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Case Study

Assessment of the Effectiveness of ICT Integration for Teaching and Learning: A Case Study of Federal College of Education, Zaria

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ABSTRACT
This study evaluates the effectiveness of Information and Communication Technology (ICT) integration in enhancing teaching and learning at the Federal College of Education (FCE), Zaria, Nigeria, using a descriptive survey design with 350 lecturers from various schools. Data were collected via a validated questionnaire (Cronbach's Alpha=0.92) and analyzed using mean and standard deviation, with a decision mean of 2.50. Findings reveal that accessible tools like Microsoft PowerPoint ($\bar{x}$=48.67, σ=16.39) and Moodle ($\bar{x}$=45.50, σ=12.81) are widely adopted, enhancing engagement and course management. Zoom/WhatsApp ($\bar{x}$=39.67, σ=14.36) and Google Forms/Quizizz ($\bar{x}$=36.83, σ=10.36) support collaboration and assessment but are limited by connectivity issues. Digital libraries ($\bar{x}$=31.00, σ=11.66), interactive whiteboards ($\bar{x}$=20.50, σ=6.41), and simulation tools ($\bar{x}$=18.50, σ=7.99) show lower adoption due to inadequate infrastructure. Social media ($\bar{x}$=25.17, σ=6.24) is moderately used for informal engagement. Vocational and Technical Education and Secondary Science Education exhibit higher adoption, while Early Childhood Care and Primary Education show the least. Systemic barriers, including unreliable internet and funding shortages, hinder effectiveness. The study recommends implementing continuous ICT training programs for educators to build digital competence, ensuring effective integration and addressing barriers to maximize ICT's transformative potential in Nigerian tertiary education.

Keywords: ICT integration, Nigerian Tertiary Education, Teaching and Learning, Federal College of Education Zaria, Digital Competence.

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INTRODUCTION

Information and Communication Technology (ICT) refers to a broad range of digital tools and systems that facilitate the creation, storage, processing, and dissemination of information. These include hardware such as computers, mobile devices, and networking equipment, as well as software applications like Learning Management Systems (LMS), multimedia tools, and online platforms (UNESCO, 2018). In the context of education, ICT serves as a transformative force, shifting traditional teacher-centered pedagogies toward interactive, student-centered learning environments. It enables access to vast digital resources, fosters collaborative learning, and supports innovative teaching methods, such as e-learning and virtual classrooms (Oluwalola, 2019). In Nigerian tertiary institutions, ICT adoption is a critical strategy for addressing educational disparities, enhancing teaching quality, and preparing students for a technology-driven global economy.

The integration of ICT in Nigerian tertiary education is driven by the need to align with global educational standards and respond to the demands of the 21st-century workforce. The Federal Government of Nigeria, through policies like the National Policy on Education (2004), has emphasized ICT as a cornerstone for educational reform (Federal Ministry of Education, 2014). Institutions such as universities, polytechnics, and colleges of education, including the Federal College of Education (FCE), Zaria, have adopted ICT tools to facilitate teaching, learning, and administrative processes. For instance, platforms like Moodle and Google Classroom are used for course delivery, while digital libraries provide access to global academic resources (Onyebuchi, 2015). These efforts aim to bridge educational gaps, particularly in underserved regions, and enhance the quality of instruction by making it more engaging and accessible.

Despite these advancements, ICT integration in Nigerian tertiary institutions faces significant challenges. Inadequate funding remains a major barrier, limiting the procurement of modern

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ICT infrastructure such as high-speed internet, computers, and software licenses (Ifinedo and Kankaanranta, 2018). Many institutions, particularly in rural areas like Zaria, struggle with outdated equipment and unreliable power supply, which hinder effective ICT use (Egielewa *et al.*, 2022). Additionally, the lack of digital literacy among lecturers and students often impedes the optimal utilization of ICT tools (Oluwafeyikemi *et al.*, 2018). These challenges are compounded by inconsistent policy implementation and a digital divide between urban and rural institutions, which affects equitable access to technology (Oni and Uko, 2016).

The need for a focused assessment of ICT's effectiveness in Nigerian tertiary education stems from these challenges and opportunities. Understanding how ICT tools are used, their impact on teaching and learning outcomes, and the barriers to their adoption is crucial for developing targeted interventions. Studies by Nigerian scholars highlight that while ICT has the potential to revolutionize education, its success depends on addressing infrastructural deficits, enhancing stakeholder training, and ensuring sustainable funding (Adeoye and Adeoye, 2019). This introduction sets the stage for a detailed examination of ICT integration at FCE Zaria, exploring its application, effectiveness, and the systemic issues that must be resolved to maximize its benefits.

