

**REIMAGINING INTEGRATED SCIENCE EDUCATION IN NIGER STATE, NIGERIA:
ADDRESSING FUNDING, EQUITY, INSECURITY AND 21ST CENTURY SKILLS FOR
SUSTAINABLE DEVELOPMENT**

BY

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Abstract

Integrated Science education in Nigeria is at a critical stage, characterized by predominantly theoretical learning, inadequate infrastructure, limited funding, and challenges in equipping students with 21st-century digital and employability skills. This paper reviews the major challenges confronting Integrated Science education, with particular attention to Niger State. The review indicates that although Nigeria's national policy framework for science education is substantively sound, its effectiveness is constrained by weak implementation, inadequate funding, inequitable distribution of qualified science teachers, deteriorating laboratory facilities, and limited access to digital learning resources. These challenges are further compounded by insecurity in communities such as Shiroro, Munya, Rafi, and Mariga, which disrupts teaching and learning. The paper argues that funding, policy implementation, teacher development, and pedagogy are interdependent and should therefore be addressed through coordinated rather than fragmented interventions. Key recommendations include increased and transparently managed public investment in education, strengthened public-private partnerships, improved teacher training, recruitment and retention incentives, integration of digital literacy and ICT-supported pedagogy, robust monitoring and evaluation, and security-responsive educational delivery models. Greater emphasis should also be placed on STEM and vocational education to enhance students' readiness for further education, employment, entrepreneurship, and sustainable development. The paper concludes that coordinated reforms in funding, policy implementation, teacher capacity, infrastructure, technology, and security are essential for revitalizing Integrated Science education in Niger State and harnessing the state's human and natural resources for inclusive, sustainable, and long-term development.

KEYWORDS: Reimagining, Integrated Science, Equity, Sustainable Development

INTRODUCTION

Science education constitutes a strategic component of national development because it develops observation, critical reasoning, creativity, problem-solving, innovation, and the capacity to apply knowledge to societal challenges. Beyond examination achievement, effective science education contributes to human capital development, technological advancement, economic diversification, and national competitiveness. In Nigeria, however, the potential of science education has not been fully realized because of persistent challenges relating to inadequate funding, weak policy implementation, insufficient infrastructure, shortages of qualified teachers, limited access to digital technologies, and insecurity. These challenges are particularly significant in Niger State, where geographical characteristics, rurality, and insecurity complicate equitable access to quality science education.

Niger State, the largest state in Nigeria by landmass, covers approximately 76,000 square kilometres and contains extensive rural and dispersed settlements. This geographical structure creates considerable challenges for the equitable distribution of teachers, instructional materials, laboratories, and other educational resources. The state also possesses substantial natural and economic resources, including extensive agricultural land and solid mineral deposits, while hosting the Kainji and Shiroro hydroelectric installations. Such resource endowment provides considerable potential for science-, technology-, engineering-, and mathematics (STEM)-driven socioeconomic development. Nevertheless, the capacity of the education system to produce adequately prepared scientific and technological human capital remains constrained by inadequate laboratory facilities, uneven distribution of qualified science teachers, limited instructional resources, and persistent concerns about students' learning outcomes.

Integrated Science occupies an important position within basic education because it introduces learners to fundamental concepts from biology, chemistry, physics, environmental science, and related disciplines in an interconnected manner. This interdisciplinary orientation enables students to understand relationships among scientific phenomena, apply scientific principles to everyday problems, and develop a foundation for further study in science and technology. Consequently, effective Integrated Science instruction is essential for developing scientifically literate citizens capable of responding to contemporary environmental, technological, health, and economic challenges.

The demands of contemporary society, however, extend beyond the acquisition of conventional academic knowledge. Twenty-first-century education emphasizes creativity, collaboration, communication, critical thinking, innovation, adaptability, problem-solving, and digital literacy. These competencies are increasingly important in a rapidly changing labour market shaped by technological advancement and digital transformation. Digital technologies, information and communication technology (ICT), and emerging tools such as artificial intelligence (AI) provide opportunities to personalize learning, facilitate access to scientific information, support inquiry-based instruction, and enhance teachers' instructional effectiveness. Recent studies have consequently emphasized the importance of integrating digital competencies and AI-supported approaches into science and STEM education (Imoniri, 2023; Samuel & Salisu, 2025; Opesemowo et al., 2025).

