

Challenges and Solutions for Advancing Science and Technology Education in Nigerian Secondary Schools

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Abstract

Science and technology education plays a vital role in societal progress and national development by fostering knowledge acquisition, economic growth, and technological innovation. Despite substantial investments by the Nigerian government in science and technology education, the country faces significant challenges in achieving the objectives outlined in its 2018 national policy on science and technology education. These challenges include overcrowded classrooms, outdated curricula, inadequate teacher support and training, insufficient funding, and poor infrastructure, all of which hinder the country's ability to compete globally in technological innovation. This article examines these obstacles in detail and offers potential solutions, including enhanced collaboration between government and educational stakeholders, to improve science and technology education in Nigerian secondary schools. By addressing these issues, Nigeria can unlock the potential of its youth and drive sustainable development through innovation.

Keywords: Science and Technology Education, Secondary Schools, Nigeria, Challenges, Solutions, National Policy

Introduction

Education represents a journey of uncovering and embracing truths, broadening one's perspective of life and the world, and acquiring tangible, practical knowledge. It is widely acknowledged as a pivotal instrument for national development, serving as the cornerstone of societal progress by propelling economic growth, nurturing future generations, and fostering social cohesion. Pal (2023) asserts that education, as a catalyst for political, economic, and social transformations, underscores its pivotal role in enabling substantial changes across these domains and serves as the driving force behind national advancement. Without education, the development of any country is rendered futile, impacting every facet of the economy. Ensuring access to basic

education for all citizens has become imperative, standing as a primary global objective for governments, necessitating substantial allocation of resources toward achieving educational goals (Ewa, 2023).

In Nigeria, the school system is separated into three levels: primary, secondary, and tertiary. The secondary educational system serves as a crucial bridge between primary and tertiary education, spanning six years divided into three years of Junior Secondary School and three years of Senior Secondary School (Udofia, 2021). This structure aligns with the Federal Government's educational policy, outlining Junior Secondary Schools as JSS1, JSS2, and JSS3, while Senior Secondary Schools consist of SS1, SS2, and SS3 (FME, 2019). Additionally, the secondary school curriculum emphasizes core subjects such as Mathematics, English, Sciences, Social Sciences, Arts, Languages, and Entrepreneurial subjects (Udofia, 2021). Students are required to sit for exams like the Basic Education Certificate Examination (BECE) after Junior Secondary School and the Senior Secondary Certificate Examination (SSCE) upon completing SS3. These exams, administered by bodies like the West African Examination Council (WAEC) and the National Examination Council (NECO), typically require credit grades or higher for admission into higher institutions (Adamu, 2020).

The primary objectives for establishing secondary education in Nigeria include diversifying the curriculum to nurture latent talents, equipping students with relevant scientific and technical knowledge for modern survival, instilling a drive for achievement and self-improvement, and cultivating self-reliance and respect for diverse perspectives— all of which are essential for societal growth and development (Adamu, 2020). Accordingly, the secondary education level serves as the foundation for Science and Technology Education, offering avenues to raise awareness and encourage exploration (Oyovwi & Jack, 2015).

Science and technology are two critical components of all efforts aimed at fostering growth and socio-economic development in nations (Mormina, 2019). Science, originating from the Latin term "scientia," represents a body of knowledge and processes sought for technological progress, elucidating natural phenomena through established laws and practices (Reddy, 2021). Science is the foundation for nation-building, as a nation's advancement relies on its empirical acquisition through observation, experiments, and logical analysis to understand and control environmental factors (Shishima, 2018). Technology, derived from the Greek term "techne" and the Latin word "technicus," signifying "art" or "craft," originally referred to a "bag of tools." Over time, technology has been perceived as the study or expertise in utilizing tools within manufacturing and industrial realms (Karagözoğlu, 2017). Technology can be defined as the systematic and scientific application of practical skills and theoretical knowledge to solve problems, particularly those hindering scientific development (Shishima, 2018).

Science and technology education is the application of scientific and technological knowledge to create or use tools, techniques, resources, and processes to harness the human and natural environment for individual well-being and societal development (FME, 2018). It is recognized globally as the bedrock of civilization and development (Shishima, 2018). Today, the world is governed by science and technology due to continuous discoveries, explorations, inventions, and innovations (Cloete, 2017). Science and technology education is also regarded as the instrument upon which nation-building relies, with every country striving for its advancement (Ewesor & Itie, 2015). Through science and technology, human needs are fulfilled, including

higher levels of food supply, enhanced public health, improved transportation, communication, and industrial output, all of which lead to development (Walsh, Murphy & Horan, 2020). Moreover, the growing influence of technology in education presents powerful learning tools, necessitating students to acquire new skills and comprehension while offering innovative methods to engage them actively (Kalyani, 2024).