History of ICT in Nigerian Tertiary Institutions

The integration of ICT in Nigerian tertiary education began in the early 2000s, driven by global digitalization trends. The Federal Ministry of Education introduced policies like the National Policy on Education (2004), emphasizing ICT as a tool for educational reform (Federal Ministry of Education, 2014). The integration of Information and Communication Technology (ICT) into Nigerian tertiary education began in the early 2000s, spurred by global digitalization trends and the need to modernize educational systems. The rapid advancement of ICT globally, particularly the proliferation of the internet and digital tools, prompted Nigeria to align its educational framework with international standards to prepare students for a technology-driven economy (Oluwalola, 2019). The Federal Ministry of Education played a pivotal role in this transformation by introducing policies aimed at embedding ICT into the educational sector. The National Policy on Education (2004) was a landmark initiative, explicitly recognizing ICT as a critical tool for educational reform, emphasizing its potential to enhance teaching, learning, and administrative efficiency in tertiary institutions (Federal Ministry of Education, 2014).

In the early stages, leading universities such as Ahmadu Bello University (ABU), Zaria, and the University of Lagos (UNILAG) spearheaded ICT adoption by establishing e-learning platforms and digital libraries. ABU, for instance, introduced computer-based learning systems in the early 2000s, enabling access to online academic resources and virtual classrooms (Yusuf and Balogun, 2011). Similarly, UNILAG developed an e-learning portal to support distance learning programs, marking a significant shift from traditional chalk-and-talk methods (Oni and Uko, 2016). Colleges of Education, including the Federal College of Education (FCE), Zaria, followed suit by integrating ICT into both academic and administrative functions. FCE Zaria adopted tools like Moodle for course management and Microsoft Office applications for administrative tasks, aiming to streamline operations and improve pedagogical outcomes (Oluwafeyikemi *et al.*, 2018).

The Nigerian government supported these efforts through initiatives like the Tertiary Education Trust Fund (TETFund), established to fund infrastructure, including ICT facilities, in tertiary institutions (Adeoye and Adeoye, 2019). TETFund facilitated the procurement of computers, internet connectivity, and training programs for lecturers, particularly in urban institutions. Additionally, partnerships with international organizations, such as UNESCO and the World Bank, provided technical assistance and funding for ICT projects, further driving adoption (Ifinedo and Kankaanranta, 2018). By the mid-2010s, many institutions had established ICT centers to support teaching, research, and student services, with some offering online courses and digital assessments.

Despite these advancements, the adoption of ICT in Nigerian tertiary institutions has faced significant challenges. Inconsistent funding has been a major barrier, with many institutions unable to sustain or upgrade ICT infrastructure due to limited budgetary allocations (Egielewa *et al.*, 2022). For instance, rural institutions like FCE Zaria often rely on outdated hardware and software, which hampers effective ICT utilization (Onyebuchi, 2015). Policy implementation gaps have further slowed progress, as the ambitious goals outlined in the National Policy on Education have not been consistently executed across institutions (Federal Ministry of Education, 2014). Additionally, the digital divide between urban and rural institutions has exacerbated inequities, with urban universities benefiting more from ICT investments than their rural counterparts (Oluwalola, 2019). The reliance on outdated infrastructure, coupled with inadequate training for lecturers and students, has limited the transformative potential of ICT in Nigerian tertiary education.

The history of ICT integration reflects a trajectory of progress tempered by systemic challenges. While pioneering institutions have laid a foundation for digital education, the sector requires sustained investment and strategic policy implementation to achieve widespread and equitable ICT adoption (Adeoye and Adeoye, 2019). The case of FCE Zaria exemplifies these dynamics, highlighting both the opportunities and obstacles in leveraging ICT for educational advancement in Nigeria.

Definition of ICT

Information and Communication Technology (ICT) encompasses a broad spectrum of technologies that facilitate the creation, storage, processing, and dissemination of information through digital and telecommunication systems. These technologies include hardware such as computers, mobile devices, and networking equipment, as well as software systems like Learning Management Systems (LMS), databases, and collaborative platforms (UNESCO, 2018). ICT integrates these components to enable efficient communication, data management, and access to digital resources, transforming how information is shared and utilized across various sectors, including education. In the educational context, particularly at institutions like the Federal College of Education (FCE), Zaria, ICT plays a pivotal role in supporting teaching, learning, and administrative processes by providing access to digital resources, enabling interactive pedagogies, and streamlining institutional operations (Oluwalola, 2019).

ICT refers to technologies that provide access to information through telecommunications, including the internet, wireless networks, and software systems (UNESCO, 2018). It integrates hardware, software, and digital platforms to facilitate communication and data management. In education, ICT supports teaching, learning, and administrative processes by enabling access to digital resources and collaborative tools.

