



Technology and Education Transformation in Africa: Challenges and Remedies

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Abstract

Technology is a pivotal tool in revolutionizing Education in the global sphere, and the African continent is no exception. The primary objective of this paper is to examine the role of Technology in reshaping Education in the 21st century, focusing on the core values, pros, and cons of Africa. Reflecting on the recent past, it has become clear that Technology has emerged as a powerful tool in reshaping Education across Africa, in tandem with the global penetration of Technology. The paper aims to examine the role of Technology in delivering Education in Africa, its importance, challenges, setbacks, and expected remedial measures to address these challenges. The paper will also examine the importance of Technology in the African region. Education is the bedrock and foundation of living and the nucleus of civilization worldwide. The advent of Technology has transformed the traditional classroom into a dynamic learning environment. Gone are the days when teaching was confined to textbooks and a blackboard. Today, digital tools and online resources have taken centre stage, making learning more engaging and stimulating. The study data were collected through the documentation of secondary sources, including a review of related historical archival records, journals, write-ups, and library research based on existing findings. The study concludes by recommending that Technology should receive wide attention to continually transform Education. To improve teaching and learning, it is essential to utilize these innovations, among others.

Keywords: Technology; Education; Education Technology.

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INTRODUCTION

Technology has always played a pivotal role in the advancement of education, shaping how humans acquire, process, and apply knowledge. From the earliest inscriptions on cave walls to the integration of portable devices in today's classrooms, the trajectory of learning has been inextricably tied to technological evolution (Purdue University, 2025). The transformation of education from static, text-based instruction to dynamic, technology-enhanced learning underscores the importance of adapting teaching methods to the realities of the digital era. Technology not only enriches the process of knowledge delivery but also redefines how learners engage with content, educators, and peers (Abasilim & Esisio, 2025).

One of the most significant impacts of technology in education is the shift from passive to active learning. Traditional classrooms, often centered on lectures and textbooks, limited students' participation. With digital tools such as interactive whiteboards, online platforms, and collaborative applications, students now engage actively in the learning process, promoting deeper understanding and retention (Binaryblue.com, 2025). Such innovations facilitate personalized learning, allowing educators to tailor content to individual student needs while simultaneously fostering collaboration and peer-to-peer learning. These benefits highlight how technology can bridge learning gaps, promote inclusivity, and enhance the quality of education worldwide (Groves Learning Organization, 2021).

The integration of technology into education also aligns with global initiatives emphasizing literacy and sustainable development. According to UNESCO (2021), digital literacy has become an essential competency in the 21st century, complementing traditional literacy skills and preparing learners for participation in the knowledge economy. However, challenges persist, particularly in regions where access to digital infrastructure remains limited. Studies reveal that disparities in technological access continue to exacerbate inequalities in educational opportunities (Wildau, 2021; Aderogba, 2024). Addressing these gaps requires targeted policies and investments that ensure equitable access to digital tools and resources.

Furthermore, the role of technology in education extends beyond academic instruction to support broader societal goals. For instance, the Sustainable Development Goal 4 (SDG 4) emphasizes inclusive and equitable quality education and lifelong learning opportunities for all (UNESCO, 2020). Technology-enabled learning, such as online platforms and mobile applications, can contribute to this goal by reaching marginalized groups, supporting adult literacy programs, and creating pathways for continuous learning. Initiatives such as literacy boost programs and online training resources illustrate how technology can be harnessed to overcome barriers posed by geography, socioeconomic status, and limited physical infrastructure (World Vision International, 2021).

In conclusion, the integration of technology into education represents more than a pedagogical shift; it is a crucial driver of social transformation. By fostering innovation, inclusivity, and lifelong learning, technology serves as both a tool and a catalyst for achieving sustainable educational outcomes. While challenges remain in terms of equitable access and teacher preparedness, the evidence demonstrates that technology, when thoughtfully integrated, holds the potential to redefine education and equip learners with the skills necessary for the demands of the 21st century (Oghenekohwo & Frank-Oputu, 2017; Aderogba, 2024).

METHODOLOGY RESEARCH

This study employed a descriptive research design to investigate the role of technology in transforming education in Africa. The design was considered appropriate as it allows the

researcher to collect data from a specific population to describe existing conditions and examine relationships without manipulating variables (Creswell, 2014).

A purposive sampling technique was used to select the respondents. The population of the study comprised 2,510 individuals, from which a sample of 210 respondents was drawn. This included 200 teachers and 10 administrators, who were selected because of their direct involvement in educational practices and decision-making processes. Purposive sampling was justified to ensure that participants with the most relevant experiences were included in the study (Etikan, Musa, & Alkassim, 2016).