Despite these opportunities, Integrated Science education in Nigeria continues to be affected by predominantly theoretical instructional practices, inadequate practical laboratory experiences, limited ICT facilities, and a widening gap between curriculum expectations and the competencies required in the twenty-first century (Okafor & Okafor, 2023). Inadequate financial investment further constrains the capacity of educational institutions to provide appropriate infrastructure, instructional materials, laboratory equipment, teacher development, and digital resources. The inadequacy of educational financing relative to international benchmarks has therefore remained a significant concern (Idowu, 2025). Similarly, poor teacher quality, excessive workloads, inadequate professional development, and limited opportunities for developing creative and employable skills continue to undermine the capacity of STEM education to contribute effectively to national development (Chisom et al., 2024).

The situation is further complicated by insecurity in several parts of Niger State. Banditry, kidnapping, armed attacks, displacement, and community-level insecurity have affected educational activities in local government areas including Shiroro, Munya, Rafi, Mariga, Mashegu, Borgu, Kontagora, and Magama. Insecurity can disrupt school attendance, displace teachers and learners, damage educational infrastructure, and discourage the deployment and retention of qualified personnel in affected communities. The consequences are particularly serious for science education, which depends substantially on regular practical activities, laboratory access, teacher availability, and sustained interaction between teachers and learners. Thus, security should be regarded as an enabling condition for effective educational delivery rather than as an issue external to education planning.

The challenges confronting Integrated Science education must also be considered within the broader context of Nigeria's educational and socioeconomic realities. Rapid population growth, urbanization, poverty, inadequate resource allocation, and economic pressures have increased the demand for educational services while simultaneously constraining the resources available for their provision (Okojie, 2020). Nigeria's large population of out-of-school children, particularly in disadvantaged and conflict-affected communities, further illustrates the magnitude of the access and equity challenge (UNESCO, 2021). These conditions threaten the capacity of the education system to provide inclusive and quality science education consistent with the aspirations of Sustainable Development Goal 4 on inclusive and equitable quality education.

Public-private partnerships (PPPs) provide one potential mechanism for addressing some of these structural challenges. Strategic collaboration among government, private organizations, industries, development agencies, communities, and educational institutions could support the provision of laboratories, ICT facilities, teacher professional development, digital learning resources, and other educational infrastructure. Such partnerships, however, require transparent governance, clearly defined responsibilities, effective monitoring, and alignment with national and state educational priorities. Investment in science education should similarly be linked to broader development objectives, particularly those relating to technological innovation, employability, entrepreneurship, environmental sustainability, and economic diversification (Tijani & Adeduyigbe, 2025; Sarpong & Wube, 2025).

The integration of AI and other emerging technologies presents an additional opportunity for transforming science education. AI-supported learning environments can facilitate differentiated instruction, provide timely feedback, support inquiry and problem-solving activities, and expand access to learning resources. However, technology alone cannot resolve the structural challenges confronting Integrated Science education. Effective technological integration requires reliable electricity and internet connectivity, appropriate digital infrastructure, teacher competence, responsible use frameworks, and sustained professional development. Consequently, technological innovation must be integrated into broader reforms in funding, pedagogy, teacher development, infrastructure, and policy implementation.

This paper therefore argues that the challenges confronting Integrated Science education in Niger State should be addressed as an interconnected policy and implementation agenda rather than as isolated

technical problems. Funding without effective implementation, curriculum reform without corresponding teacher preparation, or technology provision without adequate infrastructure and digital competence is unlikely to produce sustainable improvements in teaching and learning. A coordinated approach is required to strengthen teacher capacity, improve infrastructure, expand digital literacy and ICT-supported pedagogy, enhance practical science instruction, promote effective policy implementation, establish sustainable public-private partnerships, and develop security-responsive educational strategies.

Against this background, the paper examines the major challenges and opportunities associated with Integrated Science education in Niger State, with particular emphasis on educational financing, policy implementation, teacher development, infrastructure, ICT and AI integration, twenty-first-century skills, insecurity, and sustainable development. It further considers how coordinated investment and reform can strengthen the capacity of Integrated Science education to prepare learners for further education, employment, entrepreneurship, technological innovation, and meaningful participation in sustainable socioeconomic development.

INTEGRATED SCIENCE EDUCATION: CONCEPT AND PHILOSOPHY

Integrated Science, as conceived within Nigeria's basic education curriculum, represents a deliberate departure from the early fragmentation of science into discrete disciplines such as Biology, Chemistry, and Physics. The philosophy of integration is based on the premise that learners at the basic education level can develop a more meaningful understanding of scientific phenomena when related concepts are presented as interconnected rather than as isolated bodies of knowledge. Khabela (1975) and Cohen (1977) emphasized that integrated science reduces unnecessary duplication of subject matter and moves beyond rigid disciplinary boundaries in the organization and presentation of scientific knowledge.