At its core, ICT refers to technologies that provide access to information through telecommunications, encompassing the internet, wireless networks, cloud computing, and software applications (UNESCO, 2018). These technologies integrate hardware (e.g., computers, smartphones, and servers) with software systems (e.g., Microsoft Office, Moodle, and Zoom) to facilitate seamless communication and data management. In education, ICT enables the delivery of digital content, supports virtual collaboration, and enhances administrative efficiency through tools like student information systems and online assessment platforms (Yusuf and Balogun, 2011). For instance, platforms like Google Classroom allow lecturers to share resources and conduct assessments, while e-libraries provide students with access to global academic materials. This global definition underscores ICT's role as a transformative force in modern education, enabling innovative teaching methods and fostering student-centered learning environments (Ifinedo and Kankaanranta, 2018).

Onifade (2009) defines ICT as a system of electronic tools and platforms that enhance information sharing and learning efficiency in tertiary institutions. This definition emphasizes ICT's role in improving access to educational resources and facilitating communication between lecturers and students, especially in settings where traditional resources are limited. For example, at FCE Zaria, tools like Moodle and WhatsApp are used to share lecture notes and foster peer-to-peer interaction, aligning with Onifade's view of ICT as a catalyst for educational efficiency (Oni and Uko, 2016).

Similarly, Oluwafeyikemi *et al.*, (2018) describe ICT as a vital tool for fostering interactive pedagogy in resource-constrained environments. They highlight its ability to create dynamic learning experiences through multimedia tools and e-learning platforms, which are particularly valuable in Nigeria, where physical infrastructure and teaching materials are often inadequate. This perspective aligns with Nigeria's educational goals, as outlined in the *National Policy on Education* (2004), which emphasizes ICT as a cornerstone for modernizing education and preparing students for a digital economy (Federal Ministry of Education, 2014).

ICT Integration for Teaching and Learning in Nigeria

ICT integration in Nigeria involves incorporating digital tools into curricula, teaching methodologies, and administrative processes. The Federal Ministry of Education's ICT policy encourages e-learning, virtual libraries, and digital assessments. However, adoption varies across institutions due to funding disparities and regional differences. FCE Zaria has implemented Moodle and virtual classrooms, but challenges like power outages and limited device access persist (Oni and Uko, 2016).

Effectiveness of ICT Integration for Teaching and Learning

ICT integration at FCE Zaria enhances teaching and learning by

Improving Engagement: ICT integration at FCE Zaria enhances student engagement by making lessons more interactive and dynamic through the use of multimedia tools. Lecturers employ Microsoft PowerPoint, videos, and animations to present complex concepts in subjects like science and education, which captivate students' attention and improve comprehension (Muhammad *et al.*, 2015). For instance, biology lecturers use visual aids to illustrate processes like photosynthesis, making abstract concepts more tangible. These tools encourage active participation, as students engage in discussions prompted by interactive content, fostering critical thinking and collaboration (Oluwafeyikemi *et al.*, 2018). Studies indicate that multimedia-enhanced lessons significantly increase student motivation and participation compared to traditional methods, particularly among NCE students at FCE Zaria (Yusuf and Balogun, 2011). However, the effectiveness of these tools is limited by outdated projectors and insufficient multimedia-enabled classrooms, which hinder consistent delivery.

Enhancing Access: ICT facilitates access to a wealth of global educational resources through e-libraries and online platforms, significantly benefiting research and learning at FCE Zaria. Digital libraries, such as those accessible via Google Scholar and institutional repositories, provide NCE students and lecturers

with e-journals, e-books, and open educational resources (OERs), bridging the gap caused by limited physical library resources (Oluwafeyikemi *et al.*, 2018). For example, education students use online articles to explore modern teaching methodologies, while science students access simulations for practical experiments. This access to global knowledge enhances the quality of research and coursework, enabling students to engage with current trends in their fields (Adeoye and Adeoye, 2019). However, unreliable internet connectivity and high data costs often restrict students' ability to fully utilize these resources, particularly in rural settings like Zaria (Egielewa *et al.*, 2022).

Supporting Flexibility: Online platforms, such as Moodle, Google Classroom, and Zoom, have introduced flexibility into the teaching and learning process at FCE Zaria, allowing education to continue during disruptions like the COVID-19 pandemic. These platforms enable remote learning, asynchronous access to course materials, and virtual collaboration, accommodating students' diverse schedules and geographical constraints (Egielewa *et al.*, 2022). For instance, during lockdowns, lecturers used Zoom for live lectures and Moodle for assignment submissions, ensuring continuity of education. This flexibility is particularly valuable for part-time students and those in remote areas, as it reduces the need for physical attendance (Oni and Uko, 2016). However, the effectiveness of online platforms is compromised by poor internet infrastructure and frequent power outages, which disrupt virtual classes and access to e-learning systems (Ifinedo and Kankaanranta, 2018).

