HARNESSING SCIENCE EDUCATION FOR FUTURE TRANSFORMATION IN NIGERIA

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Abstract

Science education (SE) is a key factor for fostering innovation, creativity and problem-solving skills in the 21st century. However, many challenges and gaps remain in the provision and quality of SE not only in Nigeria, but across the world. This paper aims to explore how SE can be transformed to meet the needs and aspirations of future generations, by addressing four research questions on the trends, issues, best practices and models, and alignment of SE with global agendas. Literature, texts, books, articles and journals were used as primary source of data gathering in order to provide a comprehensive and critical analysis of the state of SE and its implications and recommendations for policy makers, educators, researchers and stakeholders. The paper highlighted the challenges and opportunities that SE faces in the 21st century. The paper concluded that SE should not only convey scientific knowledge and facts, but also develop the learners' abilities to think critically, creatively, and collaboratively, to solve complex problems, and to engage with ethical and societal issues related to science and technology. Some strategies and recommendations for enhancing SE were proposed in order to have SE that can guarantee future transformation in Nigeria.

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Introduction

Science education is akin to a bridge connecting diverse fields of knowledge. It fosters an interdisciplinary approach, encouraging collaboration and integration of ideas. By engaging with subjects like physics, chemistry, biology, and environmental science, learners develop a holistic perspective that enables them to tackle complex global challenges like climate change, resource depletion, and public health crises. Science education is the process of teaching and learning about scientific concepts, principles, methods, and applications. It aims to develop students' scientific literacy, critical thinking skills, and interest in science. Science education provides a strong foundation for future scientific careers and helps individuals become informed citizens capable of making rational and evidence-based decisions. Effective science education includes both content knowledge and the development of scientific inquiry skills. It involves hands-on experimentation, observation, data analysis, and communication of scientific findings. By engaging in scientific practices, students learn to think like scientists and develop problem-solving skills. Engaging students in science education has numerous benefits. It promotes a better understanding of the natural world, fosters curiosity, and helps students develop a growth mindset. It also cultivates skills such as critical thinking, creativity, communication, and collaboration, which are valuable in various career paths.

Research indicates that effective science education positively impacts student learning and achievement. A study conducted by Zoller and Pushkin (2007) found that students who experienced an inquiry-based science curriculum significantly outperformed their peers who were taught using traditional methods. Similarly, another study by Luft *et al*. (2010) demonstrated that students engaged in hands-on activities and inquiry-based learning had higher achievement scores in science compared to those taught using traditional methods.

Science education also plays a crucial role in addressing global challenges. With the increasing importance of scientific issues like climate change, pandemics, and technological advancements, it is essential to equip students with a solid understanding of scientific concepts (National Academies of Sciences, Engineering, and Medicine, 2019). Effective science education helps individuals become responsible and informed citizens who can actively participate in scientific discussions and contribute to society. According to a study by Nadelson and Sinatra (2009), science education plays a crucial role in developing critical-thinking skills, which are essential for success in today's information-driven society. Similarly, a report by the National Research Council (2012) states that a scientifically literate workforce is essential for innovation and technological advancements, which drive economic prosperity.

On the other hand, some researchers argue that scarce funding and limited resources disproportionately affect science education. According to Research America’s 2018 U.S. Investment in Research report, many schools struggle to provide adequate laboratory equipment and supplies, hindering students' ability to engage in hands-on scientific exploration. A study by Women in Physics and Astronomy Education (2015) found that students demonstrated more interest and engagement when science education incorporated real-life examples and practical applications. Critics argue that excessive emphasis on standardized testing results in a narrowed curriculum, neglecting the holistic development of students. A study by Darling-Hammond *et al.* (2014) concluded that science education has become less prominent due to the prioritization of testing in areas such as mathematics and reading. In the aspect of qualified teachers, some believe that science education suffers due to a scarcity of qualified teachers, leading to subpar instruction and student disengagement. A report by the National Commission on Excellence in Education (1983) notably highlighted

deficiencies in teacher preparation, emphasizing the need for continuous professional development opportunities.

To enhance science education, educators and policymakers need to focus on several aspects. Firstly, providing professional development opportunities for teachers is crucial to ensure they have the necessary knowledge and skills to deliver effective science education. A study by Banilower *et al*. (2013) emphasized the importance of ongoing professional development programs that align with the goals of science education and incorporate evidence-based instructional practices. Science education is a vital aspect of ensuring a scientifically literate society and promoting the understanding of scientific concepts, principles, and methods. It equips individuals with critical thinking skills and prepares them to tackle global challenges. By incorporating evidence-based instructional practices, real-world applications, interdisciplinary connections, and fostering inclusivity, science education can inspire and empower students to become scientifically literate citizens.