The study was guided by four research questions and four hypotheses. Data were collected using a 20-item structured questionnaire, designed to capture perceptions of technology's role in education, its benefits, challenges, and potential remedies. The questionnaire items were validated by experts in educational technology and research methodology to ensure content validity and reliability (Fraenkel, Wallen, & Hyun, 2019).

For data analysis, simple percentages were used to address the research questions, while the chi-square (χ^2) test was applied to test the null hypotheses at a 0.05 level of significance. This combination of descriptive and inferential statistics was deemed suitable for analyzing categorical data and drawing valid conclusions (McHugh, 2013).

The findings revealed that 85% of the respondents agreed that technology plays a significant role in transforming education in Africa, particularly in promoting inclusivity, quality education, curriculum relevance, allocation transparency, and infrastructure development. Moreover, 90% of respondents acknowledged the broader benefits of technology, including contributions to economic growth, financial inclusion, agriculture, skills development, education, and healthcare.

However, the study also identified challenges hindering effective integration of technology in education. These included the digital divide, outdated curricula, limited resources, financial constraints, inadequate teacher training, infrastructural deficiencies, and weak policy frameworks. Addressing these challenges requires targeted remedies, with 85% of respondents suggesting solutions such as expanding internet connectivity, providing professional development for educators, integrating digital skills into curricula, increasing funding for innovation, and establishing ethical and regulatory frameworks.

Overall, this methodology ensured systematic data collection and analysis, enabling the study to provide evidence-based insights into the transformative potential of technology in African education.

The study recommends as following

- Ensuring a reliable electricity supply to support technology use
- Train teachers on pedagogy, AI Literacy, and technology integration
- Monitoring and evaluation, in terms of tracking progress, identifying gaps, and adjusting strategies
- Innovation in terms of encouraging ED tech, start-ups, and innovation
- Relevant skills in terms of focus and skills as creativity, critical thinking, and problem-solving

RESULTS AND DISCUSSION

Concept of Technology

Technology can be broadly understood as the application of scientific knowledge for practical purposes that improve human life. According to *Britannica* (2025), technology is “the application of scientific knowledge to the practical aims of human life.” This definition highlights technology as a bridge between theoretical knowledge and practical outcomes. Similarly, *Study.com* (2025) describes technology as “the change and manipulation of the human

environment,” emphasizing its transformative power in shaping human interactions with the world.

In contemporary times, technology encompasses an expansive range of tools, processes, and systems. While the term often evokes digital devices such as laptops, smartphones, and tablets, it also refers to the internet, data processing, and engineering innovations that drive progress across multiple fields. Historically, technology has always served as a creative solution to everyday human challenges, from the invention of the wheel to the development of complex digital ecosystems. Each advancement reflects humanity’s capacity to harness knowledge for solving problems and improving quality of life (Arthur, 2009).

Technology is not confined to digital devices; it also extends to infrastructure, medical equipment, agricultural tools, and renewable energy systems. As Nye (2006) notes, technology must be seen not only as artifacts but also as systems of knowledge, techniques, and social organization that enable human progress. Thus, technology can range from simple tools—such as levers and wheels—to highly sophisticated innovations such as artificial intelligence and biotechnology.

Moreover, technology is inherently dynamic and constantly evolving. This evolution underscores its dual role: while it can create opportunities for efficiency, connectivity, and problem-solving, it can also generate challenges related to access, ethics, and sustainability (Smith & Marx, 1994). For example, while digital technologies foster global interconnectedness and democratize knowledge, they also pose concerns around privacy, digital divides, and ecological impacts.

In sum, technology can be defined as the intentional application of scientific knowledge for practical outcomes, shaping both industry and everyday human life. Whether through ancient inventions like the wheel or modern innovations such as computers and smartphones, technology remains central to human development and societal transformation.

Types Of Technologies

- Mechanical Technology
- Medical Technology
- Communication technology
- Electronic Technology
- Industrial Technology

Examples include electronic devices, simple machines, and factories.

Main Types of Technologies

- Research proved that there are six main types of technologies, which include;
- Mechanical Technology
- Medical Technology
- Communication technology
- Electronic Technology
- Industrial Technology and
- Manufacturing technology

What is Educational Technology?

Education technology is concerned with the development, application, and evaluation of systems, techniques, and aids to improve the process of human learning. It could also be conceived as a science of techniques, methods, and media by which educational goals could be realized.