Within the Nigerian basic education curriculum, Integrated Science draws content from several scientific disciplines and organizes learning around broad themes relating to living things and their environment, matter and energy, measurement, ecology, health and hygiene, forms and uses of energy, and the Earth and the universe. Such organization enables learners to recognize relationships among scientific concepts and to apply scientific knowledge to problems encountered in their immediate environment. The underlying philosophy is therefore not merely to combine topics from different

disciplines but to develop science as a coherent means of understanding, investigating, and explaining the natural world.

The integrated approach is also consistent with international developments in science curriculum design. Several education systems have retained integrated or combined science at the lower-secondary level to promote conceptual coherence, interdisciplinary understanding and the application of knowledge to real-world problems (UNESCO, 2021). The adoption of an integrated approach in Nigeria is therefore consistent with broader developments in science education. The major challenge is less a question of curriculum philosophy than the conditions under which the curriculum is enacted, particularly the availability of qualified teachers, instructional materials, laboratory facilities, adequate instructional time, appropriate assessment practices, and supportive learning environments.

An important characteristic of Integrated Science is its emphasis on inquiry and practical learning. The curriculum encourages observation, experimentation, fieldwork, project activities, measurement, problem-solving, and other forms of experiential learning. These approaches enable learners to develop scientific processes and skills rather than merely memorize scientific facts. Where practical and inquiry-oriented activities are absent, Integrated Science risks becoming predominantly textbook-based, with emphasis on vocabulary and factual recall rather than scientific reasoning and application.

The distinction between curriculum-as-designed and curriculum-as-enacted is therefore important. A curriculum may contain appropriate provisions for practical work, inquiry, digital literacy, and skills development, but its intended outcomes cannot be achieved unless teachers possess the requisite competencies and schools have adequate infrastructure and instructional resources. In Niger State, this distinction is particularly relevant because rurality, resource constraints, teacher shortages, and insecurity can significantly affect the extent to which the intended Integrated Science curriculum is translated into effective classroom practice.

ADDRESSING FUNDING GAPS THROUGH PUBLIC-PRIVATE PARTNERSHIPS

Adequate and sustainable financing is fundamental to the effective implementation of science education. Public investment alone has often been insufficient to address Nigeria's persistent deficits in school infrastructure, laboratory facilities, instructional materials, teacher development, and digital technologies. Consequently, public-private partnerships (PPPs) have gained increasing attention as a

potential mechanism for mobilizing additional resources, expertise, innovation, and technological capacity for education development (World Bank, 2021).

One major advantage of PPPs is their potential to complement government resources while introducing innovative approaches to teaching, learning, assessment, infrastructure development, and educational management. Babatunde and Adetayo (2020) argue that private-sector participation can contribute financial resources and innovative practices capable of supporting educational reforms while reducing some of the financial pressures on government. When appropriately structured, PPPs can therefore contribute to improving access, quality, efficiency, and sustainability in education.

Experiences involving private educational organizations and government agencies demonstrate the potential of technology-supported partnerships to improve teaching and learning. The collaboration between Bridge International Academies and government authorities in Lagos, for example, illustrates how private-sector expertise, data-driven instructional approaches, teacher development, and technology can be mobilized to support educational delivery in underserved communities. Such experiences provide useful lessons for developing contextually appropriate partnerships in rural and disadvantaged communities.

For Niger State, PPPs could be strategically directed towards the establishment and rehabilitation of science laboratories, provision of ICT facilities, expansion of internet-enabled learning, teacher professional development, development of digital learning resources, and support for science clubs and practical activities. Industries operating within the agricultural, energy, mining, and technology sectors could also be encouraged to establish structured partnerships with schools and tertiary institutions. Such partnerships should, however, operate within transparent regulatory frameworks, with clear accountability mechanisms and measurable educational outcomes. PPPs should complement rather than replace the constitutional responsibility of government to provide accessible and quality education.

POLICY REFORMS AND IMPLEMENTATION GAPS

Nigeria has developed several policy instruments that recognize science, technology, innovation, digital literacy, and skills development as important drivers of national development. The National Policy on Education places considerable emphasis on science and technology and advocates practical and activity-oriented approaches to learning. Complementary policy instruments, including the National Science,

Technology and Innovation Policy and the Nigeria Digital Economy Policy and Strategy, further emphasize the development of scientific, technological, digital, and human-capital capacities required for a knowledge-based economy.