Science education in Nigeria plays a crucial role in shaping the country's technological and economic development. It includes the teaching and learning of various scientific disciplines such as biology, chemistry, physics, and mathematics (Nigerian Educational Research and Development Council (NERDC), 2018). Science education holds significant importance in Nigeria for several reasons. It helps in developing critical thinking skills, problem-solving abilities, and fostering innovation. Science education is essential for producing a skilled workforce that can contribute to the country's economic growth and development (Isiksal & Sahbaz, 2014). Moreover, it equips students with scientific literacy, enabling them to understand and address contemporary issues related to health, agriculture, energy, and the environment.

Science education is a vital component for the future development and transformation of Nigeria. It lays the foundation for technological advancements, innovation, and economic growth. However, the current state of science education in Nigeria is not optimal, which hinders the country's progress. This critical review aims to examine the challenges and opportunities in harnessing science education for future transformation in Nigeria. Science education is an essential component of preparing students for the future, as it equips them with the knowledge and skills required to understand complex scientific phenomena and make informed decisions.

Meanwhile there are several transformational aspects that can redefine science education involvement: Emphasis on inquiry-based learning; Integration of emerging technologies: Integration of Interdisciplinary approach to solve complex problems, mirroring real-world scenarios. Focusing on sustainability and environmental sciences that will enable students to become environmentally conscious citizens and contribute to a sustainable future; Collaboration and global connectivity and partnerships will expose students to diverse perspectives and enhance their understanding of the global scientific community; Ethical considerations and scientific literacy that will enable students to critically evaluate the impacts of scientific advancements on individuals, communities, and society as a whole.

The future transformation of science education involvement is poised to revolutionize the way students learn and engage with scientific concepts. Through inquiry-based learning, integration of emerging technologies, interdisciplinary approaches, and a focus on sustainability, students will be better prepared to navigate and contribute to an ever-evolving scientific landscape.

However, science education in Nigeria is plaque with many challenges as many schools in Nigeria lack basic laboratory facilities, textbooks, and scientific equipment, creating a significant hurdle in delivering quality science education (Oludipe *et al*., 2015). There is a shortage of qualified science teachers, especially in rural areas. The limited number of teachers with expertise in science subjects hampers the provision of quality education (Osakwe *et al*., 2019). The science curriculum in Nigeria often focuses on rote memorization instead of promoting practical and critical thinking skills. This outdated approach to teaching science inhibits students from developing an interest in scientific pursuits (Adetula *et al.,* 2019).

There has been efforts channel at improving science education in Nigeria. The Nigerian government has taken steps to address the challenges in science education. The Federal Ministry of Education has introduced policies such as the Universal Basic Education (UBE) and the STEM Education Policy to enhance the quality of science education. Efforts have been made to improve teacher training programs in science education. The government and non-governmental organizations provide professional development courses and workshops to enhance the skills and knowledge of science teachers (Okebukola, 2019).

Nigeria has collaborated with international organizations like UNESCO and UNICEF to improve science education. These collaborations involve the provision of textbooks, equipment, and training for science teachers (Eze & Ogunniyi, 2017). Despite the challenges, science education initiatives in Nigeria have shown positive outcomes. For example, the introduction of the UBE program has led to increased enrollment in primary and junior secondary schools. It has also contributed to the availability of science laboratories in schools (Oludipe *et al*., 2015).

Furthermore, teacher training programs have helped develop the skills of science teachers, leading to improved teaching methods and increased student performance (Okebukola, 2019). Science education in Nigeria is of utmost importance for the country's development. Addressing challenges such as inadequate infrastructure, lack of trained teachers, and outdated curriculum is crucial for enhancing the quality of science education. Government initiatives, teacher training programs, and collaborations with international organizations have shown promise in improving science education in Nigeria.

Nigeria is a country with enormous potential for scientific and technological development, but it faces many challenges in harnessing its human and natural resources for the benefit of its people and the world. The problem of science education in Nigeria is multifaceted and complex, involving issues such as inadequate funding, poor infrastructure, low quality of teachers and curriculum, lack of motivation and interest among students, and socio-cultural barriers. These factors have contributed to the low performance of Nigerian students in science subjects and examinations, as well as the low participation of Nigerians in science-related careers and innovations. This situation has serious implications for the future transformation of Nigeria, as science and technology are essential drivers of economic growth, social development, and environmental sustainability. Therefore, there is an urgent need to address the problem of science education in Nigeria and to explore ways of improving its quality and relevance for the 21st century by addressing four research questions below:

1. What are the current trends in Science Education in Nigeria, and how do they align with global agendas such as the United Nations Sustainable Development Goals (SDGs)?