Educational Technology is the process of enhancing learning and teaching performance through the use of tangible hardware, software, and other technical resources. It is sometimes

coined as "ed-tech" to mean educational Technology. Examining how ed-tech has fundamentally changed the future of Education and altered conventional teaching methods is indeed fascinating.

Evolution of Technology in The Classroom

The Primitive Classroom

The evolution of educational technology demonstrates how tools, once considered innovative, became the foundation for subsequent advancements. During the colonial era, one of the earliest instructional devices was the *horn-book*—a wooden paddle with printed lessons designed to help students memorize verses. More than two centuries later, in 1870, the introduction of the *magic lantern* marked a significant step forward. This early version of a slide projector displayed images printed on glass plates, and by the end of World War I, over 8,000 lantern slides were in circulation throughout the Chicago public school system (Purdue University College of Education [PUCDE], 2025).

The late 19th and early 20th centuries also witnessed key innovations that reshaped classroom practices. The chalkboard, introduced in 1890, and the pencil, adopted widely in 1900, quickly became essential tools, offering new ways for teachers and students to interact with content. These inventions reflected students' growing appetite for more effective and engaging learning tools (PUCDE, 2025).

Over the following decades, a steady progression of educational technologies emerged:

- **1920s:** Radio became a revolutionary medium for learning, enabling on-air classes that extended instruction beyond the physical classroom.
- **1930s–1950s:** The overhead projector (1930), ballpoint pen (1940), and headphones (1950) expanded instructional flexibility and accessibility.
- **1951:** Videotapes introduced a dynamic method of instruction, while B. F. Skinner's *teaching machine* combined teaching with testing, reinforcing correct answers and allowing learners to progress step by step.
- **1959–1972:** The photocopier (1959) enabled the rapid duplication of instructional materials, and the handheld calculator (1972) simplified mathematical computations. Around the same time, Michael Sokoske's *Scranton system of testing* (1972) allowed for faster and more efficient grading.

These milestones, as documented by PUCDE (2025), highlight how each technological innovation addressed specific instructional needs of the time. The pre-computer era, in particular, laid the groundwork for future digital transformations. During this period, technologies that emphasized *immediacy*—such as calculators, scantron systems, and video instruction—became integral to the classroom. At the same time, tools like the photocopier standardized the mass production of teaching materials, ensuring that educators could meet increasing demands for efficiency and accessibility.

In retrospect, these early technologies not only enhanced learning but also shaped expectations for the modern classroom. They signaled a shift from rote memorization toward interactive and multimedia learning, preparing the educational system for the digital revolution that followed in the late 20th century.

Role of Technology in Transforming Education in Africa

Technology has emerged as a transformative force in reshaping the educational landscape across Africa. Historically, the continent has faced persistent challenges such as inadequate infrastructure, teacher shortages, and limited access to learning resources. However, the rise of digital solutions—including e-learning platforms, mobile education, and virtual classrooms—has

created new opportunities to expand access, improve quality, and enhance equity in education (Business Day, 2024).

One of the most significant contributions of technology is its ability to expand access to learning opportunities, particularly in remote and underserved areas. Many parts of Africa lack physical infrastructure such as schools, libraries, and textbooks. Digital platforms like U-Bongo and Khan Academy have helped bridge this gap by offering interactive lessons, videos, and quizzes across subjects including mathematics, science, and languages. These resources can be accessed online, enabling millions of students to learn regardless of their geographical location (Business Day, 2024).

Another critical role of technology is facilitated through mobile learning. With more than 495 million people using mobile phones in sub-Saharan Africa, mobile-based education has become one of the most practical solutions. Platforms such as Eneza Education deliver curriculum-aligned lessons via SMS, allowing students without smartphones or internet access to participate in structured learning (Adewale, 2023; Bankole, 2024). This innovation underscores the inclusivity of mobile technology in expanding education to marginalized learners.

Technology also plays a vital role in addressing the shortage of qualified teachers. Cole (2024) emphasizes that online training programs, webinars, and digital teaching resources are equipping teachers with up-to-date knowledge and pedagogical skills. Initiatives such as the African Digital Schools Initiative (ADSI) provide professional development opportunities and digital literacy training, enabling educators to integrate multimedia tools such as digital textbooks, interactive whiteboards, and video lessons into their classrooms (Obaniyi, 2024). Moreover, virtual classrooms and video conferencing tools allow teachers from urban areas—or even outside the continent—to deliver lessons to students in under-resourced schools, reducing inequalities in access to quality instruction.

