UAR Journal of Multidisciplinary Studies (UARJMS)
Vol. 1, Issue. 7, September 2025
ISSN: 3049-4346
DOI: 10.5281/zenodo.17051752

Integrating Information and Communications Technology (ICT) in Primary Education: Factors, Challenges, and Strategies.

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Article Info

Article historys:

Received: 20/08/2025
Accepted: 28/08/2025
Published: 04/09/2025

Keywords:

Information and Communications Technology (ICT), Primary Education, Teacher Training, Educational Technology Integration, Challenges, Digital Literacy.

ABSTRACT

This paper examines the critical role of Information and Communications Technology (ICT) in transforming primary education. It argues that ICT is an indispensable tool for creating dynamic, learner-centered environments that foster motivation, facilitate skill acquisition, and support teacher training. The paper explores key factors influencing successful ICT integration, including teacher characteristics (gender, attitudes, pedagogical beliefs), school culture, infrastructure, and educational policy. It further identifies significant challenges faced by teachers, such as inadequate training, large class sizes, technical problems, and a lack of administrative support. The study concludes that overcoming these impediments requires a robust strategy involving continuous professional development, improved infrastructure, protective measures for students online, and strong leadership. Recommendations are directed towards government bodies and schools to prioritize investment in technology and training, ensuring that primary education in Nigeria and similar contexts can harness the full potential of ICT to prepare students for the 21st century.

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INTRODUCTION

The 21st century is characterized by rapid technological progress, positioning Information and Communications Technology (ICT) as a transformative force across all facets of society, including education. There is a growing consensus among researchers and institutions on the critical need to equip teachers with the competencies to effectively utilize technological tools in primary education (International Society for Technology in Education, 2017). ICT encompasses a broad spectrum of technologies used to communicate, create, disseminate, store, and manage information. From an educational perspective, it includes computers and communication facilities that support teaching, learning, and related activities (Erstad, 2010). The interactive capacity of ICT offers significant potential to create pupil-centered learning environments that cater to individual needs, promote autonomy, and facilitate access to information. Its application in primary schools can enrich the study of core subjects including English, mathematics, and science making learning more accessible and engaging (Akuta, 2025; Akintunde & Akuta, 2022). In the 21st century, ICT is indispensable for educational innovation and reform, serving as a vital tool for enhancing instructional quality and equipping learners to meet the demands of a knowledge-based society (Andrew, 2015).

The integration of ICT in primary education enables the adoption of diverse pedagogical strategies. It supports not only knowledge acquisition but also fosters creativity, accelerates learning, and deepens conceptual understanding (Tondeur et al., 2017). Internet-connected computing devices offer teachers and pupils opportunities to fundamentally reshape teaching and learning processes, reducing sole reliance on printed textbooks and enabling access to a vast repository of digital educational resources.

Primary education, typically serving children aged 6 to 11, establishes the essential foundation for all subsequent learning. ICT can be leveraged to improve the efficiency and effectiveness of educational delivery through both formal and informal channels. Its use promotes enriched interaction among peers, between pupils and teachers, and between schools and parents. Teachers report that well-designed ICT-based tasks and projects unlock educational potential by incorporating digital resources, interactive multimedia, and online communication, which help sustain interest, facilitate interaction, and support knowledge construction (Tondeur et al., 2017). The distinctive learning needs of young children necessitate innovative teaching methodologies, and ICT offers expanded opportunities for interaction and exploration.

Concept of Information and Communications Technology (ICT)

Information and Communications Technology (ICT) functions as an broad term that encompasses a diverse array of digital tools, resources, and methodologies involved in the acquisition, processing, and exchange of information. Within educational contexts, ICT is frequently understood through a dual lens: as a medium for information dissemination and as a medium for knowledge construction (Papert, 2016). This dichotomy mirrors two fundamental educational objectives: the transmission of information and skills (informational) and the facilitation of knowledge creation and discovery (constructional). A balanced integration of both aspects is crucial, prompting some scholars to advocate for the use of the term "digital technologies" to underscore this necessary equilibrium.