Skill Development: ICT integration equips NCE students at FCE Zaria with digital literacy and technical skills essential for modern careers, particularly in education and technology-driven sectors. Students engage with tools like Microsoft Office, Google Workspace, and coding platforms (e.g., Scratch or Python tutorials) to develop skills in document creation, data analysis, and programming (Ifinedo *et al.*, 2019). For example, computer science students learn basic coding, while education students master presentation software to design teaching aids. These skills enhance employability and prepare students to integrate technology into their future classrooms, aligning with Nigeria's goal of a digitally competent workforce (Adeoye and Adeoye, 2019). However, limited access to computer labs and inadequate training in advanced ICT tools restrict students' ability to fully develop these competencies, particularly for those without personal devices (Onyebuchi, 2015).

Roles and Ways Lecturers at FCE Zaria Use ICT for Teaching

Lecturers at the Federal College of Education (FCE), Zaria, have increasingly integrated Information and Communication Technology (ICT) into their teaching practices to enhance pedagogical effectiveness and align with global educational trends. ICT tools enable lecturers to create dynamic, interactive, and student-centered learning environments, moving beyond traditional chalk-and-talk methods (Oluwalola, 2019). At FCE Zaria, lecturers employ a variety of ICT tools and strategies to facilitate teaching, improve student engagement, and streamline academic processes. However, the effectiveness of these efforts is often constrained by systemic challenges such as unreliable internet connectivity and limited professional development in ICT use (Onyebuchi, 2015).

Learning Management Systems (LMS)

Lecturers at FCE Zaria utilize platforms like Moodle to manage and deliver course content. Moodle allows them to upload lecture notes, share reading materials, and assign tasks to students, creating a centralized digital repository for course resources (Oni and Uko, 2016). This platform supports asynchronous learning, enabling students to access materials at their convenience, which is particularly beneficial for part-time and distance learning programs. For instance, lecturers in the Education Department use Moodle to distribute syllabi and track assignment submissions, enhancing organizational efficiency (Adeoye and Adeoye, 2019). However, the adoption of LMS is limited by inconsistent internet access and the need for technical support to maintain these systems.

Multimedia Presentations

To make lessons more engaging, lecturers employ multimedia tools such as Microsoft PowerPoint and video content. These tools enable the integration of visuals, animations, and audio to explain complex concepts, particularly in subjects like science and mathematics (Oluwafeyikemi *et al.*, 2018). For example, biology lecturers at FCE Zaria use PowerPoint slides with diagrams to illustrate biological processes, making abstract concepts more accessible. Video content, sourced from platforms like YouTube or created using tools like Camtasia, is used to demonstrate practical applications of theoretical knowledge. These multimedia approaches increase student interest and comprehension but are often hampered by outdated projectors and limited access to multimedia-enabled classrooms (Yusuf and Balogun, 2011).

Online Assessments

Lecturers leverage tools like Google Forms and Quizizz to conduct quizzes, tests, and surveys, enabling real-time feedback and assessment. These platforms allow for automated grading and data analysis, reducing the administrative burden on lecturers and providing immediate insights into student performance (Ifinedo and Kankaanranta, 2018). At FCE Zaria, lecturers in the English Department, for instance, use Google Forms to administer multiple-choice quizzes on literature topics, allowing them to gauge student understanding efficiently. However, challenges such as unreliable internet connectivity and students' limited access to devices often disrupt the seamless implementation of online assessments (Egielewa *et al.*, 2022).

Virtual Collaboration

With the rise of remote and hybrid learning, especially during the COVID-19 pandemic, lecturers at FCE Zaria have adopted platforms like Zoom and WhatsApp for virtual collaboration and communication. Zoom is used for live lectures and interactive discussions, enabling lecturers to engage with students in real-time, even when physical classes are not feasible (Egielewa *et al.*, 2022). WhatsApp groups serve as informal platforms for sharing resources, addressing student queries, and fostering peer-to-peer interaction among lecturers and students. For example, lecturers in the Social Studies Department use WhatsApp to share articles and coordinate group projects. However, the effectiveness of these tools is limited by poor network infrastructure and the lack of institutional subscriptions to premium versions of these platforms (Onyebuchi, 2015).

Roles and Ways NCE Students at FCE Zaria Use ICT for Learning

Nigerian Certificate in Education (NCE) students at the Federal College of Education (FCE), Zaria, have increasingly integrated Information and Communication Technology (ICT) into their learning processes, aligning with the global shift toward digital education. ICT tools enable students to access resources, collaborate with peers, engage with e-learning platforms, and develop essential digital skills, fostering a more interactive and self-directed learning experience (Oluwalola, 2019). At FCE Zaria, these tools are critical for enhancing academic performance and preparing students for a technology-driven workforce. However, challenges such as limited access to devices and unreliable power supply significantly hinder their optimal utilization (Ifinedo *et al.*, 2019).

Accessing Resources: NCE students at FCE Zaria use ICT to access a wide range of online resources, including digital libraries, e-journals, and Open Educational Resources (OERs). Platforms such as JSTOR, Google Scholar, and institutional digital repositories provide access to academic articles and textbooks, enabling students to conduct research efficiently (Oluwafeyikemi *et al.*, 2018). For instance, students in the Education Department utilize e-journals to explore teaching methodologies, while science students access online simulations to understand complex concepts. This access to global resources bridges knowledge gaps, particularly in a resource-constrained environment (Adeoye and Adeoye, 2019). However, limited internet connectivity and the high cost of data bundles often restrict students' ability to fully utilize these resources (Egielewa *et al.*, 2022).