The growth and development of nations are often measured by their progress in science and technology education (Paprotny, 2021). Science and technology have become integral to global culture, and any nation that neglects this importance does so at its peril, as no aspect of life is unaffected by science and technology, directly or indirectly (Oyovwi & Jack, 2015). Consequently, the National Policy on Science and Technology Education (2018) outlines the following objectives:

1. Promote the advancement of science and technology education.
2. Facilitate proficiency in scientific and technological skills.
3. Establish collaborative frameworks among institutions to enhance science and technology initiatives across all economic sectors.
4. Cultivate an environment conducive to improving scientific and technological resources for research, development, and innovation within educational institutions.
5. Ensure that graduates from science and technology programs contribute to Nigeria's economic endeavors, ensuring global competitiveness (FME, 2018).

Across the globe, the importance of science and technology education in advancing humanity's well-being is undeniable (Freeman, Marginson, Tytler, 2018). However, like many developing nations, Nigeria faces hurdles that impede the progress of science and technology education (Aduwa, 2021). Therefore, this paper will examine the challenges facing science and technology education in Nigeria's secondary school system and propose solutions for a promising future.

Challenges Facing Science and Technology Education

Nigeria's secondary education, especially in science and technology, faces critical obstacles hindering its adequacy. Some of the constraints contributing to this situation include:

1. Defective Curriculum

The current science and technology curriculum in Nigerian secondary schools fails to adequately prepare students for a rapidly modernizing society (Eberendu, 2014). There are numerous challenges associated with the curriculum, including overloaded content, reliance on rote learning, a lack of practical application, and insufficient integration of technology, all of which hinder students' ability to develop the necessary skills for real-world challenges (Sambo & Oyelade, 2020; Agboghroma, Tim & Maduewesi, 2023). The outdated focus on theoretical knowledge makes the curriculum irrelevant and overwhelming, which dampens students' curiosity and discourages practical application. This approach stifles Nigeria's potential to create a competitive workforce capable of driving innovation in the global technological landscape (Agbowuro, Oriade & Shuaibu, 2015). Moreover, the lack of creativity and innovation in the curriculum fosters student disengagement and apathy, which further contributes to poor performance and diminishes interest in pursuing careers in science and technology (Akorede,

2015). As a result, the current curriculum is a significant barrier to achieving sustainable progress in Nigeria's science and technology sectors.

2. Lack of Adequate and Qualified Teachers

In the context of advancing science and technology education in Nigerian secondary schools, the issue of inadequate and unqualified teachers is a significant challenge. Jacob and Ndubuisi (2020) discuss the ongoing shortage of professional educators in Nigeria's secondary education system, particularly highlighting the failure to meet the National Policy's recommended 1:40 student-teacher ratio. This disparity results in large class sizes, making it increasingly difficult for teachers to engage students effectively and provide personalized instruction. As a result, the quality of education suffers, especially in science and technology subjects, where hands-on learning and active student participation are critical.

Moreover, the lack of qualified science and technology teachers exacerbates the problem. Instructors in these fields are often not adequately trained, lacking formal education in modern instructional methods, technology integration, and specialized subject expertise (Mdhlalose & Mlambo, 2023). This gap in professional preparation is particularly concerning, given the importance of developing practical skills that align with current technological advancements. Without properly trained educators, students' understanding of science and technology concepts may remain superficial, preventing them from acquiring the problem-solving and critical thinking skills necessary to thrive in today's rapidly evolving technological landscape.

The deficiency of qualified science and technology teachers also affects the integration of innovative teaching methods, such as the use of digital tools and practical experiments, which are essential for creating an engaging and effective learning environment. As Mdhlalose and Mlambo (2023) suggest, this deficiency not only limits student engagement but also hampers their ability to develop practical skills, which are vital for their future careers in technology-driven fields.

3. Large Class Sizes

The concept Large class sizes present a significant challenge to the effectiveness of science and technology education in Nigerian secondary schools. The concept of class size is essential because it reflects a teacher's ability to manage, supervise, and provide individualized instruction to students. According to Kenny (2020), optimal class sizes allow teachers to foster meaningful teacher-student interactions and cater to the diverse learning needs of students. However, in Nigerian secondary schools, large class sizes hinder these key teaching functions. Ajayi and Angura (2017) highlight several drawbacks of oversized classes, including the inability to offer personalized attention, limited interaction between the teacher and students, and restricted opportunities to identify and nurture individual talents. These challenges are particularly problematic in the teaching of science and technology, where practical learning and close teacher supervision are vital.

