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Availability and Utilization of ICT Tools in Teaching and Learning of Biology among Senior Secondary Schools in Zaria, Kaduna State

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ABSTRACT
This study examined the utilization of Information and Communication Technology (ICT) tools in the teaching and learning of biology among senior secondary school students in Zaria, Kaduna State. The study was guided by three objectives and three corresponding research questions. A survey research design was employed, and data were collected using two structured questionnaires: the Questionnaire on the Availability and Utilization of ICT Tools for Teaching Biology (QAUITTB) for teachers and the Questionnaire on the Availability and Utilization of ICT Tools for Learning Biology (QAUITLB) for students. The instruments demonstrated reliability coefficients of 0.76 and 0.84, respectively. Data were analyzed using mean and standard deviation. Findings indicated a significant disparity in the availability of ICT tools for teachers, with desktop/laptop computers being the only commonly accessible resource (mean = 3.94). For students, desktop/laptop computers and smartphones/tablets were widely available (means = 3.64 and 4.01, respectively). However, the overall utilization of ICT tools for biology instruction was found to be low (mean = 2.31). Key barriers to effective ICT utilization included inadequate electricity supply (mean = 3.78), among others. Based on these findings, it was recommended that the Kaduna State Government should invest in the provision of modern, functional ICT facilities to enhance interactive and practical biology learning experiences.

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INTRODUCTION

The 21st century continues to witness rapid advancements in science and technology, making science education a crucial foundation for national development. Science is universally recognized as the bedrock of modern civilization, technological breakthroughs, and innovation (Iwuanyanwu, 2021). Globally, science education is expected to develop critical thinkers, problem solvers, and individuals who can apply scientific knowledge to address real-world challenges such as environmental sustainability, health, and technological advancement (Okebukola, 2020). Science has been variously defined, but at its core, it remains a systematic and objective pursuit of knowledge through observation, experimentation, and analysis. According to Olanrewaju (2019), science is not just a body of knowledge but also a process that enables learners to explore natural phenomena using inquiry and evidence-based reasoning. The goal of science education, therefore, is to nurture scientifically literate citizens capable of making informed decisions and contributing meaningfully to society.

Biology, as a core science subject, plays a significant role in secondary school curricula in Nigeria and serves as a gateway to numerous science-based professions including medicine, agriculture, biotechnology, and environmental sciences. The Federal Republic of Nigeria (FRN, 2014) emphasized the importance of biology education in shaping students' understanding of

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life processes and equipping them for scientific careers.

As Nigeria aims to catch up with global trends in scientific and technological advancement, attention has increasingly turned toward the quality and relevance of science education, particularly biology. Despite the strategic importance of biology, the actual state of students' understanding and performance in the subject remains a matter of concern. Although examination results in biology over the years seem to suggest improved academic performance, many educators and stakeholders have questioned the validity of these results. The rise of "special centres" and the widespread practice of examination malpractice have distorted the true picture of students' academic achievement (Adeyemi & Olayiwola, 2023). Many students struggle with core biological concepts and lack the problem-solving skills needed for higher education and professional application.

This artificial inflation of performance masks deep-seated issues such as ineffective teaching methods, lack of engaging instructional resources, and insufficient integration of digital tools in the classroom. The persistent reliance on conventional, teacher-centred approaches dominated by rote learning and memorization has failed to engage students meaningfully or promote deep understanding of biological principles (Aderibigbe & Olatunde, 2022). According to Akinyemi and Salami (2021), such approaches have led to passive learning and low retention, especially when dealing with abstract and complex biology topics. In addition, the inadequacy of instructional materials, large class sizes, and insufficient exposure to practical experiences further compound the challenges facing biology education in Nigeria. These factors contribute to students' lack of interest and confidence in the subject, thereby undermining efforts toward achieving educational goals in science and technology.

To address these challenges, educators and researchers have emphasized the need for the integration of Information and Communication Technology (ICT) into science teaching. ICT has revolutionized education worldwide by facilitating interactive, student-centred learning environments that enhance engagement and conceptual understanding (Yusuf & Onasanya, 2018; UNESCO, 2020). Tools such as simulations, virtual laboratories, educational videos, and interactive software make biology more accessible and relatable, especially for visual and practical learners. ICT integration in teaching has been proven to improve student performance, increase motivation, and support differentiated instruction tailored to learners' needs (Olaleye & Ogundele, 2021).