Collaborative Learning: ICT facilitates collaborative learning through platforms like WhatsApp, which NCE students use to form study groups, share notes, and discuss course content. WhatsApp groups are particularly popular due to their accessibility on mobile devices and low data requirements, making them a cost-effective tool for peer-to-peer interaction (Oni and Uko, 2016). For example, students in the Social Studies Department create group chats to share lecture summaries and coordinate group assignments. These platforms foster a sense of community and enable students to clarify concepts through peer discussions. However, the informal nature of these platforms can lead to distractions, and unreliable network coverage often disrupts communication (Ifinedo and Kankaanranta, 2018).

E-Learning Platforms: Platforms like Moodle and Google Classroom are integral to the learning process at FCE Zaria, enabling students to submit assignments, access course materials, and participate in online discussions. Moodle, for instance, allows students to download lecture notes and submit assignments electronically, reducing reliance on physical materials (Onyebuchi, 2015). Google Classroom is used by lecturers to post announcements and facilitate interactive tasks, such as group projects. These platforms enhance flexibility, particularly for students balancing academic and personal responsibilities. However, challenges such as limited access to computers and inconsistent internet connectivity hinder seamless engagement with these platforms (Egielewa *et al.*, 2022).

Skill Development: ICT provides NCE students with opportunities to develop digital literacy and technical skills essential for modern careers. Students engage with coding platforms like Scratch or Python tutorials to learn programming basics, particularly in computer science and mathematics education programs (Yusuf and Balogun, 2011). Additionally, tools like Microsoft Office and Google Workspace help students develop skills in document creation, data analysis, and presentation design. These skills enhance employability and prepare students for technology-driven roles in education and beyond (Adeoye and Adeoye, 2019). Nevertheless, the lack of dedicated computer labs and inadequate training in advanced ICT tools limit students' ability to fully develop these competencies (Oluwafeyikemi *et al.*, 2018).

LITERATURE REVIEW

Chrispin and Ghosh (2024) in their study on Student Perceptions on ICT Use in Teaching and Learning in Public Secondary Schools in Mbeya District, Tanzania using questionnaire, interview and secondary data from 60 respondents drawn from two secondary schools found in the Mbeya district. Their study found that most of the students had a positive attitude towards ICT integration in in the teaching and learning process as it facilitates better access to learning materials, increased involvement via interactive learning environments, and the possibility of customized learning experiences. They recommended to that staff should hold interactive training sessions for a strong feedback mechanism, and an effective way of integration in education to boost student involvement and favourable perception on ICT use in teaching and learning process to secondary school students found in Mbeya district Tanzania.

According to Onyebuchi (2015) on the Challenges in the Application of E-Learning in Teaching and Learning Among Secondary Schools in Nkanu West L.G.A of Enugu State Their study explored the challenges of adopting e-learning in secondary schools in Nkanu West, Enugu State, Nigeria, with implications for tertiary institutions like the Federal College of Education (FCE), Zaria. The study found that limited ICT infrastructure, such as outdated computers and inadequate internet connectivity, significantly impeded e-learning adoption. Additionally, the lack of teacher training in ICT tools resulted in low confidence and ineffective use of digital platforms. Many schools lacked access to Learning Management Systems (LMS) like Moodle, and teachers relied heavily on traditional methods due to unfamiliarity with e-learning technologies. Despite these challenges, e-learning enhanced student engagement by providing interactive content and access to digital resources when infrastructure was available. Students demonstrated higher motivation when exposed to multimedia tools, but the lack of robust infrastructure limited scalability. The study recommends substantial investment in ICT facilities, including modern computer labs and reliable internet, alongside comprehensive teacher training programs to build digital competence. Such interventions would enable educators to effectively integrate e-learning into their teaching practices, fostering a more engaging learning environment.

Egielewa *et al.*, (2022) on the assessment of COVID-19 and Digitized Education: Analysis of Online Learning in Nigerian Higher Education. Their study examined the impact of the COVID-19 pandemic on the adoption of online learning in Nigerian tertiary institutions, including universities and colleges of education. They discovered that the rapid shift to online learning during the pandemic increased access to education for students in urban areas with better internet infrastructure. However, it exposed significant digital divides, particularly in rural institutions like FCE Zaria, where students and lecturers struggled with unreliable internet and limited access to devices. The study highlighted disparities in ICT access between urban and rural students, with rural students often excluded from online classes due to connectivity issues and ICT improved flexibility by enabling remote learning, allowing students to continue their education during lockdowns. However, its effectiveness was curtailed by unreliable internet and power supply, they recommended that the Nigerian government and educational institutions subsidize internet access for students, particularly in rural areas, to bridge the digital divide and ensure equitable access to online learning resources.