In practice, ICT in education constitutes a suite of computer-based technologies deployed to enhance teaching and learning, foster communication and collaboration, and enable creative expression. Its application in primary education is multifaceted, serving not only to improve instructional delivery but also to support creative activities, cognitive development, and specialized learning needs—including the use of educational robotics and introductory programming. The term "ICT skills" is largely synonymous with digital literacy, encompassing foundational competencies in using digital tools. Anderson (2008) expands this notion to "applied information literacy," which integrates technical proficiencies with conceptual understanding. For teachers, this implies the ability to

design ICT-enhanced learning experiences, organize thematic instruction, and evaluate student outcomes effectively.

Beyond the classroom, ICT is deeply embedded in global economic and administrative systems, driving corporate innovation and enabling efficient public infrastructure. Similarly, in education, it adds value to institutional management and learning processes. The internet, in particular, acts as a catalyst for development and innovation worldwide. To harness these advancements, nations must cultivate a professionally skilled workforce capable of leveraging ICT across various domains. As technology continues to reshape labor markets and organizational structures, the demand for higher-order competencies intensifies. Key among these are critical thinking, broad-based analytical skills, technical fluency, adaptive problem-solving, teamwork, and effective communication (UNESCO, 2015).

Factors Associated with Information and Communications Technology Use in Primary Education

Research indicates that the integration of Information and Communications Technology (ICT) into primary education is influenced by a complex set of interrelated factors (Vanderlinde & van Braak, 2010). These can be broadly categorized into teacher-specific characteristics, school-environmental elements, and systemic or infrastructural components. Ultimately, the efficacy of ICT implementation hinges significantly on teachers' capacity to navigate and mitigate these influencing factors.

1. Teacher-Specific Factors

a. Gender

Teacher characteristics, including gender, may influence ICT adoption in primary education (Rogers, 1995; Schiller, 2003). Research by Venkatesh and Morris (2000) on technology adoption in workplace settings, utilizing the Theory of Planned Behavior, suggests that decision-making among men and younger workers is often more influenced by their personal attitudes towards a new technology. In contrast, women and older workers tend to be more affected by social pressures (subjective norms) and perceptions of control over using the technology (perceived behavioral control).

b. Attitudes

Teachers' attitudes constitute another critical determinant of ICT integration (Iwuagwu, Akuta, & Iwuagwu, 2022). These attitudes are themselves shaped by several elements, including self-efficacy, computer anxiety, perceived usefulness, perceived ease of use, and existing computer skills (Beckers & Schmidt, 2003; Davis, 1989; Al-Khaldi & Al-Jabri, 1998). A positive disposition can motivate less proficient teachers to acquire the skills needed for technology-based instruction. Conversely, as Harrison and Rainer (1992) found, negative attitudes are correlated with lower skill levels and a greater resistance to adopting new technologies.

c. Pedagogical Beliefs and Training

The intersection of technological, pedagogical, and content knowledge is crucial, a concept formalized in the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006). This model emphasizes that effective integration requires teachers to synthesize knowledge across all three domains. Studies within Nigeria affirm the importance of assessing and developing this integrative knowledge among both pre-service and in-service teachers (Chukwuemeka et al., 2019; Chukwuemeka & Iscioglu, 2016). Internationally, teacher ICT competency frameworks, such as the one outlined by Thomas and Knezek (2008), encompass key areas including:

a. Technological proficiency and operational skills.
b. The ability to design ICT-enhanced learning environments.
c. Strategies for integrating ICT into curricula to improve outcomes.
d. Using ICT for assessment and evaluation.
e. Leveraging technology for professional productivity.

2. School-Environmental Factors

a. Community Environment

The broader school community—encompassing administrators, parents, and local stakeholders—plays a significant role in ICT integration. A supportive environment provides essential encouragement, resources, and a positive disposition towards technological change, including reliable technical support and encouraging leadership. Without this supportive ecosystem, even schools with adequate equipment may fail to implement and sustain effective ICT use.

b. School Culture

School culture, defined as the shared assumptions, norms, values, and artifacts within a school (Maslowski, 2001), is a paramount consideration for ICT integration. A primary challenge in developing nations is embedding technology into the prevailing cultural fabric (Martinez, 1999). The acceptance of an innovation like ICT depends on its alignment with the existing culture. School leaders are instrumental in cultivating a culture that is receptive to technological and pedagogical innovations (Zaifada & Ebuk, 2020; Ebuk, 2019). These shared perceptions indirectly shape organizational attitudes and behaviors (Devos et al., 2007). Consequently, teacher resistance to technology often signals a fundamental misalignment between the innovation and the school's core cultural values (Albirini, 2006).