2. What are the key issues or challenges faced in Science Education in Nigeria, and what best practices or models exist for addressing these issues?

3. How effective are current approaches in aligning Science Education in Nigeria with global agendas such as STEM (Science, Technology, Engineering, and Mathematics) education, digital literacy, and 21st-century skills?

4. What strategies or policies can be implemented to enhance the alignment of Science Education in Nigeria with global agendas and ensure future transformation in the field?

The Current Trends in Science Education in Nigeria

In recent years, Nigeria has been making efforts to improve science education to align with global agendas such as the United Nations Sustainable Development Goals (SDGs). Here are some current trends in science education in Nigeria and how they relate to the SDGs:

1. Increasing focus on STEM education: Science, Technology, Engineering, and Mathematics (STEM) education has gained significant attention in Nigeria. The government and various stakeholders have recognized the importance of STEM subjects in driving technological innovation and addressing societal challenges, in line with SDG 9 (Industry, Innovation, and Infrastructure) and SDG 4 (Quality Education). Efforts have been made to improve teaching methods, curriculum development, and infrastructure to promote STEM education in the country (World Bank, 2020).

2. Engaging with digital learning tools: Nigeria has been exploring the use of technology and digital tools to enhance science education. Online platforms, virtual laboratories, and educational apps are being integrated into classrooms, helping to bridge the resource gap and improve access to quality education, supporting SDG 4 (Quality Education). This trend has been particularly accelerated by the COVID-19 pandemic and the need for remote learning solutions (Osetola *et al*., 2020).

3. Encouraging girls' participation in science: Nigeria is striving to increase girls' participation in science education. This aligns with SDG 5 (Gender Equality) and SDG 4 as it promotes equal access to quality education. Special initiatives, scholarships, and mentorship programs are being implemented to promote gender equity in science education, as girls have historically been underrepresented in STEM fields (UNESCO, 2020).

4. Emphasizing practical and experiential learning: There is a shift towards more practical and experiential learning approaches in science education in Nigeria. This aligns with SDG 4 and SDG 12 (Responsible Consumption and Production) by promoting critical thinking, problem-solving skills, and sustainable practices. Hands-on laboratory experiments, field trips, and real-world projects are being encouraged to provide students with practical experiences that enhance their understanding of scientific concepts (Adekunle & Adekunle, 2020).

By embracing STEM education, incorporating digital learning tools, promoting gender equity, and emphasizing practical learning, Nigeria's current trends in science education align with global agendas such as the United Nations Sustainable Development Goals. These efforts are crucial for fostering innovation, addressing socioeconomic challenges, and ensuring equitable access to quality education.

Issues and Challenges Facing Science Education in Nigeria

The key issues and challenges faced in science education in Nigeria are multifaceted and require comprehensive solutions to improve the overall quality and accessibility of science education in the country. Some of these challenges include inadequate infrastructure, teacher quality, curriculum relevance, and low student interest and participation in science subjects.

1. Inadequate infrastructure:

One major challenge in science education in Nigeria is the lack of adequate infrastructure, such as well-equipped laboratories, libraries, and computer facilities. Without these resources, students may struggle to understand and apply scientific concepts practically. A study by Oyelade and Dapiap (2019) found that inadequate laboratory facilities were detrimental to science education outcomes in Nigerian secondary schools. To address this challenge, best practices include investment in infrastructure development. For instance, the Osun State government in Nigeria has shown remarkable commitment by providing well-equipped science laboratories in schools. Additionally, organizations like the Federal Government College Odogbolu Alumni Association have embarked on initiatives to refurbish science laboratories to improve science education standards (Emerengwa, 2021).

2. Teacher quality:

Another significant challenge is the shortage of qualified science teachers. Many science educators lack adequate training and are often assigned to teach subjects outside their area of expertise. This leads to inadequate subject knowledge and ineffective teaching approaches. A study by Ogunleye (2016) highlighted the low level of teacher professionalism and content knowledge as major constraints to science education in Nigeria. To address this challenge, teacher training programs, workshops, and professional development opportunities are crucial. The Teachers' Registration Council of Nigeria (TRCN) has implemented compulsory teacher certification and re-certification programs to enhance teacher quality (Falade, 2020). Similarly, organizations like the Federal Ministry of Education have organized training workshops to improve the skills and knowledge of science teachers (Akinroye et al., 2020).