Bans-Akutey (2020) in their study on the Change Management Amid Pandemic: A Case of Tertiary Educators in Ghana. The study investigated the challenges faced by tertiary educators in transitioning to online teaching during the COVID-19 pandemic, offering insights relevant to Nigerian contexts like FCE Zaria. His study found that Ghanaian educators faced significant challenges, including limited ICT skills, inadequate institutional support, and unreliable internet connectivity. Many lecturers were unprepared for the sudden shift to platforms like Zoom and Google Classroom, leading to initial resistance and inefficiencies in online teaching. The study noted that professional development programs were critical in improving educators' confidence and competence in using ICT tools. Also, with targeted training, ICT adoption improved, enabling lecturers to deliver interactive lessons and engage students effectively through virtual platforms. The use of multimedia and collaborative tools enhanced student participation, but ongoing technical challenges persisted. The study recommends implementing continuous ICT training programs for educators to build and sustain digital skills, ensuring effective integration of ICT into teaching practices.

Oubibi *et al.*, (2024). Interactive Technologies in Online Teacher Education in Africa: A Systematic Review 2014-2024. Their systematic review analyzed the use of interactive technologies in online teacher education across Africa, including Nigeria, over a decade. They found that interactive tools, such as virtual simulations, gamified learning platforms, and collaborative software like Microsoft Teams, significantly enhanced learning outcomes in teacher education programs. These tools fostered student engagement and critical thinking but required robust technical support to function effectively. The study noted that limited access to devices and internet connectivity in many African institutions, including Nigeria, restricted the widespread adoption of these technologies. Also, interactive technologies had a positive impact on student engagement, enabling hands-on learning experiences and collaborative projects. However, their effectiveness was limited by access issues and the need for ongoing technical support to maintain system functionality. They recommended developing dedicated technical support systems within institutions to ensure the seamless operation of interactive ICT tools, addressing issues like software glitches and connectivity disruptions.

Research Questions

This study will provide answer to the research question:

1. What is the effectiveness of ICT integration in enhancing teaching and learning processes at the Federal College of Education, Zaria?

METHODOLOGY

The study assessed the assessment of the effectiveness of ICT integration for teaching and learning in Nigerian tertiary education: a case study of Federal College of Education, Zaria. Descriptive survey design was adopted for the study. To achieve this, the researcher collected data from 350 lecturers, from various Schools including, General Education, Secondary Arts and Social Sciences, Secondary Language Education, Secondary

Science Education, Vocational and Technical Education, Early Childhood Care and Primary Education and Special, Adult and Non Formal Education. The instrument for data collection for this study was adopted and modified from the original questionnaire designed by Ghavifekr and Rosdy (2015). The research instrument, a structured questionnaire, was validated for face and content validity by experts in educational technology and curriculum studies to ensure its relevance and alignment with the study's objectives (Creswell and Creswell, 2018). To assess the instrument's reliability, the Cronbach's Alpha test was utilized, yielding a reliability coefficient of 0.92. According to Creswell and Creswell (2018), a Cronbach's Alpha value between 0.70 and 0.95 indicates high reliability, confirming the instrument's consistency in measuring the intended constructs. The questionnaire was designed using a four-point Likert scale, with response options ranging from Strongly Agree (4 points), Agree (3 points), Disagree (2 points), to Strongly Disagree (1 point). Data collected from the questionnaire were analyzed by computing the mean and standard deviation for each item. The cumulative mean for each table was compared against a decision mean of 2.50, calculated as the average of the Likert scale points: (4+3+2+1)/4=2.50. This decision mean served as the threshold for determining the level of agreement with statements regarding ICT integration. The statistical package of version 26 was used to analyze the data obtained from the lecturers from various schools in Federal College of Education, Zaria, Kaduna State (Creswell and Creswell, 2018).

Question One: What is the effectiveness of ICT integration in enhancing teaching and learning processes at the Federal College of Education, Zaria?

The Table 1 on the effectiveness of ICT integration in enhancing teaching and learning processes at the Federal College of Education, Zaria shows that the use of Microsoft PowerPoint and video content (S/N 2) exhibits the highest adoption rate, with a mean frequency of 48.67 (σ=16.39), indicating widespread use, particularly in Vocational and Technical Education (F=65) and Secondary Science Education (F=60). Moodle (S/N 1) follows closely with a mean of 45.50 (σ = 12.81), reflecting its popularity for course management across all schools.