Despite the National Policy on Education's recommendation of a 1:40 student-teacher ratio, the reality in many Nigerian secondary schools deviates significantly from this ideal. Jacob and Ndubuisi (2020) emphasize that overcrowded classrooms are a common issue, contributing to the difficulty of managing large groups of students effectively. This disparity between policy and practice exacerbates the challenges faced by both teachers and students in science and technology education. Teachers in large classrooms often struggle to provide hands-on experiences, which are

essential for developing students' practical skills in fields like chemistry, physics, and computer science.

Moreover, large class sizes reduce the amount of direct interaction between teachers and students, limiting the opportunity for students to ask questions, seek clarification, and engage with the subject matter in depth. In science and technology, where practical demonstrations and experiments play a crucial role in learning, the inability to conduct these activities effectively in overcrowded classrooms further compromises the quality of education. As Ajayi and Angura (2017) assert, the lack of individualized attention and the diminished quality of teacher-student interactions directly impact students' engagement and understanding of science and technology concepts.

4. Poor Funding and Inadequate Infrastructure

A critical element Poor funding and inadequate infrastructure are significant barriers to advancing science and technology education in Nigerian secondary schools. Funding is a critical factor in ensuring the acquisition of essential resources, such as qualified staff, laboratory equipment, and other necessary materials (Oyovwi & Jack, 2015). These resources are crucial for delivering high-quality education in the fields of science and technology. Without sufficient financial support, the quality of education suffers, as schools struggle to meet the demands of a modern curriculum and provide students with the necessary skills for future careers in science, technology, engineering, and mathematics (STEM) fields.

UNESCO recommends that 26% of a nation's annual budget be allocated to education, with a particular focus on science and technology (Ayoko, Peter & Jegede, 2023). However, in Nigeria, the allocation of funds to secondary school education remains inadequate, particularly for science and technology programs. This lack of investment translates into poor infrastructure, including outdated classrooms, insufficient laboratory equipment, and a lack of libraries and learning resources. As a result, science and technology education suffers, and students do not have access to the hands-on learning experiences necessary to foster critical thinking and practical skills (Abershi, Mikky & Ogunode, 2022).

The shortage of resources also impacts curriculum development and teacher training. Science and technology curricula require continuous updates to reflect advancements in knowledge and industry practices, but limited funding prevents these updates from being implemented effectively. Additionally, teachers, who play a key role in delivering quality education, often lack access to ongoing professional development opportunities due to financial constraints. This situation undermines the ability of educators to stay current with teaching methods and technological advancements, further limiting their effectiveness in the classroom (Oyovwi & Jack, 2015).

The lack of modern facilities and practical learning opportunities in Nigerian secondary schools also affects students' ability to develop the skills necessary for success in the modern workforce. In science and technology education, hands-on experiences are essential for developing technical competencies, but without the proper infrastructure, students are often left with limited opportunities to engage in practical experiments and technological applications. As a result, their preparedness for real-world challenges is compromised, affecting both their academic performance and future career prospects.

5. Poor Teachers' Packages

In Nigeria's secondary schools, poor teacher packages—including low salaries, inadequate incentives, and neglect—are significant challenges to the advancement of science and technology education. Aduwa (2021) emphasizes that teachers in the country are often underpaid and lack the necessary support, which undermines their motivation and the quality of education they provide. Low remuneration is a key factor contributing to teacher dissatisfaction, which, according to Fomunyan (2019), often leads skilled educators to leave the profession or seek opportunities in other fields. This job dissatisfaction results in high turnover rates, which negatively affect teacher retention and disrupt continuity in the education system, ultimately impacting student performance.

Moreover, the lack of competitive compensation and professional recognition contributes to a broader issue of brain drain. As skilled educators and science professionals are drawn to more financially rewarding opportunities abroad, Nigeria suffers from a depletion of expertise in critical areas of science and technology (Okwara, 2023). The migration of qualified teachers and professionals diminishes the pool of experienced educators who can contribute to the development of science and technology education. This results in a long-term detrimental effect on the quality of teaching and the development of students' skills in these fields.