Similarly, successive education-sector roadmaps have identified STEM education, laboratory development, teacher preparation, curriculum modernization, and improved learning outcomes as important priorities. These policy directions are broadly consistent with the competencies required for twenty-first-century education and with the objectives of Sustainable Development Goal 4, which emphasizes inclusive, equitable, and quality education.

The major challenge, therefore, is not necessarily the absence of policy direction but the persistent gap between policy formulation and policy implementation. Educational policies may articulate appropriate objectives, yet their effectiveness depends on adequate financing, institutional capacity, monitoring, accountability, teacher preparedness, and sustained implementation at state and local levels. Japhet-Nwapi (2026) draws attention to the continuing implementation challenges within Nigeria's education sector. This implementation gap is particularly important in Niger State, where geographical dispersion, rural poverty, infrastructure deficits, and insecurity may weaken the capacity of institutions to translate national policy objectives into consistent classroom practice.

Comparative experiences from countries such as Kenya, Ghana, and Rwanda suggest that sustained investment in teacher development, digital transformation, STEM education, and institutional capacity can contribute to improved educational outcomes (World Bank, 2021). However, international experiences should not be transferred mechanically to Nigeria. Rather, they should provide evidence for adapting context-sensitive strategies to Nigeria's institutional, demographic, socioeconomic, and security realities.

For Niger State, policy reform should therefore move beyond the formulation of additional policy documents towards strengthening implementation mechanisms. Priority should be given to clearly defined funding commitments, transparent resource allocation, regular monitoring and evaluation, teacher deployment based on need, infrastructure development, digital inclusion, and security-sensitive educational planning. Such measures would help narrow the gap between the intended curriculum and the learning experiences actually available to students.

REFORMING EDUCATIONAL INFRASTRUCTURE AND TEACHER TRAINING

The quality of Integrated Science education is strongly influenced by the physical and human resources available within schools. Effective science teaching requires functional classrooms, laboratories, electricity, water, instructional materials, ICT facilities, and adequate space for practical activities. Reports on basic education infrastructure in Nigeria have continued to identify deficits in essential school facilities, particularly in underserved and rural communities (UBEC, 2021). Such deficits limit the capacity of schools to implement activity-based and inquiry-oriented science curricula effectively.

The infrastructure challenge extends beyond the provision of buildings. Modern Integrated Science education increasingly requires access to digital devices, reliable electricity, internet connectivity, multimedia resources, laboratory equipment, and platforms that support collaborative and inquiry-based learning. In schools where these facilities are unavailable or unreliable, teachers are compelled to rely heavily on conventional lecture and textbook-based approaches. Consequently, students may complete their basic education with limited opportunities to conduct experiments, use scientific instruments, analyse data, or apply digital tools to scientific problems.

Teacher quality is equally central to successful reform. Integrated Science requires teachers who possess sufficient knowledge across relevant scientific domains as well as competence in inquiry-based pedagogy, laboratory practice, assessment, ICT integration, classroom management, and inclusive teaching. The rapid development of digital technologies and artificial intelligence further requires teachers to acquire new forms of technological and pedagogical competence.

In Niger State, the distribution of qualified science teachers presents an additional challenge. Qualified teachers tend to be more readily available in urban and semi-urban communities, while rural schools often experience greater difficulty attracting and retaining specialized personnel. Factors such as inadequate social amenities, professional isolation, limited opportunities for continuing professional development, transportation difficulties, and insecurity can make rural postings less attractive. The challenge becomes more pronounced in communities affected by banditry and other forms of insecurity, where teachers may be reluctant to accept or remain in postings.

The consequences for Integrated Science education are substantial. Where qualified science teachers are unavailable, schools may assign the subject to teachers without adequate preparation in scientific content or methodology. Such teachers may lack the confidence and competence required to conduct practical activities, facilitate inquiry, use laboratory equipment, integrate ICT, or guide students through scientific investigations. Integrated Science consequently risks reverting to teacher-centred instruction, memorization, and textbook recitation.

Teacher development should therefore constitute a central component of educational reform. Continuing professional development (CPD) provides opportunities for teachers to update their subject knowledge, develop contemporary pedagogical skills, improve technological competence, and respond to emerging educational demands. Adebayo (2021) emphasizes the importance of professional development in enabling teachers to adapt to changing instructional requirements. Effective CPD programmes can strengthen teachers' confidence in using technology, implementing inquiry-based learning, adopting inclusive practices, and facilitating student-centred instruction.