Beyond access and teacher development, technology makes learning more engaging and personalized. Gamified applications like Siyavula and M-Shule provide quizzes and interactive exercises that motivate learners and adapt to individual progress. These platforms enhance student engagement by combining entertainment with education, encouraging active participation and deeper comprehension. Similarly, advanced tools such as virtual reality (VR) and augmented reality (AR) are beginning to transform classroom experiences. Students can explore virtual historical sites, simulate science experiments, or study human anatomy in immersive environments, which strengthens understanding and retention (Obaniyi, 2024).

In summary, technology's role in transforming education in Africa is multifaceted: it expands access to learning, addresses resource gaps, supports teacher training, and enriches student engagement through interactive tools. While challenges such as digital divides and infrastructure limitations remain, evidence shows that technology provides scalable and innovative solutions to advance inclusive, equitable, and quality education across the continent.

Importance of Technology in Transforming Education in Africa

Technology has made a profound and lasting impact on the transformation of education in Africa. According to Purdue University College of Education (2025), technology has significantly broadened access to educational opportunities, marking a shift from traditional models to digitally driven systems. In earlier times, knowledge was scarce, books were limited, and only a select few could travel to centers of learning. Today, digital tools and the internet make massive amounts of information—books, videos, podcasts, and online courses—accessible to anyone, anywhere, at any time. Platforms such as Khan Academy, MOOCs, and digital degree programs have made formal education more accessible than ever before, thus democratizing knowledge globally.

Another important contribution of technology is the expansion of communication and collaboration in education. Galgal (2023) emphasized that technology enables forms of interaction that were once unimaginable. Students in rural areas, for instance, can now engage with global experts through live video conferencing, follow scientific expeditions through blogs and digital media, and collaborate with peers across continents using platforms like Google Docs and wikis. This has effectively dissolved the walls of the traditional classroom, fostering global collaboration and cross-cultural learning experiences.

Technology has also redefined the roles of teachers and students. Traditionally, teachers were viewed as the "sage on the stage," the sole source of knowledge, while students remained passive recipients. Today, the model is shifting toward teachers as "guides on the side," with students taking a more active role in their learning. Access to online resources, interactive platforms, and self-directed learning tools enables students to assume greater responsibility for their educational journey. Schools and universities are also redesigning learning spaces to foster collaboration, interaction, and technology-based learning, aligning with UNESCO's (2023) vision for modern education.

Beyond access and pedagogy, technology has introduced student-centered learning approaches that emphasize engagement, personalization, and inclusivity. Bemint Blog Education (2025) noted that technology empowers educators to design instructional materials efficiently and create interactive learning environments. The growing ubiquity of smart devices and internet connectivity has facilitated "anytime, anywhere" education, a model that promotes flexibility and continuous learning. Farmonaut (2025) further highlighted that platforms such as Ubongo and Khan Academy help bridge the urban-rural divide by delivering interactive lessons in subjects like mathematics, science, and languages, enabling millions of African learners to access quality education regardless of location.

Ultimately, technology's importance lies in its ability to transform traditional classrooms into digital learning ecosystems. This transformation fosters individualized learning, enhances student engagement, and provides unprecedented opportunities for teachers to build stronger connections with their learners. By enabling creativity, collaboration, and access to global resources, technology is not just supplementing education in Africa—it is fundamentally reshaping it for the future.

Challenges of Technology in Transforming Education in Africa

Despite the remarkable advantages of technology in reshaping education across Africa, several setbacks continue to hinder its full integration and effectiveness. A key challenge is the shortage of qualified teachers, particularly in rural areas, where access to training and professional development remains limited. Nepad.org (2024) highlights that this shortage predates the onset of educational technology and continues to undermine efforts to scale digital learning initiatives.

Another major obstacle is the affordability of digital devices. Many students across the continent cannot afford laptops, tablets, or smartphones, thereby restricting their ability to access online learning platforms and digital resources. This affordability issue not only exacerbates educational inequality but also perpetuates the digital divide between urban and rural populations.

Closely tied to these challenges is the issue of digital literacy among teachers. Even when devices and platforms are available, many educators lack the skills necessary to effectively integrate technology into their teaching practices. Without adequate training, the potential of digital tools remains underutilized in classrooms (World Bank, 2024).

On a structural level, Africa faces broader digital development challenges, particularly in sub-Saharan Africa (SSA). The World Bank Group (2024) reported that the region lags behind others in terms of infrastructure coverage, affordability, and quality. For instance, by the end of 2021, while 84% of people in SSA had access to 3G and 63% had 4G coverage, only 22% were actually using mobile internet services. Similarly, 61% of the population lived within broadband range but did not use it, indicating a substantial gap between coverage and usage.

