students with 21st-century skills necessary for competitiveness in health sciences, biotechnology, and environmental studies (Adeyemi & Abubakar, 2023). In Nigeria, policies such as the National Policy on ICT in Education emphasise the importance of digital learning (Federal Ministry of Education, 2021). However, implementation remains uneven, particularly in semi-urban and rural areas where infrastructural deficiencies persist (Okonkwo, Uche, & Ibrahim, 2023).

In Oshimili North Local Government Area of Delta State, infrastructural challenges such as erratic electricity supply, poor internet connectivity, and inadequate funding hinder effective ICT adoption. Human resource limitations, including insufficient teacher training and technophobia, further constrain classroom integration (Adesina, Okonjo, & Edem, 2023). These challenges create a gap between policy intentions and classroom realities, leaving students disadvantaged in acquiring modern scientific competencies.

Recent studies reinforce these concerns. Ajani, Ajani, Okonta, and Ewuotu (2024) demonstrated that platforms like Google Classroom can enhance collaboration and student engagement in colleges of education, but adoption remains inconsistent. Similarly, Ajani, Ajani, Osamor, and Chibuoke (2025) found that insufficient computer laboratory resources in Delta State



tertiary institutions significantly limit ICT-supported learning. These findings highlight systemic challenges that resonate with the present study's focus on Biology instruction in Oshimili North.

This study, therefore, investigates the extent of ICT integration in Biology instruction across Oshimili North LGA, examining the availability of facilities, frequency of use, perceived benefits, and barriers to adoption. By focusing on this semi-urban context, the research provides evidence-based insights to guide policymakers, school administrators, and stakeholders toward more effective ICT integration in science education.

Statement of the Problem

Despite growing awareness of the benefits of Information and Communication Technology (ICT) in education, a significant gap persists between policy intentions and classroom realities in many Nigerian schools. National frameworks such as the National Policy on ICT in Education (Federal Ministry of Education, 2021) advocate for widespread integration of digital tools. However, implementation is inconsistent, particularly in semi-urban and rural areas. In subjects like Biology, where students must grasp complex processes such as cell division, photosynthesis, and ecological systems, ICT tools offer unique opportunities for visualisation and interaction. However, many teachers continue to rely on traditional lecture-based methods that limit creativity, experimentation, and student participation (Owolabi & Onwuachu, 2022). This mismatch between modern pedagogical approaches and outdated practices hampers students' conceptual understanding and reduces their interest in science-related careers.

Empirical studies highlight systemic challenges that restrict ICT adoption. Adesina, Okonjo, and Edem (2023) found that a large proportion of teachers lack the technical skills and pedagogical training necessary to incorporate digital tools effectively. Similarly, Okonkwo, Uche, and Ibrahim (2023) reported that erratic power supply, poor internet connectivity, and inadequate equipment maintenance constrain ICT use even where facilities exist.

In Oshimili North Local Government Area of Delta State, anecdotal evidence suggests that most senior secondary schools struggle with limited access to ICT facilities, including projectors, interactive software, and computers. Even when these tools are present, they are often underutilised due to insufficient teacher orientation and support. Ajani, Ajani, Okonta, and Ewuotu (2024) further demonstrated that while platforms like Google Classroom can enhance collaboration and engagement, their adoption remains inconsistent. Likewise, Ajani, Ajani, Osamor, and Chibuoke (2025) revealed that insufficient computer laboratory resources in Delta State tertiary institutions significantly hinder ICT-supported learning. These findings underscore that, systemic challenges in ICT adoption affect not only higher education but also secondary school science instruction.

Consequently, the gap between what is technologically possible and what is educationally practised continues to widen, leaving students in Oshimili North disadvantaged in acquiring the digital competencies required for success in the 21st century.