In addition to inadequate salaries, the erratic payment of teachers exacerbates the situation, making it even more difficult for educators to remain committed to their work (Katete & Nyangarika, 2020). The unpredictability of salaries negatively affects teachers' morale and productivity, as they may struggle to meet personal financial needs, which in turn affects their performance in the classroom. Teachers who are not adequately compensated or supported are less likely to be motivated to innovate, engage in professional development, or offer the high level of instruction that science and technology education demands.

The low social status of teachers and scientists in Nigeria further contributes to the challenges faced in the sector (Kalu & Ede, 2022). Despite the crucial role they play in shaping future generations, teachers and scientists are not afforded the respect and recognition they deserve. This lack of societal esteem, combined with poor financial compensation, discourages many talented individuals from pursuing or staying in the profession. As a result, the education system struggles to attract and retain the best minds, which undermines efforts to improve science and technology education.

Ultimately, the poor packages offered to teachers in Nigerian secondary schools undermine the overall quality of education. This lack of motivation, coupled with low social status and financial insecurity, contributes to a cycle of disillusionment that hampers the development of students' skills and knowledge, particularly in science and technology.

Solutions for a Promising Future

To overcome the challenges facing science and technology education in Nigeria's secondary schools, concerted efforts are needed from various stakeholders, including government, educational institutions, and the private sector. The following solutions can pave the way for a promising future in these critical fields:

The curriculum needs a thorough overhaul to emphasize practical learning, critical thinking, and the integration of modern methodologies. Osuafor (2012) suggests that the curriculum should move beyond theoretical concepts to include hands-on projects that engage

students in real-world problem-solving. Incorporating technology into lessons, aligning teaching methods with industry needs, and encouraging innovation will empower students to tackle future challenges effectively. By restructuring the curriculum to align with the evolving demands of science and technology fields, students will gain relevant skills that prepare them for the workforce and contribute to national progress (Osuafor, 2012).

To combat the shortage of qualified teachers, Nigeria should implement a targeted recruitment drive for specialized science and technology educators. According to UNESCO (2021), prioritizing teacher training in both subject expertise and instructional methods is essential. Ongoing professional development programs, such as workshops and training sessions, are vital for equipping teachers with modern pedagogical skills and the ability to integrate technology into their lessons. This continuous training will enable educators to stay updated with new teaching strategies and ensure that students receive high-quality instruction in science and technology (Tyagi & Misra, 2021).

Large class sizes have long been a significant barrier to effective teaching in science and technology education. Policies should be introduced to reduce class sizes, aligning with the National Policy on Education's recommended teacher-student ratio of 1:40 (UNESCO, 2021). By restructuring class sizes, students will receive more individualized attention, and teachers will be able to engage more effectively with each student. Smaller classes will also facilitate better teacher-student interaction, enabling more hands-on learning opportunities. This shift would create a more conducive environment for quality science and technology instruction (FME, 2018; Olagbaju & Nnorom, 2019).

One of the key solutions is increasing investment in science and technology education, in line with UNESCO's recommendation of allocating 26% of public spending to education, with a focus on science and technology sectors (Kennedy & Cherry, 2023). Funding should be directed towards improving infrastructure, including laboratories, classrooms, and libraries, as well as ensuring adequate teacher salaries and provision of modern teaching materials. Additionally, creating sustainable funding models and public-private partnerships will ensure long-term financial support for curriculum development, teacher training, and technological advancements. These investments will foster a competitive and progressive educational environment, enhancing the learning experience for students (UNESCO, 2021).

Addressing the poor remuneration of teachers is crucial for the success of science and technology education in Nigeria. Arain, Jafri, Ramzan, and Ali (2014) argue that better salaries and incentives are necessary to retain skilled educators and prevent brain drain. Regular and timely payment of salaries is essential to maintain teachers' morale and productivity, thereby improving teaching quality. Enhancing the social status of teachers and scientists through recognition and support will also foster a positive work environment, motivating educators to invest in their students' success. This, in turn, will lead to improved learning outcomes in science and technology subjects and contribute to the development of a skilled workforce (Ventista & Brown, 2023).

Conclusion

The challenges in Nigeria's secondary school science and technology education require urgent attention for a better future. Collaborative efforts between the government and stakeholders must prioritize a curriculum overhaul, emphasizing practical learning, critical thinking, and

modern teaching methods. Addressing the shortage of qualified teachers through targeted recruitment, training, and professional development is essential. Reducing class sizes and aligning with recommended student-teacher ratios will improve learning experiences. Additionally, increasing funding for science and technology education and enhancing teachers' remuneration will help retain skilled educators and improve teaching quality. These solutions are vital to advancing science and technology education in Nigeria.

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