3. Systemic and Infrastructural Factors

a. Educational Policy

A clear, well-defined ICT policy at the national or institutional level is critical for guiding integration in primary schools. Such policies provide the necessary strategic framework, mandate, and funding for sustainable implementation (Tondeur et al., 2017), helping to transition ICT from isolated initiatives to a core component of the curriculum. A significant implementation challenge, however, is the gap between policy design and classroom practice. For policies to be effective, they must be practical, sufficiently resourced, and actively championed by school leaders and teachers (Vanderlinde, van Braak & Dexter, 2012).

b. ICT Infrastructure

Effective integration requires reliable hardware, software, and robust internet connectivity (Chukwuemeka & Dominic, 2020; Ohiare-Udebu & Chukwuemeka, 2024). Conversely, barriers arise from absent or obsolete equipment, unreliable internet, limited access to computer labs, and curriculum-specific constraints (Legontis, 2015).

c. Access to Tools

The mere presence of ICT tools in a school is insufficient. Successful integration depends on equitable and reliable access for both teachers and students. This means tools must be functional, available when needed, and supported by appropriate software and connectivity. Often, resources are physically present but inaccessible—locked away, broken, reserved for administrative use, or offline—which prevents their seamless use in lessons and denies students crucial hands-on experience (Iwuagwu, Akuta, & Iwuagwu, 2022; Iwuagwu, Iwuagwu, & Akuta, 2021). Therefore, ensuring available, functional, and well-maintained tools is a fundamental prerequisite for moving from theoretical to practical daily use.

d. Institutional and Technological Factors

This category encompasses the overarching structures that enable ICT use, including stable funding, reliable foundational infrastructure like electricity, and efficient maintenance systems (Buabeng-Andoh, 2012; Ohiare-Udebu & Chukwuemeka, 2024). Furthermore, institutional support through clear guidelines, allocated time for training, and technical assistance is crucial. The absence or instability of these factors creates significant barriers to consistent and effective technology integration in primary education.

Importance of Information and Communication Technology in Primary Education

The integration of Information and Communication Technology (ICT) into primary education is critically important for several compelling reasons that reflect the demands of the 21st century.

First, the unprecedented pace of technological advancement necessitates a parallel evolution in educational systems. To remain relevant and effective, primary education must integrate ICT to bridge the gap between traditional schooling and the digitally-saturated world in which children live. Equipping children with digital literacy skills from an early age empowers them and provides a crucial advantage for future success. This imperative for reform extends to teacher preparation programs, which must be redesigned to ensure they possess the necessary technological and pedagogical competencies for effective integration—a pressing need specifically identified within the Nigerian educational context (Usman, Orji, & Fasanya, 2019).

Second, the pervasive influence of ICT, particularly the internet, on young learners requires a fundamental shift in pedagogical approach. Learning activities must be reoriented from closed, textbook-centric models to dynamic, open-source, and resource-rich environments. The COVID-19 pandemic starkly underscored this necessity, acting as a global catalyst that highlighted the indispensable role of robust ICT systems in ensuring educational continuity during disruptions (Chukwuemeka, Dominic, et al., 2021; Falode, Chukwuemeka, & Falode, 2022). Consequently, ensuring widespread and reliable internet access has become an unavoidable priority for educational authorities.

Third, the prevalence of digital entertainment, including multimedia and online games, presents a challenge that educational institutions must address proactively. Rather than attempting to isolate pupils from these influences—an effort that is largely futile outside school hours—a more effective strategy is for schools to guide digital engagement. Teachers can facilitate this by promoting edutainment and integrating teacher-vetted educational games into the learning process. Furthermore, schools can support parents in monitoring and guiding children's online activities at home. Initiatives such as creating secure class blogs or digital portfolios can channel pupils' creativity into productive online expression, such as sharing stories, poems, and news, thereby reducing the allure of negative content and laying a foundation for responsible and knowledgeable internet use.

Fourth, despite its significance, ICT integration has often been neglected in educational reform agendas, receiving insufficient attention and prioritization from the state. Therefore, a concerted effort and strong initiative from both schools and government institutions is required to champion and advance ICT implementation.