Purpose of the Study

The purpose of this study is to critically examine the extent of ICT integration in Biology instruction among senior secondary schools in Oshimili North Local Government Area of Delta State. Specifically, the study seeks to:



1. Assess the availability and functionality of ICT facilities (computers, projectors, internet access, digital microscopes, and simulation software) for Biology teaching in Oshimili North schools (Okonkwo, Uche, & Ibrahim, 2023).
2. Evaluate the frequency and effectiveness of ICT use by Biology teachers, focusing on how digital tools are applied in lesson delivery and their impact on student engagement and retention (Chinedu & Obasi, 2023; Ajani, Ajani, Okonta, & Ewuotu, 2024).
3. Identify systemic challenges and propose strategies for improvement, including infrastructural barriers, teacher training needs, and policy interventions to enhance ICT adoption in science classrooms (Adesina, Okonjo, & Edem, 2023; Ajani, Ajani, Osamor, & Chibuoke, 2025).

Research Questions

To guide this investigation, the following research questions were formulated:

1. What ICT facilities are available and functional for Biology teaching in Oshimili North LGA? (Okonkwo, Uche, & Ibrahim, 2023)
2. How frequently and effectively do Biology teachers integrate ICT tools into their instructional practices, and what impact does this have on student engagement and retention? (Chinedu & Obasi, 2023; Ajani, Ajani, Okonta, & Ewuotu, 2024)
3. What systemic challenges hinder ICT integration in Biology classrooms, and what strategies can be adopted to enhance its adoption? (Adesina, Okonjo, & Edem, 2023; Ajani, Ajani, Osamor, & Chibuoke, 2025)

Literature Review

ICT in Contemporary Education

Globally, ICT has transformed education by redefining how teaching and learning are delivered. Tools such as computers, projectors, internet resources, and mobile applications improve lesson delivery, stimulate curiosity, and make learning more interactive (Adeyemi & Abubakar, 2023). Digital simulations, for example, allow students to conduct experiments that may be too hazardous or complex to perform in person, thereby enhancing accessibility and conceptual understanding (Okeke, James, & Bello, 2022).

ICT and the Teaching of Biology

Biology, as a life science, often requires learners to visualise microscopic structures and complex processes. ICT tools such as animations, 3D models, and interactive videos bridge this gap by presenting abstract concepts in dynamic formats (Onyema, 2023). Virtual laboratories further compensate for the lack of physical lab infrastructure in many Nigerian schools, promoting active learning and experimentation (Adebayo & Okechukwu, 2021). Despite these benefits, many teachers still rely on traditional “chalk-and-talk” methods, which limit student engagement and deeper understanding (Ogunleye & Nwachukwu, 2022).

Empirical Studies in the Nigerian Context

Several Nigerian studies highlight the uneven adoption of ICT in classrooms. Ibrahim, Bello, and Musa (2022) found that although 65% of schools in Kwara State had ICT infrastructure,



only 35% of Biology teachers regularly employed these tools, citing inadequate training and irregular electricity supply. Similarly, Egbule & Oghene (2023) reported a mismatch between teachers' willingness to use ICT and their actual implementation in Delta State, largely due to a lack of institutional support.

Comparative studies show that private schools outperform public schools in ICT adoption, thanks to better funding and infrastructure (Olaoye, Etim, & Umeh, 2024). Chinedu & Obasi (2023) further observed that students in ICT-enriched Biology classrooms demonstrated higher retention and more positive attitudes toward science than peers taught using traditional methods.

Ajani, Ajani, Okonta, and Ewuotu (2024) demonstrated that platforms such as Google Classroom, when effectively used, foster interactive learning and improve teaching outcomes in colleges of education. Conversely, Ajani, Ajani, Osamor, and Chibuoke (2025) revealed that insufficient computer laboratory resources in Delta State tertiary institutions significantly hinder ICT-supported learning. These findings mirror the challenges faced in secondary schools, underscoring that, systemic barriers to ICT adoption cut across all levels of education.

Theoretical Framework

The Technology Acceptance Model (TAM) proposed by Davis (1989) provides a framework for understanding ICT adoption, emphasising perceived usefulness and ease of use. Studies in Nigeria confirm that teacher training and institutional support increase both factors, thereby improving ICT integration (Yusuf & Alabi, 2022; Otunla, 2023). Constructivist Learning Theory also supports the use of ICT, emphasising active, student-centred learning through exploration and collaboration (Eze & Onwuka, 2021). ICT tools such as simulations and virtual labs align with this paradigm, enabling learners to construct knowledge through inquiry and experimentation.