For Niger State, teacher reform should extend beyond periodic workshops. A sustainable model should incorporate continuous professional learning, mentoring, peer collaboration, communities of practice, school-based support, digital training, laboratory-skills development, and opportunities for career progression. Recruitment and retention incentives should also be designed to encourage qualified science teachers to serve in rural and insecurity-affected communities. Such incentives could include hardship allowances, accommodation support, accelerated professional advancement, access to further training, and improved working conditions.

Infrastructure and teacher development should be treated as mutually reinforcing components of reform. Providing laboratories without adequately trained teachers may result in underutilization, while training teachers without providing appropriate facilities limits their ability to apply newly acquired competencies. Consequently, investment in Integrated Science education should combine functional infrastructure, qualified teachers, professional development, instructional resources, digital technologies, and effective institutional support.

Ultimately, improving Integrated Science education in Niger State requires a transition from isolated interventions towards an integrated reform strategy. Funding, policy implementation, infrastructure,

teacher competence, technology, pedagogy, and security are interconnected determinants of educational quality. Addressing these dimensions collectively would increase the likelihood that the Integrated Science curriculum will move beyond its intended design on paper to become a meaningful, practical, inquiry-oriented, and skills-based learning experience for students.

SECURITY DIMENSION

Insecurity introduces an additional dimension to the challenges confronting Integrated Science education in Niger State. While national education policies address broad concerns relating to access, quality, infrastructure, and teacher development, they do not always adequately account for the consequences of prolonged insecurity on educational delivery. Communities in parts of Shiroro, Munya, Rafi, Mariga, Mashegu, Kontagora, Magama, and neighbouring local government areas have experienced varying forms of insecurity, including banditry, kidnapping, armed attacks, displacement, and disruption of schooling.

The consequences extend beyond school closures and reduced attendance. Displacement of learners and teachers, destruction or abandonment of educational facilities, teacher turnover, parental anxiety, and interruptions to instructional time collectively weaken the continuity and quality of education. The effects are particularly serious for Integrated Science because the subject requires practical activities, laboratory equipment, consumable materials, observation, experimentation, and sustained teacher-student interaction. Under conditions of repeated disruption, subjects that require fewer physical resources and can be taught largely through textbooks may be easier to sustain. Integrated Science, by contrast, is particularly vulnerable to the erosion of its practical component.

Consequently, schools operating in security-affected communities may retain Integrated Science on the timetable while substantially reducing its practical and inquiry-based content. Where qualified science teachers are unavailable, non-specialist teachers may be required to teach the subject, further increasing reliance on textbook-based instruction and factual recall. This creates a widening disparity between the intended curriculum and the learning experiences available to students in relatively secure and well-resourced schools.

Insecurity also interacts with existing gender and socioeconomic inequalities. Concerns about the safety of travelling to and remaining in school can influence parents' decisions concerning children's continued

attendance, with potentially greater consequences for girls in communities where gender-related barriers to education already exist. Accordingly, educational interventions in affected communities should incorporate gender-sensitive and protection-oriented measures alongside strategies for maintaining instructional continuity.

Security must therefore be recognized as an enabling condition for effective science education rather than as a problem belonging exclusively to another sector. Any reform agenda for Integrated Science education in Niger State should incorporate security-responsive planning, teacher protection and retention strategies, safe access to schools, continuity mechanisms for displaced learners, and targeted support for communities disproportionately affected by insecurity.

IMPROVING INTEGRATED SCIENCE THROUGH EDUCATIONAL DEVELOPMENT

Bridging the educational funding gap in Nigeria requires stronger political commitment, improved resource mobilization, and more effective management of available resources. Government should prioritize education through increased and predictable budgetary allocations, transparent financial management, and effective accountability mechanisms. Funding should extend beyond the construction of new schools and laboratories to include the rehabilitation and maintenance of existing facilities, procurement of laboratory equipment and consumables, provision of ICT infrastructure, teacher professional development, and access to digital learning resources.

Public-private partnerships involving government, private organizations, development agencies, industries, and non-governmental organizations can complement public investment by mobilizing additional financial resources, technical expertise, and technological innovations. Such partnerships should be structured around clearly defined educational objectives and should prioritize underserved rural and security-affected communities rather than concentrating interventions in urban centres.

Effective monitoring and evaluation are equally important. Institutions responsible for basic education should strengthen systems for tracking budget disbursement, infrastructure provision, teacher deployment, laboratory functionality, ICT availability, and student learning outcomes. Transparent reporting of such indicators would strengthen accountability and enable policymakers to identify implementation gaps and redirect resources where they are most needed.