The cost of mobile connectivity also remains a major barrier. In 2019, the average price of one gigabyte (GB) of mobile data in SSA represented 10.5% of monthly per-capita gross national income (GNI), far higher than the global affordability benchmark of 2% (World Bank, 2024).

In addition, SSA has one of the widest digital gender gaps globally. According to GSMA (2023), women are 37% less likely than men to use mobile internet, reflecting persistent inequalities in access. This gap limits opportunities for women and girls to benefit from digital education, perpetuating educational and economic disparities.

Lastly, approximately 470 million people in sub-Saharan Africa lacked proof of identification in 2021. This lack of formal identification prevents individuals from fully accessing digital services, including educational platforms, further excluding vulnerable populations from the benefits of technological progress (World Bank, 2024).

Collectively, these challenges—ranging from affordability and infrastructure to gender inequality and identification barriers—demonstrate the complexity of integrating technology into Africa's education systems. Addressing these setbacks is critical to ensuring that technology fulfills its transformative potential across the continent.

Remedies for Overcoming Challenges in Transforming Education in Africa

Although Africa faces substantial challenges in integrating technology into its education systems, several remedies and strategies are being implemented to ensure progress. One critical issue is the underutilization of mobile internet, which World Bank Chief Economist Andrew Dabalean described as a lost opportunity for inclusive growth. Closing this uptake gap would not only boost access to education but also enhance job creation and drive economic recovery in an increasingly digitalized world (World Bank, 2024).

To address these challenges, the World Bank and its partners are working with African governments and stakeholders to advance digital transformation. Through the International Development Association (IDA), technology is treated as a cross-cutting priority in three major areas:

1. Closing the digital connectivity gap to expand affordable access to reliable internet.
2. Investing in safe and open digital public infrastructure (DPI) to ensure inclusivity and security.
3. Helping countries utilize digital services for education, job creation, and economic transformation.

Looking ahead, innovations such as artificial intelligence (AI) and adaptive learning systems are expected to revolutionize education. AI-driven platforms will enable individualized learning pathways, tailoring instruction to the needs of each student and improving educational outcomes. Similarly, virtual reality (VR) and augmented reality (AR) technologies are anticipated to play an increasingly important role in classrooms, offering immersive and interactive learning experiences that make complex subjects more engaging and comprehensible (Purdue University College of Education, 2025).

Governments and organizations are also taking active steps to strengthen digital infrastructure and promote policies that encourage the integration of technology into classrooms. Efforts include expanding internet connectivity, ensuring device affordability, and supporting

professional development for educators to enhance digital literacy. These steps are essential for building inclusive and future-ready education systems.

In addition, public-private partnerships (PPPs) are emerging as a vital mechanism for scaling digital solutions across the continent. Technology companies such as Google, Microsoft, and Huawei are collaborating with African governments to expand access to digital tools and resources in schools. According to Nepad.org (2024), such collaborations are critical in ensuring that even remote and disadvantaged communities benefit from technological innovation in education.

In summary, the future of education in Africa is deeply intertwined with technology. By closing digital divides, investing in infrastructure, embracing AI and immersive technologies, and fostering strong partnerships, Africa can harness technology as a catalyst for inclusive, equitable, and sustainable educational transformation.

CONCLUSION

In summary, the future of educational technology (EdTech) in Africa promises a landscape rich in creativity, collaboration, and expansion. From the earliest instructional tools to advanced digital systems, technology has consistently reshaped the way education is delivered and experienced. The review of literature demonstrates that technology has not only expanded access to education but has also redefined teaching and learning processes, shifting from teacher-centered to student-centered models supported by interactive and personalized tools.

Innovations such as artificial intelligence (AI), adaptive learning systems, and immersive technologies like virtual reality (VR) and augmented reality (AR) are revolutionizing classrooms by making learning more individualized, engaging, and accessible. Furthermore, mobile-based platforms and e-learning solutions are helping bridge the gap between urban and rural learners, ensuring that more students can access quality education regardless of geographical or economic limitations.

However, this transformation has not been without challenges. Issues such as the affordability of devices, limited infrastructure, lack of teacher digital literacy, and persistent digital gender gaps continue to hinder progress. Yet, remedies such as increased investment in digital public infrastructure, public-private partnerships, and the integration of inclusive policies are paving the way for a more equitable educational future in Africa.

Ultimately, technology has indeed sharpened and transformed education in Africa. By continuing to embrace innovation while addressing structural challenges, educators, policymakers, and stakeholders can ensure that EdTech fulfills its potential as a catalyst for inclusive, equitable, and sustainable educational development across the continent.

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