In countries like Finland, Singapore, and the United Kingdom, the adoption of ICT in education has led to significant improvements in students' academic achievement and digital competence (OECD, 2019). Nigeria, however, continues to lag due to infrastructural deficits, limited teacher training, poor policy implementation, and inadequate funding (Ogunbanjo, 2020). While Nigeria's National Policy on Education encourages the use of ICT in teaching and learning, the reality on the ground shows that many schools, especially in rural and semi-urban areas lack access to basic digital tools, and where these facilities exist, they are often underutilized (Adejoh & Akubo, 2022). Teachers themselves are frequently untrained or lack the confidence to incorporate ICT effectively into their instruction, particularly in science subjects.

To move forward, it is critical that government, policymakers, and stakeholders commit to investing in ICT infrastructure, providing ongoing professional development for teachers, and implementing accountability systems to ensure effective usage of available tools (Uzoegwu & Chukwu, 2023). Teachers must be equipped not only with technical skills but also with pedagogical strategies that enable them to use technology to enhance inquiry, experimentation, and conceptual clarity in biology. Given the concerning disconnect between students' examination performance and their actual competence in biology, this study seeks to examine the availability and utilization of ICT facilities in the teaching of biology in senior secondary schools in Zaria Local Government

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Area. It aims to assess how the integration or lack thereof of digital tools is influencing the quality of biology instruction and the authenticity of students' learning outcomes in this era of technological advancement and examination malpractice.

STATEMENT OF THE PROBLEM

In recent years, student performance in biology at the senior secondary school level in Nigeria has appeared to improve significantly, with many students recording high grades in external examinations. However, beneath this surface of academic excellence lies a growing concern about the credibility and authenticity of these results. The widespread use of "special centres" and other forms of examination malpractice has cast doubt on the actual understanding and competence of students in the subject. Rather than reflecting genuine mastery of biological concepts, many of these impressive results are the product of systemic corruption within the examination process. This situation undermines the core objectives of science education, which is to develop critical thinking, problem-solving abilities, and practical skills. As a result, students who pass biology with high grades often struggle with basic scientific applications and concepts when they proceed to higher levels of education or enter science-related fields.

Despite various reforms and continuous professional development efforts led by educational stakeholders and associations like the Science Teachers Association of Nigeria (STAN), many schools continue to rely on conventional teaching methods. These traditional approaches limit student engagement and fail to promote deep, conceptual understanding of biology. Furthermore, the lack of integration of modern instructional tools particularly Information and Communication Technology (ICT) has hindered the transformation of science classrooms into interactive and inquiry-driven learning environments. In the current digital age, ICT has the potential to revolutionize the teaching of biology through simulations, virtual laboratories, and real-time data analysis. Yet, many schools in Nigeria, including those in Zaria, still face challenges in adopting ICT-based teaching due to inadequate infrastructure, limited teacher training, and poor access to digital resources. This research wants to determine if senior secondary schools in Zaria have imbibed the culture of using ICT into teaching and learning biology.

Objectives of the Study are to:

1. Identify the ICT facilities that are used in teaching and learning biological concepts in selected secondary schools.
2. Ascertain the level of ICT literacy among teachers at the selected schools.
3. Determine the challenges encountered by teachers in the use of ICT facilities for teaching biological concepts.

Research Questions

The following research questions guided the study:

1. What types of ICT facilities are available for teaching and learning biology in the secondary schools?
2. How often do biology teachers use ICT facilities for biology instructions in the secondary schools?
3. What are the challenges encountered by the biology teachers when using ICT facilities for teaching biology?

METHODOLOGY

A descriptive survey research design was adopted for this study. The sampling technique employed was simple random sampling. The study population consisted of sixty-three (63) Biology teachers, all of whom were purposively selected due to their relatively small number. Additionally, the population comprised four hundred and sixteen (416) Senior Secondary School II Biology students, from which a sample of 201 students was drawn using the Krejcie and Morgan (1970) sample size determination table and the simple random sampling technique.