Persistent disparities in educational resources can create what may be described as a two-track Integrated Science curriculum. Although learners are officially expected to receive the same national curriculum, students in relatively well-resourced urban and peri-urban schools are more likely to experience practical, inquiry-based, and technology-supported science education. In contrast, many rural and security-affected schools may experience a reduced curriculum characterized by textbook instruction, limited practical activities, inadequate facilities, and shortages of qualified teachers. Addressing this disparity is essential for achieving equity in science education and ensuring that students' educational opportunities are not determined primarily by geographical location or security conditions.

ADAPTING INTEGRATED SCIENCE CURRICULUM TO TWENTY-FIRST-CENTURY DEMANDS

The relevance of an education system depends partly on its capacity to prepare learners for changing social, technological, and economic realities. Contemporary workplaces increasingly require competencies such as critical thinking, creativity, communication, collaboration, digital literacy, adaptability, innovation, and problem-solving. Integrated Science provides an important platform for developing these competencies because of its interdisciplinary nature and potential for inquiry, experimentation, project work, and application of scientific knowledge to real-world problems.

However, the effectiveness of Integrated Science in developing these competencies depends on the quality of curriculum implementation. Concerns about outdated instructional practices, inadequate practical activities, limited research capacity, and shortages of qualified STEM educators continue to constrain science and technology education in Nigeria (Okoye & Mante, 2024). These limitations reduce the capacity of schools to prepare learners for participation in an increasingly knowledge- and technology-driven economy.

Curriculum reform should therefore focus not only on adding new topics but also on transforming how scientific knowledge is taught and assessed. Greater emphasis should be placed on inquiry-based learning, experimentation, project-based activities, environmental problem-solving, digital literacy, computational thinking, entrepreneurship, and interdisciplinary STEM learning. Emerging areas such as biotechnology can also be appropriately introduced to provide learners with practical knowledge

relevant to agriculture, healthcare, environmental management, food production, and other sectors of the economy (Tokunbo et al., 2025).

Artificial intelligence and other emerging technologies provide additional opportunities for curriculum modernization. Their responsible integration can support personalized learning, scientific investigation, simulation, data analysis, feedback, and access to diverse learning resources. However, technological integration should be accompanied by teacher preparation, infrastructure development, ethical guidance, and appropriate assessment practices.

Curriculum reform should consequently be supported by appropriate legal and policy frameworks, investment in educational infrastructure, teacher professional development, and stronger research collaboration across STEM disciplines (Chisom et al., 2024; Michel, 2024). The objective should be to develop an Integrated Science curriculum that is responsive to local environmental and socioeconomic challenges while simultaneously preparing learners for participation in the global scientific and technological community.

SUSTAINABLE DEVELOPMENT AND INTEGRATED SCIENCE EDUCATION

Sustainable development refers to development that balances economic progress, social well-being, and environmental protection while ensuring that present development does not undermine the ability of future generations to meet their needs. The Sustainable Development Goals (SDGs) provide a global framework for addressing poverty, inequality, environmental degradation, education, health, and other interconnected development challenges (Olaniyan et al., 2023).

Education occupies a central position within this agenda because sustainable development requires citizens who possess relevant knowledge, skills, values, and capacities to make informed decisions and participate meaningfully in society. SDG 4, which focuses on inclusive and equitable quality education and lifelong learning, is particularly relevant to Integrated Science education. Through science education, learners can develop the knowledge and problem-solving abilities needed to understand environmental change, resource management, public health, energy, agriculture, technology, and other challenges associated with sustainable development.

Nigeria's substantial natural-resource endowment creates significant opportunities for economic development, but the benefits of these resources depend on effective governance, responsible resource management, human-capital development, and technological capacity. Weak governance, inadequate accountability, poverty, and insufficient investment in human capital can limit the contribution of natural resources to inclusive development. Sustainable development therefore requires stronger institutions, transparency, accountability, entrepreneurship, and investment in education and skills development.

Integrated Science can contribute directly to this process by connecting scientific knowledge with practical community and environmental problems. Students can, for example, investigate water quality, waste management, energy use, agricultural productivity, biodiversity, climate change, pollution, and public health within their local environments. Such experiences can transform science education from the acquisition of abstract knowledge into a mechanism for developing practical solutions to societal problems.