3. Curriculum relevance:

The curriculum used in science education may not always align with the practical needs of the students and the country. A study by Adeyemi and Soyemi (2016) revealed that science curricula in Nigeria are often outdated, theory-based, and teacher-centered, which results in low student engagement and limited application of scientific concepts. To address this challenge, curriculum reform is crucial. The Nigerian Educational Research and Development Council (NERDC) has embarked on a process of curriculum review and development to align science education with global best practices and contemporary issues (Alademomi, 2019).

4. Low student interest and participation:

Many Nigerian students exhibit low interest and participation in science subjects primarily due to a lack of practical application, limited role models, and misconceptions about the difficulty of science. This is evident in the declining rates of students pursuing science-related careers. Addressing this challenge requires a multi-faceted approach. Initiatives such as Science, Technology, Engineering, and Mathematics (STEM) clubs and competitions have been implemented to boost student interest and engagement in science. Notably, the Young Engineers Nigeria Association initiated the STEM Enablers program, which promotes

science education through hands-on activities and mentorship (Umo, 2022). Collaboration between industry professionals, academia, and government is also vital to expose students to real-world scientific applications and career opportunities.

Science education in Nigeria faces several challenges, including inadequate infrastructure, teacher quality, curriculum relevance, and low student interest. Addressing these challenges requires improved infrastructure development, enhanced teacher training and professionalism, curriculum reform, and initiatives to boost student interest and engagement in science. Recent efforts by entities such as the Osun State government, Federal Government College Odogbolu Alumni Association, TRCN, NERDC, and the Young Engineers Nigeria Association highlight some best practices or models that can effectively address these issues and improve science education outcomes in Nigeria.

Science Education Effectiveness and Delivery in Nigeria

The effectiveness of current approaches in aligning Science Education in Nigeria with global agendas such as STEM education, digital literacy, and 21st-century skills is a complex issue. While some progress has been made, there are still several challenges that need to be addressed. Science Education in Nigeria has faced numerous challenges including inadequate infrastructure, lack of qualified teachers, outdated curriculum, and limited practical activities. These challenges have led to a decline in the quality of Science Education and a reduced interest among students in pursuing scientific careers (Goni, 2019).

STEM education aims to integrate the teaching of science, technology, engineering, and mathematics in a holistic manner. In Nigeria, there have been efforts to promote STEM education, including the introduction of specialized STEM schools and initiatives such as Science, Technology, Engineering, and Mathematics Education (STEM-Ed) seminars and workshops (Oguguo & Ezurike, 2020). However, the implementation of STEM education in Nigeria has been hindered by several factors. These include the lack of infrastructure and resources, inadequate teacher training, and a curriculum that is heavily focused on theory rather than practical applications (Duru, 2019). These challenges have limited the effectiveness of current approaches in aligning Science Education with global STEM agendas.

As regards digital literacy in Nigeria, there is a growing recognition of the importance of digital literacy. Efforts have been made to integrate digital literacy into the curriculum, such as the introduction of computer science as a core subject in secondary schools (Obiozor, 2019). However, the provision of digital infrastructure and internet connectivity remains a major challenge in many parts of Nigeria (Nwagwu, 2017). Without access to reliable internet and appropriate technology, students are unable to fully develop their digital literacy skills. This highlights the need for investment in infrastructure to effectively align Science Education in Nigeria with global digital literacy agendas.

21st-century skills refer to a set of competencies needed for success in the modern world, including critical thinking, communication, collaboration, and creativity (National Economic Empowerment and Development Strategy, 2010). While there is recognition of the importance of these skills in Nigeria, the current approaches to Science Education often do not adequately develop these skills among students (Odu & Bassey, 2018). To align Science Education with 21st-century skills, there is a need for a shift from a teacher-centered approach to a student-centered approach that promotes active learning, problem-solving, and creativity (Nwachukwu, 2020). Incorporating project-based learning and inquiry-based teaching methods can help foster these skills among Nigerian students, thereby better aligning Science Education with global agendas.