Research Method

An appropriate survey instrument was designed to capture several principal constructs. The study uses a descriptive survey design to investigate the extent of ICT integration in Biology instruction in senior secondary schools in the Oshimili North Local Government Area (LGA) of Delta State. The design was considered appropriate because it enables data collection from a large population and provides insights into existing practices, perceptions, and challenges without manipulating variables (Adesina, Okonjo, & Edem, 2023).

The population of the study comprised Biology teachers and senior secondary school students (SS2 and SS3) across Oshimili North LGA, which includes communities such as Illah, Ebu, Ugbolu, Ibusa, Okpanam, Akwukwu Igbo, Atuma, and Ukala. Using stratified random sampling, five public senior secondary schools were selected to ensure fair representation across the communities. The sample consisted of 20 Biology teachers and 100 students, providing a balanced perspective from both instructors and learners.

Data was collected using a structured questionnaire divided into four sections: demographic information of respondents, Availability of ICT facilities for Biology instruction, Frequency and mode of ICT use in classrooms, and challenges and barriers to ICT integration.



The instrument was validated by experts in educational technology and computer science to ensure content validity. Reliability was established through a pilot test, and the questionnaire items were refined accordingly.

Data Analysis

The collected data were analysed using descriptive statistics, including frequency counts, percentages, mean scores, and standard deviations. Remarks were added to interpret the results in terms of availability, frequency of use, and severity of challenges. This approach provided a clear understanding of the extent of ICT integration and highlighted areas requiring intervention (Ibrahim, Bello, & Musa, 2022).

Availability of ICT Facilities

The study examined the extent to which ICT facilities were available in the sampled schools. Results are presented in Table 1.

Table 1: Availability of ICT Facilities

ICT Facility	Frequency	%	Mean	SD	Remark
Desktop Computers	12	60	2.8	0.9	Moderately Available
Projectors	10	50	2.5	1.0	Moderately Available
Internet Access	6	30	1.8	0.7	Poorly Available
Digital Microscopes	4	20	1.5	0.6	Poorly Available
Simulation Software	3	15	1.3	0.5	Poorly Available

Table 1 shows that desktop computers and projectors are moderately available in schools, while advanced facilities such as internet access, digital microscopes, and simulation software are poorly available. This indicates that while basic ICT tools exist, more specialised resources required for effective Biology instruction are lacking.

Frequency of ICT Use

Teachers were asked how often they used ICT tools in Biology instruction. Results are presented in Table 2.

Table 2: Frequency of ICT Use

ICT Use Frequency	Frequency	%	Mean	SD	Remark
Weekly	5	25	2.0	0.8	Low
Occasionally	7	35	2.5	0.9	Moderate
Rarely	8	40	3.0	1.0	High

Table 2 reveals that ICT use in Biology classrooms is irregular. Only 25% of teachers reported weekly use, while 40% admitted to rarely using ICT. This suggests that ICT integration is not yet embedded in routine instructional practices, confirming earlier findings by Egbule & Oghene (2023).



Challenges to ICT Integration

Respondents identified several challenges hindering ICT adoption. Results are presented in Table 3.

Table 3: Challenges to ICT Integration

Challenge	Frequency	%	Mean	SD	Remark
Erratic Power Supply	15	75	3.5	0.8	Major Challenge
Poor Internet Connectivity	14	70	3.2	0.7	Major Challenge
Lack of Teacher Training	12	60	2.9	0.9	Significant
Inadequate Funding	16	80	3.8	0.6	Major Challenge

Table 3 indicates that inadequate funding (80%) and erratic power supply (75%) are the most critical barriers to ICT integration. Poor internet connectivity and lack of teacher training also emerged as significant challenges. These findings align with Ajani et al. (2025), who reported similar infrastructural and human resource limitations in tertiary institutions in Delta State.