The primary instrument for data collection was the questionnaire. Two separate sets of questionnaires were developed: one titled “Questionnaire on the Availability and Utilization of ICT Tools for Teaching Biology (QAUITTB)” for

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teachers, and the other titled "Questionnaire on the Availability and Utilization of ICT Tools for Learning Biology (QAUITLB)" for students. Both instruments were structured using a 5-point Likert scale format: Strongly Agree (SA), Agree (A), Undecided (UN), Disagree (D), and Strongly Disagree (SD), and Very High Extent (VHE), High Extent (HE), Partial Extent (PE), Very Poor Extent (VPE) and No Extent (NE) and were all divided into relevant sections. The teacher questionnaire comprised four sections, while the student questionnaire had two sections.

To ensure validity, the instruments underwent face, content, and construct validation by experts in Biology Education from the Federal University of Education, Zaria. For reliability testing, a pilot study was conducted involving 15 teachers and 50 students who were not part of the main study. The test-retest method was used, and reliability was measured using the Pearson Product Moment Correlation (PPMC), yielding reliability coefficients of 0.76 for teachers and 0.84 for students at a 0.05 level of significance, indicating strong and consistent reliability of the instruments. The questionnaires were personally administered by the researchers to both teachers and students to minimize errors and avoid wastage. All respondents completed and returned the questionnaires immediately after administration. Data collected were analyzed using mean and standard deviation with a benchmark of Mean ≥3.0 = Accepted; Mean < 3.0= Rejected.

RESULTS

Table 1: Available ICT Tools for Teaching

S/N	ICT TOOLS	X	S.D	DECISION
1	Computer desktops/laptops	3.94	1.30	Available
2	Internet	2.19	1.15	Not Available
3	Slide projectors	2.11	1.40	Not Available
4	Local Area Network	2.71	1.40	Not Available
5	Digital library	2.52	1.39	Not Available
6	Interactive Whiteboard	2.75	1.44	Not Available
7	Educational software and simulations	2.37	1.34	Not Available
8	Smartphones and tablets	2.14	1.22	Not Available
9	Virtual laboratories	2.71	1.39	Not Available
10	Learning Management Systems (LMS)	2.56	1.37	Not Available
	Cumulative Mean	**2.60**	**1.34**	**Not Available**

Benchmark: Mean ≥3.0 = A; Mean < 3.0= NA

Table 1 shows the availability of various ICT tools for teaching in secondary schools. The data indicate that only computer desktops/laptops are sufficiently available for teaching purposes, with a mean score of 3.94, which is above the acceptance benchmark of 3.0. This suggests that most teachers have access to these devices for instruction. However, all other ICT tools including internet access, slide projectors, local area networks, digital libraries, interactive whiteboards, educational software and simulations, smartphones/tablets, virtual laboratories, and learning management system have mean scores below 3.0, indicating limited availability for teaching. The cumulative mean of 2.60 confirms that the overall availability of ICT tools for teaching is inadequate.

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Table 2: Available ICT Tools for Learning

S/N	ICT TOOLS	X	S.D	DECISION
1	Computer desktops/laptops	3.64	1.33	Available
2	Internet	2.05	1.30	Not Available
3	Multimedia Projectors	2.28	1.44	Not Available
4	Digital Libraries	2.15	1.41	Not Available
5	Learning Management Systems (e.g., Google Classroom, Moodle)	2.29	1.43	Not Available
6	YouTube and Educational Channels	1.97	1.26	Not Available
7	Online Quizzes and Assessment Tools (e.g., Kahoot, Quizlet)	2.22	1.45	Not Available
8	Smartphones and tablets	4.01	1.15	Available
9	Cloud Storage Services (e.g., Google Drive, Dropbox)	2.31	1.41	Not Available
10	Online Collaborative Tools (e.g., Padlet, Trello)	2.28	1.41	Not Available
	Cumulative Mean	**2.52**	**1.36**	**Not Available**

Benchmark: Mean ≥3.0 = A; Mean < 3.0= NA

Table 2 presents data on the availability of various ICT tools for learning in secondary schools. The findings reveal that only computer desktops/laptops and smartphones/tablets are widely available, as indicated by their mean scores of 3.64 and 4.01 respectively, both exceeding the acceptance benchmark of 3.0. This means these tools are generally accessible to students and teachers. However, the remaining ICT tools including the internet, multimedia projectors, digital libraries, learning management systems, YouTube and educational channels, online quizzes and assessment tools, cloud storage services, and online collaborative tools have mean scores below 3.0, indicating limited availability in the schools surveyed. The cumulative mean of 2.52 further emphasizes that most ICT facilities are not sufficiently available to support learning activities. The relatively high standard deviation of 1.36 suggests there is considerable variability in the availability of these tools across different schools. Overall, the data indicate a significant gap in ICT infrastructure availability, with only a few key tools being commonly accessible.