Achieving this potential requires collaboration among government, educational institutions, private organizations, communities, development partners, and industries. Such collaboration can support infrastructure, research, teacher development, innovation, and opportunities for learners to apply scientific knowledge to real-world problems. Attention must also be given to regional and community differences to ensure that disadvantaged populations are not excluded from the benefits of science and technology education (Blackmore et al., 2016; Ackah-Jnr & Fluckiger, 2021).

Thus, strengthening Integrated Science education in Niger State should be regarded as part of a broader sustainable development strategy. A scientifically literate population equipped with digital, technical, entrepreneurial, and problem-solving competencies is better positioned to contribute to responsible resource utilization, economic diversification, environmental sustainability, and inclusive socioeconomic development.

CONCLUSION

Integrated Science education in Niger State stands at the intersection of several interrelated challenges, including inadequate and uneven funding, gaps between policy formulation and implementation, insufficient infrastructure, shortages of qualified science teachers, limited integration of contemporary

pedagogy and technology, and persistent insecurity. These challenges constrain the capacity of the subject to fulfil its potential as a vehicle for scientific literacy, problem-solving, innovation, and twenty-first-century skills development.

The paper has demonstrated that these challenges cannot be effectively addressed through isolated interventions. Curriculum reform without adequate financing and teacher preparation is unlikely to transform classroom practice. Increased funding without transparent governance and monitoring may fail to improve learning conditions, while teacher training without attention to rural deployment, infrastructure, and security may not achieve equitable access to quality science instruction. The reform agenda must therefore be coordinated across funding, policy and governance, teacher capacity, infrastructure, pedagogy, partnerships, and security-responsive educational delivery.

The significance of this agenda extends beyond examination performance. Niger State possesses substantial agricultural, energy, and mineral resources that provide opportunities for economic diversification and sustainable development. Realizing this potential requires a scientifically literate population capable of applying knowledge, technology, creativity, and innovation to local and global challenges. Well-delivered Integrated Science education can contribute significantly to developing such human capital.

Reimagining Integrated Science education in Niger State is therefore not simply an educational priority; it is an important component of the state's broader development strategy. Coordinated investment in teachers, laboratories, digital infrastructure, curriculum implementation, research, partnerships, and safe learning environments can help transform Integrated Science from a predominantly theoretical subject into a practical, inquiry-oriented, technology-supported learning experience. Such transformation would strengthen learners' preparedness for further education, employment, entrepreneurship, and responsible participation in sustainable socioeconomic development.

RECOMMENDATIONS

Based on the issues examined in this paper, the following recommendations are proposed:

1. Strengthen public-private partnerships.

The Niger State Government should establish structured partnerships with private-sector organizations, industries, philanthropic bodies, development agencies, and non-governmental

organizations to support laboratory development, ICT infrastructure, teacher training, digital learning, and science innovation. Such partnerships should include explicit provisions for rural and security-affected communities.

2. Increase and improve the management of educational funding.

Government should increase investment in basic science education and ensure that funds are transparently allocated, disbursed, monitored, and evaluated. Priority should be given to laboratory rehabilitation, equipment, consumables, electricity, ICT facilities, internet connectivity, instructional materials, and maintenance of existing infrastructure.

3. Recruit, train, and retain qualified Integrated Science teachers.

Niger State should strengthen both pre-service and in-service preparation in Integrated Science and relevant scientific disciplines. Rural and security-affected schools should receive appropriate incentives, including hardship allowances, accommodation support, opportunities for professional advancement, and access to continuing professional development.

4. Strengthen monitoring and evaluation.

A data-driven monitoring system should track teacher deployment, laboratory functionality, ICT availability, budget implementation, curriculum delivery, attendance, and learning outcomes at the school level. Findings should be used to improve accountability, resource allocation, and policy implementation.

5. Adopt security-responsive educational delivery models.

In communities where insecurity disrupts conventional schooling, government and relevant partners should provide safe and flexible learning alternatives, including community-based learning spaces, radio-supported instruction, offline digital resources, mobile learning arrangements, and other context-appropriate approaches that maintain continuity of science education.

6. Modernize Integrated Science curriculum implementation.

Curriculum delivery and assessment should emphasize inquiry-based learning, practical activities, project work, experimentation, critical thinking, creativity, collaboration, problem-solving, digital literacy, and interdisciplinary STEM competencies. Emerging technologies, including artificial intelligence, should be integrated responsibly where infrastructure and teacher capacity permit.

7. Link teacher professional development to career progression.

Continuing professional development should be continuous, school-relevant, and linked to opportunities for career advancement. Teachers should receive practical training in laboratory methods,

ICT-supported pedagogy, inclusive education, inquiry-based instruction, assessment, and emerging technologies.