Fifth, teachers are central to this transformation and must act as the primary motivators and initiators of ICT adoption. They need to be conscious agents of change by transitioning from classical teaching methodologies to modern, and technology-enhanced pedagogies. They must actively participate in the global shift towards innovative teaching and learning modifications, as emphasized by UNESCO (2003).

Sixth, the developmental stage of primary school children (typically ages 6-11) makes this level of education uniquely critical. Primary education forms the foundational pillar upon which all subsequent learning is built, and the quality of education received in these formative years significantly influences a child's entire academic trajectory (Akintunde & Akuta, 2021; Iwuagwu, Akuta, & Agbo, 2022). This stage represents a crucial period of cognitive imprinting where children are naturally curious, playful, and receptive to hands-on manipulation. Infusing ICT at this level allows learners to actively construct their educational foundation, equipping them with essential digital skills for lifelong learning and future success (Selwyn & Bullon, 2002). Consequently, primary education represents the most impactful level for introducing and sustaining meaningful educational change.

The Roles of ICTs in Children Education

A central question in modern pedagogy is whether ICT genuinely enhances learning and, if so, how it improves the quality of primary education. The educational effectiveness of ICT is not inherent but is contingent upon its application and pedagogical purpose. While the multisensory appeal of technology can be highly engaging, it is crucial to recognize that ICT, like any educational tool, is not a universal solution and its impact varies across contexts. When utilized effectively, ICT can significantly enhance primary education through three primary roles: (1) increasing learner motivation and engagement, (2) facilitating the acquisition of basic skills, and (3) enhancing teacher training. Ultimately, these tools are considered transformational for their capacity to promote a shift from teacher-centered instruction to a learner-centered paradigm (UNESCO, 2015).

Increasing Learning Motivation and Engagement: The integration of ICT can profoundly increase children's motivation to learn. Primary school pupils, naturally curious, are most receptive to instruction when they are engaged. ICT tools—including videos, television, and multimedia software that synthesize text, sound, and dynamic visuals—can deliver challenging and authentic content that captivates pupils' interest (Altınay-Gazi & Altınay-Aksal, 2017; Tarus, 2015). This sustained motivation fosters greater self-engagement and morale for learning (Umeh & Agbor, 2003). Furthermore, interactive ICT activities that incorporate sound effects, songs, dramatizations, and comic skits serve to compel student attention and active involvement in lessons (Altınay-Gazi & Altınay-Aksal, 2017).

Facilitating the Acquisition of Basic Skills: ICT tools are highly effective in supporting the transmission and mastery of basic skills and concepts that form the foundation for higher-order thinking and creativity. This is often achieved through structured drill and practice exercises (UNESCO, 2015; Altınay-Gazi & Altınay-Aksal, 2017). The efficacy of such technology-assisted strategies is corroborated by research in Nigerian classrooms; studies on collaborative and computational teaching methods in basic science and physics have demonstrated positive impacts on both academic achievement and student interest (Orji, Ogar, & Aiyedun, 2018; Ekpo, Orji, & Ihaq, 2022). Educational television and computer-based learning programs also serve as valuable resources for both teachers and learners, enhancing skill acquisition through repetition and reinforcement (UNESCO, 2015).

Enhancing Teacher Training: ICT plays a vital role in expanding access to and improving the quality of professional development for primary school teachers. Continuous teacher training in ICT should be encouraged. However, for such training to be effective, it must be supported by strong leadership and strategic planning at the school level. School leaders must be at the forefront of reprioritizing resources and fostering a culture of continuous learning among their staff, as indicated by studies on educational management in the FCT (Ebuk, 2019; Zaifada & Ebuk, 2020; Ebuk et al., 2025). Using digital tools enable the scalable training of teachers across different geographical areas, allowing them to collectively gain skills essential for their professional development (Tarus, 2015). This is particularly critical in an era of educational expansion, where improving the quality of training is a paramount concern. ICT-facilitated training provides flexible, accessible opportunities for continuous professional learning, which is essential for effective classroom integration of technology.

The Most Effective ICT Tool in Primary Education

Empirical evidence and teacher feedback frequently identify video as one of the most effective ICT components for primary-level instruction. Educators emphasize that the pedagogical value of video is maximized not only through the medium itself but through creative and thoughtful presentation. The modern scope of educational video is extensive, encompassing multimedia CDs, interactive games, animations, digital slideshows, video books, and digital storytelling all formats that synergize visual, textual, and auditory elements to be delivered across various platforms.

