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Assistive Innovative Technology for Inclusive Education in Nigeria: Benefits and Challenges

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Abstract: *Inclusive education has evolved significantly by integrating innovative technologies that enhance accessibility and learning experiences for students with diverse needs. This paper explores the role of assistive technologies, artificial intelligence (AI), adaptive learning systems, and immersive learning in promoting inclusive computer education. AI-powered tools, such as speech recognition software, text-to-speech converters, and predictive text applications, assist learners with disabilities in overcoming learning barriers. Adaptive learning technologies use AI-driven algorithms to personalize educational content, improving engagement and academic performance. Additionally, virtual and augmented reality provide interactive simulations that help students, particularly those with special needs, develop cognitive and technical skills in a controlled environment. Despite these advancements, challenges such as high implementation costs, inadequate infrastructure, and insufficient teacher training hinder the widespread adoption of assistive technologies. Sustainable funding models, robust policy interventions, and ongoing professional development for educators are crucial to ensuring effective technology integration. Furthermore, user-centered design approaches involving students with disabilities in developing assistive tools can enhance usability and effectiveness. This review's findings highlight innovative technologies' transformative potential in fostering an inclusive learning environment. Leveraging AI, adaptive learning, and immersive technologies, educators can create more accessible and engaging computer education programs.*

Keywords: *Assistive, Innovation technology, Inclusive education, Benefits, Challenges*

Introduction

Innovative technology is critical in promoting inclusive education, particularly in computer education. The objective is to ensure that all learners, regardless of their abilities or disabilities, have equal access to educational resources and opportunities. Integrating innovative technologies has significantly improved accessibility, particularly in computer-based learning. Assistive technologies play a crucial role in this transformation by addressing barriers faced by students with disabilities. With rapid advancements in artificial intelligence, augmented reality, virtual reality, and adaptive devices, students can now engage more effectively in digital learning environments. Technological innovation has revolutionized inclusive education by creating tools that cater to diverse learning needs.

According to de Zúñiga *et al*. (2023), the ability of non-human computers to carry out intelligent tasks based on data-driven decision-making is artificial intelligence. By providing adaptive learning systems that modify content according to a student's ability, artificial intelligence has significantly contributed to the personalization of education. Chatbots and virtual assistants powered by AI offer real-time assistance, assisting students with cognitive impairments in comprehending ideas and utilizing digital platforms. AI-powered reading aids have also shown promise in helping those with learning disabilities that impact their reading and writing skills. Olayemi and Oluwaseun (2024) reported that students with dyslexia may not be able to read words even if they have studied and taught them several times. Reading or sounding out words that the child knows may take extra effort. Additionally, students with dyslexia may even mix up letters and read, interpret, or say them in an incorrect order.

Augmented reality (AR) and virtual reality (VR) introduced immersive learning experiences that enhance comprehension for students with disabilities. AR applications allow visually impaired students to access digital information in tactile or auditory formats, while VR simulations provide an engaging learning environment for students with mobility impairments. Research has shown that ramified VR platforms help students with autism spectrum disorder (ASD) develop social and cognitive skills in a controlled environment, as observed by Failla *et al*. (2024).

The Internet of Things (IoT) has created smart classrooms that enhance accessibility. IoT-based adaptive learning environments can adjust lighting, sound, and screen settings based on individual needs, benefiting students with sensory sensitivities. Wearable IoT devices provide real-time feedback for students with hearing impairments, improving their engagement in class discussions. Smart boards, which enable interactive learning experiences, have also proven effective for students with motor disabilities (Xie *et al*., 2022).

Innovative technologies refer to new or improved tools, systems, methods, and processes that significantly enhance existing solutions' efficiency, effectiveness, or capability (Schilling, 2020). These technologies typically arise from advancements in science and engineering by their ability to solve problems novelly, improve user experiences, reduce costs, or create new markets. Innovative technology has revolutionized how we live and work in recent years, with advancements in various fields such as healthcare, transportation, communication, and many others. These technologies have made our lives more convenient and efficient and opened up new opportunities for research, development, and growth in various industries.