Table 3: Utilization of ICT Tools for Biology Instruction

S/N	ITEMS	X	S.D	DECISION
1	Computer desktops/laptops	2.30	1.22	Not Utilized
2	Internet	1.97	1.13	Not Utilized
3	Slide projectors	2.71	1.33	Not Utilized
4	Local Area Network	2.19	1.25	Not Utilized
5	Digital library	2.08	1.22	Not Utilized
6	Interactive Whiteboard	2.18	1.29	Not Utilized
7	Educational software and simulations	1.92	1.10	Not Utilized
8	Smartphones and tablets	2.41	1.24	Not Utilized
9	Virtual laboratories	2.87	1.30	Not Utilized
10	Learning Management Systems (LMS)	2.93	1.31	Not Utilized
	Cumulative Mean	**2.31**	**1.23**	**Not Utilized**

Benchmark: Mean ≥3.0 = U; Mean < 3.0= NU

The data in Table 3 reveal that the utilization of ICT tools for biology instruction in secondary schools is generally low. All the listed ICT tools including computer desktops/laptops, internet, slide projectors, local area network, digital library, interactive whiteboard, educational software and simulations, smartphones and tablets, virtual laboratories, and learning management systems have mean scores below

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the benchmark of 3.0, indicating poor utilization. Smartphones and tablets, although somewhat more used than other tools, still fall short of the acceptable level with a mean of 2.41. The cumulative mean of 2.31 further confirms that the overall use of ICT tools in biology teaching is inadequate. This suggests that despite the availability of some ICT facilities, their integration into biology instruction remains limited.

Table 4: Factors hindering effective utilization of ICT Facilities

S/N	ITEMS	X	S.D	DECISION
1	Lack of sufficient computer desktops /laptops.	3.60	1.25	Accepted
2	Poor electricity supply	3.78	1.15	Accepted
3	Inability of the teachers to operate ICT materials and transfer knowledge with them.	3.02	1.28	Accepted
4	Lack of adequate facilities maintenance	2.44	1.44	Rejected
5	Lack of literacy in internet	2.24	1.40	Rejected
	Cumulative Mean	**3.02**	**1.30**	**Accepted**

Benchmark: Mean ≥3.0 = Accepted; Mean < 3.0= Rejected

The results in Table 4 indicate that the major factors hindering the effective utilization of ICT facilities in biology instruction include the lack of sufficient computer desktops/laptops (mean = 3.60), poor electricity supply (mean = 3.78), and the inability of teachers to operate ICT materials effectively (mean = 3.02), as these means are above the acceptance benchmark of 3.0. These factors suggest that inadequate hardware, unreliable power, and limited teacher skills are significant challenges. However, lack of adequate maintenance (mean = 2.44) and low internet literacy (mean = 2.24) were not perceived as major hindrances since their mean scores fell below the acceptance threshold. Overall, the cumulative mean of 3.02 reflects that the primary obstacles to ICT utilization are mostly related to infrastructure and teacher readiness rather than maintenance or internet skills.

DISCUSSION

The finding that computer desktops and laptops are the predominant ICT tools available to biology teachers aligns with the broader narrative of ICT infrastructure challenges in Nigerian schools. Adejoh and Akubo (2022) highlight that many schools, especially in rural and semi-urban areas, lack access to a wide variety of digital tools, and where they exist, they are unevenly distributed or insufficient. This limitation restricts teachers' ability to fully harness diverse ICT resources that could enhance biology instruction, such as virtual laboratories and interactive whiteboards. Ogunbanjo (2020) also confirms that infrastructural deficits remain a critical barrier to ICT adoption in Nigerian education. The reliance primarily on desktops and laptops reflects an incomplete ICT ecosystem that falls short of enabling rich, interactive, and multi-modal teaching approaches necessary for effective science education. However, the presence of desktops and laptops does provide a foundation upon which further ICT integration can be built, as noted by UNESCO (2020), who assert that even limited access to such technology can begin to transform traditional, teacher-centred approaches to more student-centred, interactive learning environments.