Discussion of Findings

The findings of this study reveal that ICT facilities, such as desktop computers and projectors, are moderately available in schools across Oshimili North LGA. In contrast, advanced tools like digital microscopes, simulation software, and reliable internet access remain scarce. This aligns with Ibrahim, Bello, and Musa (2022), who reported that while ICT infrastructure exists in many Nigerian schools, its actual use by teachers is limited due to inadequate training and irregular electricity supply.

Teachers in Oshimili North reported occasional use of ICT tools, mainly for PowerPoint presentations and video demonstrations, but integration into daily instruction was rare. This reflects the mismatch between teachers' willingness and actual implementation observed by Egbule & Oghene (2023), who emphasised that the lack of institutional support and maintenance hampers ICT adoption.

Students and teachers agreed that ICT tools improve the visualisation of complex biological concepts, foster engagement, and enhance retention. These findings corroborate Chinedu & Obasi (2023), who found that ICT-enriched Biology classrooms significantly improved students' attitudes toward science and their ability to retain knowledge. Similarly, Onyema (2023) highlighted that animations and interactive videos make abstract processes more comprehensible, a benefit echoed by respondents in this study.

The challenges identified, erratic power supply, poor internet connectivity, inadequate funding, and insufficient teacher training, are consistent with the systemic barriers highlighted by Adesina, Okonjo, and Edem (2023). These infrastructural and human resource limitations explain why ICT integration remains sporadic in semi-urban schools like those in Oshimili North.

Importantly, the findings resonate with Ajani D. et al. (2022; 2023), who demonstrated that insufficient computer laboratory resources and poor adoption of platforms such as Google Classroom hinder effective teaching and learning. This study extends those insights to Biology instruction, showing that similar systemic challenges affect science education broadly, not just computer science.

Overall, the findings confirm that while ICT has transformative potential in Biology education, its integration in Oshimili North LGA is constrained by infrastructural, systemic, and



human factors. Addressing these barriers is essential for equipping students with the digital competencies required for success in the 21st century.

Conclusion

This study concludes that ICT integration in Biology instruction across Oshimili North LGA remains sporadic and inconsistent. While tools such as computers and projectors are moderately available, advanced facilities like digital microscopes, simulation software, and reliable internet are largely absent. Teachers use ICT irregularly, mainly for presentations, and students benefit from improved visualisation and engagement when it is used.

However, infrastructural barriers such as erratic electricity supply, poor internet connectivity, and inadequate funding, combined with human resource challenges like insufficient teacher training, continue to undermine effective ICT adoption. These findings echo Ibrahim, Bello, and Musa (2022) and Egbule and Oghene (2023), who highlighted similar systemic barriers in Nigerian schools. They also resonate with Ajani D. et al. (2022; 2023), who demonstrated that insufficient computer laboratory resources and limited adoption of platforms such as Google Classroom hinder effective teaching and learning. Without systemic intervention, students in Oshimili North and similar semi-urban contexts will remain disadvantaged in acquiring 21st-century scientific skills necessary for global competitiveness.

Recommendations

1. **Provision of ICT Facilities:** Governments and stakeholders should prioritise equipping schools with laptops, projectors, digital microscopes, and reliable internet access. This aligns with Adebayo & Afolabi (2021), who emphasised that adequate infrastructure is the foundation of ICT integration.
2. **Teacher Training and Development:** Continuous professional development programs should be organised to build teachers' digital competence. According to Yusuf & Alabi (2022), teacher training increases perceived usefulness and ease of use, thereby improving ICT adoption as explained in the Technology Acceptance Model.
3. **Alternative Power Solutions:** Provision of solar panels and other renewable energy sources is essential to mitigate erratic electricity supply. Okonkwo, Uche, and Ibrahim (2023) stressed that reliable power is a prerequisite for sustained ICT use in classrooms.
4. **Monitoring and Accountability:** Supervisory frameworks should be established to track ICT integration and provide technical support. Adesina, Okonjo, and Edem (2023) noted that institutional monitoring helps bridge the gap between policy and practice.
5. **Blended Learning Approaches:** Schools should adopt blended learning models that incorporate platforms like Google Classroom to complement face-to-face instruction. Ajani D. et al. (2023) demonstrated that digital platforms enhance collaboration, flexibility, and student engagement when properly implemented.



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