Assistive technology comprises various tools and systems designed to support individuals with disabilities in performing tasks across different aspects of life. Computer education has bridged accessibility gaps by enabling students with disabilities to participate fully in digital learning. Screen readers such as JAWS and NVDA help visually impaired students navigate digital content by converting text into speech. Magnification software enhances text visibility for low-vision students, ensuring they can comfortably access educational materials (Al-Azawei and Lundqvist, 2022). Speech recognition and text-to-speech applications have also enhanced accessibility. Speech-to-text software, such as Dragon NaturallySpeaking, allows students with

mobility impairments or writing difficulties to dictate their responses. Text-to-speech tools support students with dyslexia by reading aloud digital content and improving their comprehension (Alper and Gross, 2020).

Adaptive input devices have further expanded accessibility in computer education. Eye-tracking technology enables students with severe mobility impairments to control computers using only their eye movements. Specialized keyboards and joysticks are available to accommodate individuals with motor challenges, ensuring they can effectively interact with digital content. Tactile and haptic technologies, including devices like the Dot Pad, allow blind students to read digital Braille text and feel graphical representations through touch-based feedback (Al-Azawei and Lundqvist, 2022).

Inclusive Education

Inclusive education refers to practices that allow all individuals, including those with disabilities or learning differences, to participate fully in educational activities. It promotes the idea that all students can learn and benefit from a diverse learning environment where the necessary support and accommodation to succeed are available. According to Margas (2023), this focuses on creating a supportive and accepting classroom environment where all students feel valued and included.

One of the fundamental tenets of inclusive education is that every student has the right to the same curriculum and teaching, irrespective of any barriers or difficulties. Teachers must modify their teaching strategies and methods to meet the needs of every student and give them the resources and skills they need to succeed. According to Ng and Kwan (2020), inclusive education also highlights the value of cooperation and teamwork between educators, parents, and students to guarantee that every child gets the assistance they require to achieve.

Rujs *et al*. (2010) found that students with disabilities in inclusive classrooms significantly improved their academic and social skills compared to those in segregated classrooms. Additionally, research by Gallagher *et al*. (2015) found that inclusive education can help promote positive attitudes and acceptance of diversity among students, leading to a more inclusive and supportive school community. Also, inclusive education has positively affected student achievement. Mastropieri and Scruggs (2010) observed that students in inclusive classrooms perform better academically and show more significant gains in reading and math skills than in segregated classrooms. The mentions highlight the importance of giving all students equal access to high-quality education and support services, regardless of their abilities or disabilities.

Creating places, services, gadgets, or goods that are useful to everyone, including those with disabilities, is known as accessibility. It guarantees that people may see, comprehend, navigate, and engage with various systems and infrastructures unaffected by limitations. Devices, software, or equipment known as assistive technologies are to help people with disabilities complete tasks that would otherwise be challenging or impossible. This technology allows them to access information and engage more fully in daily life. Assistive technology includes peripherals, software, hardware that help individuals with impairments access computers or other

information technologies, and mobility devices like wheelchairs and walkers. For instance, people with restricted hand functions might utilize a keyboard with large keys.

Accessibility and assistive technology are interconnected concepts aimed at creating an inclusive society where individuals with disabilities can participate fully and independently. When designing accessible environments and implementing appreciative assistive technologies, barriers and minimized equal opportunities are promoted for all. Fernández-Batanero *et al*. (2022) recommended that incorporating assistive technologies in education can improve the academic performance and overall well-being of students with disabilities. The authors mentioned the importance of providing accessible learning materials and technologies to ensure all students have the support they need to succeed in school. Similarly, assistive technologies in inclusive classrooms can facilitate communication and collaboration among student with disabilities and their peers. Scheef *et al*. (2019) emphasized the role of technology in promoting inclusive education and fostering a sense of belonging for all students.

In addition to scholarly study, several organizations and resources support the promotion of accessibility and assistive technologies in education. The National Center for Universal Design for Learning provides materials and principles to help educators develop inclusive learning environments for all students. Assistive technology and accessibility are essential for advancing inclusive education and guaranteeing that every student has the resources they require to thrive. Teachers may establish a more welcoming and encouraging learning environment for all students by implementing these resources in the classroom.