The versatility of video allows for its application in diverse learning contexts. It is particularly powerful for simplifying

abstract or complex curricular topics that are difficult to convey through conventional methods alone. Teachers report high efficacy in using video to teach subjects with strong visual components, such as scientific processes (e.g., planetary movements, biological phenomena, and evolutionary theories), geographical formations, and mathematical concepts. These resources can make so-called 'hard spots' in the curriculum more accessible and engaging for young learners. Furthermore, video has proven effective in subjects like social studies, where it can provide authentic contexts and narratives.

Beyond mainstream classroom enhancement, video serves broader educational purposes, including the production of content on critical themes such as disaster management, child rights, and health education. Innovations like audio description also make video content accessible to visually impaired learners, underscoring its potential for inclusive education.

Despite its recognized benefits, a significant challenge remains the perception of video as an extracurricular supplement rather than an integral pedagogical tool. To overcome this, a clear policy framework for ICT in education, developed through broad stakeholder consultation, is necessary. Successful integration requires systematic capacity building for teachers and schools to reframe educational video not as a mere visual aid, but as a vital extension of experiential learning. However, practical obstacles such as the scarcity of reliable playback devices, computers, and supporting infrastructure in many schools present substantial barriers. Addressing these limitations and achieving seamless integration demands a concerted transformation at the grassroots level, involving collaboration among educational authorities, policymakers, and community agencies.

Challenges facing teachers while integrating ICT in teaching and learning

While teachers are the principal agents driving ICT integration in primary education, their success is contingent upon overcoming a multitude of significant challenges. These barriers can be categorized into issues of preparedness, classroom realities, infrastructural deficits, and systemic support.

1. **Lack of Training and Negative Attitudes**: A fundamental barrier is inadequate professional preparation. Many teachers lack sufficient training, leading to a fear of new technologies, negative attitudes, and a reluctance to incorporate ICT into their pedagogy. This apprehension often stems from a fear of the unknown, resistance to change, and a lack of knowledge on how to use ICT effectively for teaching (Davis, 2003). Without comprehensive and continuous training, teachers cannot be expected to transfer essential digital skills to their learners (Iwuagwu et al., 2021; Akuta, 2021; Chukwuemeka et al., 2019). The dynamic nature of technology necessitates ongoing professional development that provides teachers with time to learn, practice, and collaborate with peers. A critical component of this training must address and reshape teachers' underlying attitudes and beliefs about ICT, as a lack of understanding regarding its purpose and application remains a major impediment to implementation (Higgins and Moseley, 2011; Obijiofor, 2009).

2. **Classroom Management and Logistical Hurdles**: The practical reality of large class sizes presents a formidable challenge to effective ICT integration. Managing a classroom becomes significantly more difficult when limited ICT resources, such as a few computers, must be shared among many pupils. This often leads to chaotic environments, frustrates teachers, and makes it difficult to achieve learning objectives, as only a few students can actively engage with the technology at any given time (Blatchford et al., 2011; Kiptalam and Rodrigues, 2010). While ICT is often proposed as a solution for managing large classes, insufficient tools can paradoxically exacerbate the problem, forcing teachers to adopt inflexible teaching methods.

3. **Inadequate Infrastructure and Technical Problems:** Unreliable infrastructure is a pervasive obstacle. Teachers routinely face technical problems such as power cuts, malfunctioning devices, and a lack of maintenance support. Poor ICT infrastructure, including inadequate computer laboratories, severely limits the potential of technology-enhanced lessons (Iwuagwu, Akuta, & Iwuagwu, 2022; Iwuagwu, Iwuagwu, & Akuta, 2021; Ohiare-Udebu & Chukwuemeka, 2024). A stable power supply is a particularly critical and often overlooked component; erratic electricity remains a fundamental barrier in Nigerian schools, directly disrupting the learning environment (Ekpo, Orji, & Ihaq, 2022). The absence of a proper maintenance structure places an additional burden on teachers, who may be held responsible for broken equipment, thereby fostering a fear of using the technology altogether (Liu and Szabo, 2009). This forces teachers to waste valuable instructional time on improvisation and troubleshooting instead of teaching.

