



Physics Education as a Catalyst for sustainable Development in ... Baba, A. M., Et. al. (2026)

Physics Education as a Catalyst for Sustainable Development in Nigeria: Roles, Challenges and Future Directions

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Abstract

Sustainable development in Nigeria cannot be meaningfully pursued without deliberate investment in science and technology education. Among the science disciplines, physics education occupies a strategic and often underappreciated position because it provides the conceptual and practical foundation for technological innovation, industrial growth, renewable energy development, and scientific problem-solving. In a country grappling with energy shortages, youth unemployment, environmental pressures, and technological dependence, physics education offers pathways toward resilience and long-term national progress. This paper critically examines the role of physics education in advancing sustainable development in Nigeria. It argues that physics education must be viewed not merely as a school subject but as a transformative tool for building scientific literacy, promoting entrepreneurship, strengthening industrial capacity, and promoting environmental responsibility. The paper explores the ways in which physics education contributes to Nigeria's development aspirations, analyzes the systemic barriers limiting its impact, and proposes strategic future directions. The paper recommend that repositioning physics education is essential for Nigeria's transition into a sustainable, innovation-driven, and globally competitive society.

Keywords: Physics education, sustainable development, STEM education, curriculum reform

Introduction

Nigeria's quest for sustainable development is inseparable from the quality of its educational system. As Africa's most populous nation, with a rapidly growing youth population and abundant natural resources, Nigeria possesses enormous developmental potential. Yet this potential remains constrained by persistent structural challenges, including unreliable electricity supply, low industrial productivity, environmental degradation, high unemployment, and dependence on imported technologies (World Bank, 2025). Knight, (2023) stated that addressing these challenges requires more than economic reforms; it requires a deliberate strategy for building human capital through relevant and future-oriented education. Science education, especially physics education, plays a central role in this process. Physics is foundational to engineering, telecommunications, renewable energy, transportation, manufacturing, and emerging digital industries. It shapes how societies understand and manipulate energy, materials, and technological systems for productive purposes.

In the Nigerian context, physics education carries significance beyond the classroom. It is directly linked to national aspirations for industrialization, technological self-reliance, and sustainable development. The Federal Government's National Development Plan (2021–2025) identifies science, technology, and innovation as key drivers of economic diversification and resilience. However, these ambitions cannot be realized without strengthening foundational disciplines such as physics (Federal Government of Nigeria, 2021). Aina, (2024) opined that despite this relevance, physics



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education in Nigeria often suffers from low enrollment, weak practical exposure, inadequate teaching resources, and societal misconceptions that portray the subject as difficult and inaccessible. Such conditions limit its transformative potential and undermine broader development efforts. This paper therefore, examines how physics education can serve as a catalyst for sustainable development in Nigeria.

Physics Education and Sustainable Development in the Nigerian

Sustainable development in Nigeria must be interpreted through the lens of a nation navigating complex developmental contradictions. On one hand, Nigeria possesses immense natural endowments including crude oil, natural gas, vast arable land, abundant solar radiation, and a youthful population that could serve as a demographic dividend. On the other hand, the country continues to grapple with persistent infrastructure gaps, technological dependence, environmental degradation, youth unemployment, and inadequate investment in scientific research and innovation (International Energy Agency, 2025). These tensions define the urgency of rethinking development pathways that are not only economically productive but also socially equitable and environmentally sustainable. The concept of sustainable development, as articulated by the World Commission on Environment and Development, refers to development that meets present needs without compromising the ability of future generations to meet their own needs (WCED, 1987). This definition has become foundational in global policy discourse, its implications for Nigeria are uniquely significant. Sustainable development in the Nigerian context involves reducing dependence on extractive industries, diversifying the economy, promoting clean and affordable energy systems, strengthening human capital, and building institutions capable of supporting innovation-driven growth (United Nations Development Programme, 2024).