This finding is consistent with the observation by Adejoh and Akubo (2022) that many ICT tools remain unavailable or underutilized by students. Smartphones and tablets, which have become more widespread due to their affordability and portability, offer an important alternative channel for student engagement with digital content. Yusuf and Onasanya (2018) emphasize that mobile technologies can play a critical role in enhancing learning opportunities, especially where fixed ICT infrastructure is limited. Nonetheless, Ogunbanjo (2020) notes that despite the increasing

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penetration of smartphones, their educational utilization is often hindered by lack of appropriate content, teacher guidance, and digital literacy skills among students. Thus, while smartphones/tablets offer potential, their current educational value remains underexploited.

The overall low utilization of ICT tools resonates with the findings of Uzoegwu and Chukwu (2023), who point to a significant gap between policy advocacy for ICT use and actual practice in Nigerian schools. Many teachers are either untrained or lack the confidence to integrate technology effectively into their pedagogy, particularly in complex subjects like biology (Adejoh & Akubo, 2022). This underutilization directly contributes to the continued prevalence of rote learning and teacher-centred instruction criticized by Akinyemi and Salami (2021). On the other hand, international experiences shared by OECD (2019) demonstrate that when ICT is effectively integrated, it leads to improvements in academic achievement and student engagement. This contrast highlights the unrealized potential within Nigerian biology education due to systemic constraints rather than a lack of willingness or recognition of ICT benefits.

These barriers are well-documented in the literature. Ogunbanjo (2020) and Adejoh and Akubo (2022) identify infrastructural challenges such as inconsistent electricity supply and inadequate ICT hardware as major impediments to technology adoption in Nigerian schools. The lack of stable electricity not only limits the operation of computers and other digital tools but also demotivates both teachers and students from embracing ICT (Uzoegwu & Chukwu, 2023). Furthermore, teacher capacity is a crucial factor. As highlighted by Uzoegwu and Chukwu (2023), many educators have not received sufficient professional development to build confidence and pedagogical skills in using ICT, resulting in reluctance or ineffective use of available technologies. This deficiency perpetuates traditional teaching methods that do not leverage digital tools for inquiry and conceptual clarity as recommended by Olanrewaju (2019). Infrastructure and training challenges are not the sole causes of low ICT utilization. For example, Aderibigbe and Olatunde (2022) suggest that the entrenched culture of rote learning and examination malpractice also creates resistance to innovative teaching practices. Thus, even where ICT tools exist, systemic issues in educational culture and assessment methods may dampen their impact.

CONCLUSION

The findings from this study have significant implications for learning and education in secondary schools. The limited availability and low utilization of ICT tools in biology instruction suggest that students are missing out on the benefits of technology-enhanced learning, such as increased engagement, better conceptual understanding, and development of critical thinking skills. This gap undermines efforts to modernize education and prepare learners for the demands of the 21st-century knowledge economy, where digital literacy and scientific competence are crucial. Without adequate ICT resources and effective integration, teaching remains predominantly teacher-centred and reliant on rote memorization, which limits students' ability to apply scientific knowledge in real-world contexts.

More broadly, these results highlight systemic challenges in the educational sector, including infrastructural deficits and insufficient teacher preparedness, which negatively impact the quality of education. To bridge this divide and foster meaningful learning experiences, stakeholders must recognize that improving ICT availability and utilization is not just about access to technology, but also about creating an enabling environment that supports innovative pedagogical practices. Thus, the study underscores the urgent need for comprehensive strategies that integrate technology into education to enhance teaching effectiveness and improve student outcomes across subjects beyond biology.

RECOMMENDATIONS

1. Kaduna state government should allocate resources to provide schools with modern, functional ICT tools that

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support interactive and practical learning experiences.

2. Management of Secondary schools in Kaduna state should provide improved grid connections or alternative energy solutions like solar power for consistent electricity, to facilitate the effective use of ICT in teaching.
3. Professional development programs should be organized by Kaduna state ministry of education to focus on equipping teachers with both technical skills and pedagogical approaches for integrating ICT in curriculum delivery.

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