Computer Education and Innovation Technology

Computer education has become a fundamental component of modern learning, equipping students with essential digital skills required for academic and professional success. As technology evolves, computer education has expanded beyond basic digital literacy to encompass advanced fields such as programming, artificial intelligence, cybersecurity and data science. However, ensuring that computer education is inclusive remains a significant challenge, particularly for students with disabilities. The integration of assistive technologies and innovative accessibility tools has played a crucial role in making computer education more equitable and inclusive for all learners. Since technology is developing so quickly, digital tools are becoming essential in the classroom. Critical thinking, problem-solving, and analytical abilities are developed through computer education and are vital for students in all areas. Access to computer-based learning environments can be life-changing for students with disabilities, providing individualized and flexible learning experiences that are catered to their specific needs. Students who have visual, auditory, or motor disabilities can still interact with digital learning materials such as screen readers, speech-to-text apps, and adaptive input devices.

Today, AI provides individualized learning experiences, it has further improved inclusion in computer education. To guarantee that students with learning disabilities get the help they require, AI-driven solutions are able to evaluate students' progress, recognize learning difficulties, and offer real-time support. Research has shown that AI-powered reading assistants and speech

recognition tools significantly improve comprehension and communication skills among students with dyslexia and speech impairments (McClain *et al*., 2022).

Innovative Technology Inclusion in Teaching Computer Education Courses

Innovative technologies encourage inclusion in computer courses, guaranteeing that every student has equal educational opportunities regardless of background or skill level. Turning text into speech, assistive technologies - like screen readers and text-to-speech software - help students with visual learning difficulties engage entirely in class. According to Adebayo and Ayorinde (2022), assistive technology significantly improves computer science instruction for children with special needs in inclusive learning settings.

Furthermore, artificial intelligence (AI) has revolutionized education by providing individualized learning experiences. AI-powered learning resources adjust to each student's unique learning preferences and rates, guaranteeing that every student receives instruction specifically catered to them. Olakunle *et al*. (2024) found that AI-driven platforms improve digital literacy and inclusivity, leading to better academic performance and engagement.

Information and Communication Technologies (ICTs) also contribute to inclusive education by providing various digital resources that address diverse learning challenges. Johnson and Udo (2020) highlight how integrating ICTs into classrooms can help create a more accessible learning environment that meets the needs of all students. Integrating advanced technologies such as assistive tools, AI-driven learning, and ICT resources has greatly enhanced inclusivity in computer education. These innovations ensure that all students, regardless of their challenges, have access to quality education and the opportunity to succeed.

Challenges of Assistive Technology in Nigeria

Despite the benefits of adaptive innovation education, various challenges have served as barriers or setbacks to effectively adopting these innovative technologies in Nigeria. These are:

i. **Lack of Infrastructure**: There is inadequate infrastructure for implementing innovative technology, which is currently trending in the global system and which every educational sector is adopting. Ijadunola *et al*. (2018) observed the infrastructural challenges faced by students with disabilities at Obafemi Awolowo University, Ile-Ife. The research found that only the administrative building had a functioning elevator and a mere 54.5% of lecture theatres were equipped with public address systems. This lack of infrastructure remains a significant challenge in Nigeria's adoption and effective use of assistive technology. Addressing this issue requires government intervention, investment in technology and public facilities, and promotion of local production of assistive devices. By improving infrastructure, Nigeria can create a more inclusive society where persons with disabilities have equal opportunities to thrive.

ii. **Lack of Adequate Software**: The Implementation of assistive technology (AT) in Nigeria faces significant challenges due to a lack of adequate software that narrows it

to the needs of individuals with disabilities. Okonji and Ogwezzy (2018) opined that awareness and knowledge of assistive computer technologies (ACTs) among visually impaired individuals in Nigeria are notably low, with only 36% of visually impaired adults aware of ACTS and a mere 17.4% possessing sound knowledge of their usage. This limited awareness contributes to the underutilization of available assistive software. Therefore, there is a need for increased investment in local software development, ensuring affordability and relevance to users to address the lack of adequate software assistive technology. The government should provide training programmes to equip users and learners with the necessary skills, while nationwide awareness campaigns can promote the adoption of available tools.