4. **Lack of Administrative and Peer Support**: Effective integration requires robust support systems that are often absent. A lack of informed and decisive leadership from school administrators specifically tailored for technological integration is a significant challenge (Ebuk, 2019; Zaifada & Ebuk, 2020). While supportive leadership and pedagogical assistance are known to encourage technology use (Stoll et al., 2012), the reality is that many teachers feel helpless and overwhelmed due to a lack of collaboration and peer support (Ertmer and Otternbreit-Leftwich, 2010). Without a supportive ecosystem, teachers are left to navigate the complexities of ICT integration alone.

5. **Low Self-Confidence**: Finally, many teachers simply lack the confidence to use ICT in their lessons. This reluctance can be attributed to several factors, including skepticism about the educational effectiveness of computers, poorly designed software, a lack of administrative backing, the considerable time investment required to achieve proficiency, and a fear of diminishing their authority in a more learner-centered classroom environment.

Strategies Teachers Can Adopt to Address the Limitations of ICT Use in Primary Education

The integration of Information and Communication Technology (ICT) into teaching at the primary level offers immense opportunities, but it also presents certain challenges that teachers must carefully address. To ensure safe and effective use of ICT, teachers can adopt the following strategies:

1. Protecting Pupils from Inappropriate Content

Before introducing pupils to web-based projects, it is essential for teachers to review existing school policies on internet use. The internet through blogs, wikis, or social networking platforms can sometimes expose children to unsuitable content. This risk can be reduced by installing filtering software (Becta, 2006) and by teaching pupils, alongside their parents, how to critically evaluate websites for accuracy and appropriateness. By equipping pupils with these evaluative skills, teachers can help them navigate digital spaces responsibly and avoid the dangers associated with unverified or inappropriate online content.

2. Protecting Pupils from Strangers

Children frequently interact through social networking sites, chat rooms, instant messaging, and discussion boards, all of which carry risks if not properly monitored. Teachers, in collaboration with parents, need to establish clear rules for both school and home use. Pupils should be cautioned against sharing personal information online, as this can expose them to unwanted contacts or exploitation. For example, unsolicited emails often contain spam or misleading content, while instant messaging services may allow strangers to disguise their identities. Teachers and parents should therefore monitor pupils' online connections, such as buddy lists, and, where possible, act as moderators in online groups to regulate participation.

Blogging platforms and web pages present further risks, as they may contain adult content or allow unrestricted sharing of personal details such as photos, addresses, or phone numbers. Since any information posted online can easily become public, it is important to train pupils to recognize the dangers of overexposure. With careful guidance, students can still benefit from the rich opportunities these platforms offer for collaborative learning and knowledge sharing, while remaining protected from potential predators.

3. Establishing Guidelines and Promoting Digital Etiquette

To maximize the benefits of ICT while reducing risks, teachers should establish clear rules for classroom use of digital tools such as emails, blogs, and web forums. These guidelines should not only regulate behavior but also promote awareness of online safety. Parents should be involved in these discussions, as their role in reinforcing safe digital habits at home is crucial. Just as children are taught manners and social etiquette in face-to-face interactions, they should also be introduced to "netiquette" which are the standards of respectful and responsible behavior online. When consistently applied, such guidelines foster a safe, structured, and engaging learning environment.

Conclusion

In conclusion, the integration of ICT in primary education is not merely a luxury but a necessity for preparing young learners for a digital future. This paper has demonstrated that while the potential benefits are profound, including increased student motivation, facilitated acquisition of basic skills, and enhanced teacher training – the path to effective integration is fraught with challenges. These challenges are complex, stemming from teacher preparedness, institutional constraints, infrastructural deficits, and broader socio-economic factors. The successful implementation of ICT is therefore dependent on a holistic approach with a concerted and dedicated effort from all stakeholders which will address these interconnected issues simultaneously. It requires committed leadership, continuous and practical teacher professional development, significant investment in reliable infrastructure, and the development of clear safety protocols for students. By adopting the strategies outlined and heeding the recommendations for stakeholders, educational systems, particularly in developing nations like Nigeria, can overcome these barriers. Ultimately, a concerted effort will ensure that ICT fulfills its promise as a transformative tool, shifting the educational paradigm from traditional, teacher-centered instruction to a modern, engaging, and student-centered learning experience.

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