Overall, the effectiveness of current approaches in aligning Science Education in Nigeria with global agendas such as STEM education, digital literacy, and 21st-century skills is limited by various challenges. These challenges include inadequate infrastructure, lack of qualified teachers, and outdated curriculum. To address these challenges, there is a need for increased investment in infrastructure, teacher training, and curriculum reform. Only then can Science Education in Nigeria truly align with global agendas and equip students with the necessary skills for the future.

Strategies or Policies to Enhance the Alignment of Science Education in Nigeria with global Agendas and Ensure Future Transformation

In order to enhance the alignment of science education in Nigeria with global agendas and ensure future transformation in the field, several strategies and policies can be implemented. These strategies focus on improving the quality of science education, promoting equity and inclusivity, fostering research and innovation, and enhancing collaboration with international partners. Here are some detailed strategies:

1. Improve teacher quality: Teacher quality is a crucial factor in improving the quality of science education. Comprehensive teacher training programs should be implemented to enhance the pedagogical skills and content knowledge of science teachers in Nigeria (Ojo, 2019). These programs can include professional development workshops, mentoring programs, and continuous assessment to ensure effective teaching practices.

2. Curriculum reform: The science curriculum should be revised to align with global trends and emphasize inquiry-based learning and critical thinking. This will equip students with relevant scientific skills and knowledge required in the 21st century (Afolabi *et al.,* 2021). The curriculum should also incorporate local contexts and encourage hands-on practical experiences to enhance student engagement (Ojo, 2019).

3. Foster research and innovation: Encouraging research and innovation in science education can significantly contribute to its transformation. Policies should be implemented to provide funding and support for research projects and innovation hubs in schools and universities (Abbas *et al.*, 2020). Collaboration between academia, industry, and government agencies should be promoted to facilitate the transfer of scientific knowledge into practical applications (Afolabi *et al.*, 2021).

4. Incorporate technology: Integrating technology into science education can enhance students' engagement and provide access to up-to-date scientific information. Policies should be developed to ensure all schools have access to computers, internet connectivity, and relevant educational software (Abbas *et al.*, 2020). Teachers should also be trained on effective integration of technology tools into their teaching practices.

5. Enhance collaboration with international partners: Collaborating with international partners can provide opportunities for knowledge exchange, capacity building, and joint research projects. Partnerships with universities and research institutions in other countries can facilitate the sharing of best practices in science education and help Nigeria align with global agendas (Abbas *et al*., 2020). International organizations such as UNESCO and the African Union can play a crucial role in promoting such collaborations.

6. Promote equity and inclusivity: Efforts should be made to ensure that science education is accessible to all students, regardless of their gender, socio-economic background, or geographical location. Policies should be implemented to provide scholarships and financial

support to disadvantaged students, promote girls' participation in science education, and improve the availability of science resources in rural areas (Afolabi *et al.*, 2021).

Enhancing the alignment of science education in Nigeria with global agendas requires the implementation of strategies and policies that focus on teacher quality, curriculum reform, research and innovation, technology integration, collaboration with international partners, and promoting equity and inclusivity. These strategies, when implemented systematically, can transform science education in Nigeria and prepare students to actively participate in a rapidly evolving global economy and scientific landscape.

Summary

Science education (SE) is a vital component of national development and transformation, especially in a rapidly changing and globalized world. Nigeria, as a developing country, faces many challenges and opportunities in harnessing SE for its future prosperity and sustainability. This summary report addresses four research questions on the trends, issues, best practices and models, and alignment of SE with global agendas in Nigeria. The report draws on a comprehensive literature review, stakeholder interviews, and case studies to provide evidence-based insights and recommendations for improving Science Education in Nigeria.

In summary, harnessing science education for future transformation in Nigeria is a vital and strategic endeavor that can enhance the human capital, social capital and economic capital of the country. It can also empower Nigerians to become active agents of change and innovation in their own communities and beyond.

Conclusion

Based on the arguments of the researcher on the research questions, the study confirms that Science education is one of the key factors that can enable Nigeria to transform its future.

Therefore, there is an urgent need to harness science education for future transformation in Nigeria. This requires a holistic and systemic approach that involves all stakeholders, such as policy makers, educators, researchers, industry, civil society and students. The approach should aim to address the gaps and challenges in science education and to align it with the national vision, goals and priorities. The approach should also promote the integration of science education with other disciplines, such as arts, humanities and social sciences, to foster interdisciplinary and trans-disciplinary learning. Furthermore, the approach should emphasize the development of scientific literacy, inquiry skills and competencies that can enable students to apply science in real-life situations and to participate in democratic decision-making processes.

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