iii. **Lack of Trained Teachers**: The shortage remains a major challenge in effectively implementing assistive technology (AT). Many educators lack the necessary skills to integrate AT into teaching, limiting its impact on students with disabilities. Without proper training, teachers struggle to use specialized software, adaptive devices, and inclusive teaching strategies that support learners with special needs. According to Adeoye and Olubela (2017), most Nigerian teachers have limited exposure to AT tools, making it challenging to provide inclusive education. Addressing this issue requires targeted training programs, including AT courses in the teacher education curriculum, and continuous professional development to ensure teachers can effectively support students with disabilities.

iv. **High Implementation Cost**: High cost often results from reliance on imported AT solutions, limited local production, inadequate government funding, and the need for specialized training programs, making assistive technologies less accessible to those who need them. Okonji and Ogwezzy (2019) observed that the high cost of assistive technologies (AT) is a significant barrier to their adoption among visually impaired individuals in Nigeria. The financial burden of acquiring AT devices renders them inaccessible to many who would benefit from their use. Reducing the high cost of assistive technology in Nigeria requires local production of devices to decrease reliance on expensive imports. The government should provide subsidies and financial support to individuals with disabilities to enhance affordability.

v. **Lack of Funding**: Inadequate funding hinders the implementation of assistive technology (AT) in Nigeria, which affects the acquisition, development, and maintenance of necessary devices and services. Chukwuemeka and Samaila (2020) suggest that insufficient financial resources have led to underutilization and abandonment of AT devices in educational settings. Okonji and Ogwezzy (2018) also emphasize that the prohibitive cost associated with AT and limited government support restricts access for individuals with visual impairments. Addressing these financial constraints is crucial to enhancing assistive technologies' availability and effectiveness for learners with disabilities in Nigeria. To address the lack of funding for assistive technology in Nigeria, the government should increase budgetary allocations and

provide subsidies to reduce costs for individuals with disabilities. Public-private partnerships can attract investments and drive local production of affordable assistive devices, ensuring a steady supply of cost-effective assistive solutions.

vi. **Lack of Robust Policy**: Implementing robust policies is essential for enabling assistive technology and promoting the inclusion of persons with disabilities (PWDs) in Nigeria. The National Commission for Persons with Disabilities (NCPWD) has initiated the establishment of a dedicated Department of Assistive Technology to coordinate and implement AT solutions, focusing on local manufacturing to reduce costs and improve accessibility. Strengthening assistive technology policies, practical implementation, increased government commitment, local production incentives, and stakeholder collaboration will help access and create awareness to ensure the sustainable inclusion of this policy.

Conclusion and Recommendations

In conclusion, innovative technology, particularly in computer education, is pivotal in fostering inclusive education for all learners, regardless of their abilities or disabilities. These technologies have improved accessibility and personalized learning experiences, addressing barriers faced by students with disabilities and promoting a more inclusive classroom environment. Integrating assistive technologies, artificial intelligence, augmented reality, and adaptive devices has substantially improved accessibility and engagement in digital learning environments. The advancements not only promote personal growth for learners with disabilities but also enrich the learning experiences for all students through diverse instructional methods. However, challenges such as a lack of infrastructure, adequate software, trained teachers, high implementation costs, and funding constraints hinder the effective adoption of these technologies in Nigeria, limiting their impact on learners with disabilities.

Inclusive education thrives on the belief that all learners deserve equal access to the curriculum supported by collaborative efforts among educators, parents, and the community. Therefore, addressing the challenges associated with inclusive education will be essential for creating inclusive educational environments that maximize the potential of every learner. Thus, a collaborative effort among policymakers, educators, and technology developers is the key to effective implementation of inclusive education. Therefore, the government should invest in technology and public facilities, local software development, teacher training programs, subsidies for assistive devices, increased funding, and robust policies to ensure sustainable inclusion and accessibility for all learners.

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