Similarly, Zoom/WhatsApp (S/N 4, $\bar{x}$=39.67, σ=14.36) and Google Forms/Quizizz (S/N 3, $\bar{x}$=36.83, σ=10.36) show moderate adoption, indicating their utility for collaboration and assessment but constrained by connectivity issues. Digital libraries (S/N 5, $\bar{x}$=31.00, σ=11.66) have lower adoption, suggesting limited access to online resources. Simulation tools (S/N 7, $\bar{x}$=18.50, σ=7.99) and interactive whiteboards (S/N 6, $\bar{x}$=20.50, σ=6.41) have the lowest adoption rates, reflecting their dependence on advanced infrastructure. Social media platforms (S/N 8, $\bar{x}$=25.17, σ=6.24) show moderate adoption, primarily for informal engagement. Standard deviations range from 6.24 (social media) to 16.39 (PowerPoint), indicating moderate to high variability. Higher variability for PowerPoint and Zoom/WhatsApp suggests uneven adoption across schools, while lower variability for simulation tools and interactive whiteboards indicates uniformly low adoption due to resource constraints.

However, Vocational and Technical Education and Secondary Science Education consistently show higher adoption across most methods, likely due to their technical orientation. Early Childhood Care and Primary Education exhibits the lowest adoption (e.g., F=11 for digital libraries, F=13 for Zoom/WhatsApp), possibly due to less reliance on technology-driven teaching. Secondary Language Education also shows lower adoption, reflecting a preference for traditional methods. The results indicate that while accessible ICT tools like PowerPoint and Moodle are widely adopted, advanced tools requiring robust infrastructure are underutilized, highlighting systemic barriers such as inadequate funding and connectivity issues.

DISCUSSION

The high adoption of Microsoft PowerPoint ($\bar{x}$=48.67) and Moodle ($\bar{x}$=45.50) at FCE Zaria aligns with Oluwafeyikemi *et al.*, (2018), who found that lecturers in Nigerian tertiary institutions prefer accessible tools like PowerPoint due to their ease of use and minimal infrastructure requirements. Moodle's widespread use reflects its role as a centralized platform for course management, consistent with Oni and Uko (2016), who emphasize the importance of learning management systems in streamlining academic processes in resource-constrained settings. The moderate standard deviations (σ=12.81 for Moodle, σ=16.39 for PowerPoint) suggest slight variations in adoption, likely due to differences in digital literacy and access to multimedia-enabled classrooms across schools (Ifinedo *et al.*, 2019).

The moderate adoption of Zoom/WhatsApp ($\bar{x}$=39.67) and Google Forms/Quizizz ($\bar{x}$=36.83) underscores their utility for real-time collaboration and assessment but highlights connectivity challenges, corroborating Egielewa *et al.*, (2022), who noted that unreliable internet hindered online learning during the COVID-19 pandemic in Nigerian tertiary institutions. Similarly, the lower adoption of digital libraries ($\bar{x}$=31.00) aligns with Adeoye and Adeoye (2019), who identified high data costs and limited internet access as barriers to accessing online resources in rural institutions like FCE Zaria.

The low adoption of simulation tools ($\bar{x}$=18.50) and interactive whiteboards ($\bar{x}$=20.50) is consistent with Oluwalola (2019), who highlighted the scarcity of advanced infrastructure in Nigerian colleges, particularly in rural areas. These tools require significant investment in hardware and technical support, which are often unavailable at FCE Zaria, as noted by Onyebuchi (2015). The moderate adoption of social media ($\bar{x}$=25.17) aligns with Yusuf and Balogun (2011), who observed its informal use for engagement but limited integration into formal teaching due to institutional policy gaps.

Table 1: Effectiveness of ICT Integration for teaching and learning in Nigerian Tertiary Education: Case of Federal College of Education, Zaria.

Sl. No.	ICT Integration for Teaching and Learning	Sch. of General Education	Secondary Arts and Social Sciences	Secondary Language Education	Secondary Science Education	Vocational and Technical Education	Early Childhood Care and Primary Education	$\bar{x}$	σ
		F	F	F	F	F	F		
1	Lecturers utilize platforms like Moodle to deliver course content, share lecture notes, and manage assignments.	50	45	40	55	60	23	45.50	12.81
2	Lecturers use tools like Microsoft PowerPoint and video content to create interactive lessons.	55	50	45	60	65	17	48.67	16.39
3	Lecturers employ tools like Google Forms and Quizizz for quizzes and formative assessments.	40	35	30	45	50	21	36.83	10.36
4	Lecturers use Zoom for live lectures and WhatsApp for informal communication, fostering collaboration and addressing student queries.	45	40	35	50	55	13	39.67	14.36
5	Lecturers incorporate digital libraries and online databases, such as Google Scholar and JSTOR, into their teaching to provide students with access to global academic resources.	35	30	25	40	45	11	31.00	11.66
6	Lecturers use interactive whiteboards to deliver dynamic lessons, allowing real-time annotations and interactive exercises.	20	15	15	25	30	28	20.50	6.41
7	Lecturers use simulation tools like virtual labs to demonstrate experiments that may be impractical in physical settings due to limited resources.	15	10	10	20	25	31	18.50	7.99

Sl. No.	ICT Integration for Teaching and Learning	Sch. of General Education	Secondary Arts and Social Sciences	Secondary Language Education	Secondary Science Education	Vocational and Technical Education	Early Childhood Care and Primary Education	$\bar{x}$	σ
8	Lecturers leverage platforms like Twitter and Facebook to share educational content, post announcements, and engage students in discussions on current issues, fostering a sense of community and encouraging active participation.	25	20	20	30	35	21	25.17	6.24

Source: Field Survey, 2024, Key: Sch: School, F=frequency % = Percentage $\bar{x}$ = Mean σ = Standard Deviation.