8. Promote science education for sustainable development.

Integrated Science programmes should connect classroom learning to local challenges involving agriculture, water, energy, environmental conservation, waste management, climate change, public health, and natural-resource management. This would strengthen learners' ability to apply scientific knowledge to sustainable development.

Reference

- Adebayo, F.T (2021). Continuing professional development for Nigeria teachers: Challenges and prospects. *Educational review*, 73(1), 54-68. <https://doi.org/10.1080/00131911.2019.1710599>
- Agyemang, K. (2021). Ghana's progress in STEM education. *African Education Review*, 18(4), 55572. <https://doi.org/10.1080/18146627.2020.1812579>
- Brigde international academic 2021., transforming education for understanding communities. Brigde international academics annual report <https://brigdeinternationalacademics.com/annual-report-2021>
- Chisom ,O.N., Unachhukwu C.C& Osawaru,B (2024) STEM EDUCATION ADVANCEMENTS IN NIGERIA: International journal of applied researcher social sciences,5(10)614 fair east publishers
- Duncan,A. 2009 statement from U.S department of education available at: www.ed.gov/pressrelease/2009/06/06152009.html
- Ejiogu.A.M (2021) Curriculum reform in Nigeria Aligning education with the demands of digital economy. *Journal of digital literacy and digital economy*. 4(2)111-130 <https://doi.org/10.1080/00220272.2021.1975500>
- Haruna, A. (2025). Revitalizing Nigerian Libraries through Digital Infrastructure: A Blueprint for Equitable National Knowledge Access. *Journal of Science Innovation and Technology Research*.
- Idowu.F (2025) from crisis to opportunity re-imaging Nigeria education system for the 21st century, SSRN electronic journal
- Isma,il, A., Bello A., Bashir,S, knowledge and their perceived competency in integrated STEM concepts; implications on natural and global trends. Dergipark istanbul university
- Japhet-nwapi, ihunda aruchi. "challenges hindering state governments from accessing universal basic education (ube) counterpart funds in nigeria." *International Journal of Education, Management & Global Development* 2.3 (2026): 105-114.

- Matazu S.S (2021). undergraduates perception of STEM education as a tool for enchainning economic development in sokoto state, Nigeria international journal of scientific research in science engineering and technology. 162 <https://doi.org/1032699>
- Michael,O.(2024) Building a future ready workforce; re-evaluating over educational system. SSRN electronic journal. <http://doi.org/10.2139/ssrn>
- National bureau of statistic (2022); Nigeria education statistics, Nigeria national bureau of statistics <http://nigerianstat.gov.ng>
- Njuguna, F. (2021). Competency-based curriculum and its impact on student outcomes in Kenya. Kenya Journal of Education, 15(1), 45–61. <https://doi.org/10.1002/jed.21821>
- Ofoegbu, F.(2020). Teacher quality and its influence on student outcome in West Africa. *West African educational journal*,5(1),23-45. <https://doi.org/10.1177/009400211221012>
- Okafor, C.N, & Okafor L.U.(2023) Re-imaging STEM education in Nigeria: Addressing the gaps for National development. African Journal Educational Studies, 15(2),112-125
- Okeye & Mante 2024 Internation journal of research and innovation in social science VIII (IIIS) 3793-3809 DOI: 47772/2/IJRISS.2024.803275C
- OKOJIE.P (2023) Population growth and the impact on educational reform in Nigeria. African population studies 34(2), 34-48 <https://doi/10.11564 laps.v341217402>
- Tijani, B.E., & Adeduyighe, A.m for self-reliance.and economic growth in nigeria: a systematic literature review. Discover education.4(1) <https://doi/10.1007/54421717-025>
- Tokunbo ,D.B.,Modupe,K.-I.T& Adebayo.O.A(2025) The role of biotechnology education in Nigeria's industrialization and sustainable development. International journal of research and scientific innovation, 862
- UBEC 2021., Universal basic education infrastructure report, Universal basic education commission
- UNESCO (2021) Research and development in Africa: Trends and Challenges, Global education monitoring report in Nigeria. United Nations Educational, scientific and cultural organization <Http://unesco.org/stemreport>
- World bank 2021, Educational in africa strategies for overcomming barries to learning,. the world bank group. <https://documents.worldbank.org/en/publication/> documents reports
- World Bank. (2021). Digital education in sub-Saharan Africa: Nigeria’s EdTech potential. World Bank Education Report. <https://documents.worldbank.org/en/publication>