The higher adoption in Vocational and Technical Education and Secondary Science Education reflects their reliance on technology for practical applications, as supported by Ifinedo and Kankaanranta (2018), who argue that technical disciplines prioritize ICT to meet industry demands. Conversely, the lower adoption in Secondary Language Education and Early Childhood Care and Primary Education suggests a preference for traditional methods, possibly due to less perceived need for technology in these fields (Oluwafeyikemi *et al.*, 2018). This disciplinary variation is further evidenced by Chrispin and Ghosh (2024), who found that ICT adoption in Tanzanian secondary schools varied by subject, with science-related disciplines showing higher utilization.

The moderate to high standard deviations indicate variability in adoption, particularly for tools requiring infrastructure, aligning with the digital divide noted by Egielewa *et al.* (2022) between rural and urban institutions. Systemic barriers, such as inadequate funding and power outages, as highlighted in the National Policy on Education (Federal Ministry of Education, 2014), continue to limit ICT's effectiveness. These findings underscore the need for targeted interventions, such as infrastructure upgrades and training, to enhance ICT integration at FCE Zaria, consistent with broader Nigerian tertiary education trends (Adeoye and Adeoye, 2019).

CHALLENGES OF ICT INTEGRATION

Inadequate Infrastructure: Many institutions lack modern computers and reliable internet (Oni and Uko, 2016).

Insufficient Funding: Low budget allocation limits ICT investment (Ifinedo and Kankaanranta, 2018).

Limited Digital Literacy: Lecturers and students often lack adequate ICT skills (Onyebuchi, 2015).

Power Outages: Frequent electricity disruptions hinder ICT use (Oluwafeyikemi *et al.*, 2018).

Digital Divide: Rural institutions like FCE Zaria face greater access challenges than urban ones (Egielewa *et al.*, 2022).

Policy Implementation Gaps: Inconsistent execution of ICT policies slows progress (Federal Ministry of Education, 2014).

CONCLUSION

The integration of Information and Communication Technology (ICT) at the Federal College of Education (FCE), Zaria, represents a significant opportunity to transform teaching and learning processes, aligning with Nigeria's broader educational goals of fostering a digitally competent workforce and enhancing academic outcomes. ICT tools, such as Learning Management Systems (LMS) like Moodle, multimedia presentations, and virtual collaboration platforms, have demonstrated substantial potential to improve student engagement, increase accessibility to educational resources, and promote the development of critical digital skills. However, the effectiveness of ICT integration at FCE Zaria is significantly constrained by persistent infrastructural, financial, and skill-related challenges. Addressing these barriers requires coordinated, multi-stakeholder efforts involving government agencies, educational institutions, and private sector partners to ensure sustainable and equitable ICT adoption.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

FUNDING

The Nigerian government in collaboration with Federal Ministry of Education should allocate a higher percentage of the national budget to education for ICT infrastructure development Stakeholder.

ENHANCED TRAINING PROGRAMS

Federal College of Education Zaria Administration Institutions should implement mandatory ICT training for lecturers and students to boost digital competence.

IMPROVED POWER SUPPLY

The Kaduna State Electricity Company (KAEDCO) should collaborate with energy providers to ensure stable electricity for ICT operations and reduce reliance on alternative fueled power generators to reduce the burden of cost of refueling and maintenance.

PROVISION OF ALTERNATIVE ENERGY

The Nigerian Ministry of Education should place priority on ICT developmental projects such as provision of green energy, solar plants and generators for provision of stable electricity for ICT equipments to enhance teaching and learning.

PROVISION OF SUBSIDIZE DEVICES FOR LECTURERS AND STUDENTS

Private Sectors like UNESCO could support education programmes in FCE Zaria for the provision of affordable devices through public-private partnerships to bridge the digital divide.

STRENGTHEN POLICY IMPLEMENTATION

The National Universities Commission in partnership with Ministry of Education for the establishment, monitoring mechanisms to ensure ICT policies are effectively executed in all Nigerian tertiary education.

DEVELOPMENT OF TECHNICAL SUPPORT SYSTEMS

FCE Zaria IT Department could be supported with training programmes and viable dedicated IT support units in institutions to maintain ICT tools used for teaching and learning to avoid wear and tear from ICT equipments used during teaching and learning and examinations.

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