Achieving these objectives requires more than policy declarations; it demands a transformation in the nation's educational priorities. Education particularly science, technology, engineering, and mathematics (STEM) remains one of the most effective instruments for building a sustainable future. STEM disciplines cultivate analytical thinking, technological creativity, and evidence-based decision-making, all of which are essential for addressing national development challenges (UNESCO, 2025). Within this broader framework, physics education occupies a strategic and often underappreciated position. According to Aina and Adedoyin, (2023), physics is widely regarded as the foundational science because it explains the principles governing matter, energy, motion, and interactions in the natural world. Its applications extend into engineering, medicine, telecommunications, environmental science, energy systems, transportation, and digital technologies. In practical terms, the modern infrastructure of any society from electricity grids and internet systems to medical imaging devices and renewable energy technologies depends on concepts rooted in physics. Therefore, strengthening physics education is not merely about improving academic performance; it is about equipping citizens with the scientific literacy and technical capacity needed to drive national transformation. In Nigeria, the relevance of physics education is particularly evident in the energy sector. Despite being a major oil-producing country, Nigeria faces chronic electricity shortages, with millions lacking reliable access to power. This energy crisis affects industrial productivity, healthcare delivery, education, and overall quality of life. Physics education provides the intellectual foundation for understanding and developing alternative energy systems such as solar, wind, hydroelectric, and battery storage technologies. Given Nigeria's significant solar potential estimated at one of the highest in the world training learners in applied physics can support local expertise in renewable energy deployment and maintenance (International Renewable Energy Agency, 2025).



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Okeke, (2024) stated that beyond energy, physics education contributes directly to technological innovation and industrialization. Sustainable economies are built on the capacity to produce, adapt, and improve technologies rather than merely consume imported systems. Nigeria's aspiration to become a knowledge-based economy depends on cultivating a workforce capable of scientific inquiry, engineering design, and problem-solving. Physics education develops these competencies by fostering quantitative reasoning, experimentation, and systems thinking. These skills are indispensable in sectors such as manufacturing, robotics, aerospace, telecommunications, and climate science. Ogunleye and Ibrahim, (2023) opined that equally important is the role of physics education in addressing environmental sustainability. Nigeria faces multiple ecological challenges, including desertification in the north, coastal erosion in the south, recurrent flooding, oil pollution in the Niger Delta, and rising urban waste burdens. Understanding environmental systems, energy efficiency, atmospheric processes, and material sciences all areas informed by physics enables communities and policymakers to design more effective adaptation and mitigation strategies. Physics education thus supports not only technological advancement but also ecological stewardship.

However, Adewale et al., (2024) stated that the potential of physics education in advancing sustainable development in Nigeria remains under-realized. Several structural barriers continue to limit its impact. Many schools operate without functional laboratories, making practical learning difficult. Teacher shortages, outdated curricula, and inadequate funding weaken instructional quality. Furthermore, societal perceptions often portray physics as abstract, difficult, and disconnected from everyday life, discouraging student engagement and limiting enrollment in advanced studies. These issues collectively undermine the nation's ability to build a strong pipeline of future scientists, engineers, and innovators. To reposition physics education as a driver of sustainable development, Adewale et al., (2024) stated that there is a need for contextualized curriculum reform. Physics teaching in Nigeria should be more closely linked to local realities renewable energy systems, agricultural mechanization, climate resilience, water purification, and low-cost technological solutions. Such contextualization can make learning more meaningful while directly aligning educational outcomes with national development needs (Nigerian Educational Research and Development Council, 2024). Another essential step is investment in teacher capacity building. Teachers are central to translating curriculum goals into classroom realities. Continuous professional development programs should focus on inquiry-based learning, sustainability integration, and digital competence. This is especially important in an era where simulation tools, virtual laboratories, and artificial intelligence are reshaping science education globally (World Bank, 2025). Ultimately, sustainable development in Nigeria cannot be achieved without investing in the intellectual infrastructure that drives progress. Physics education forms part of that infrastructure. It develops the scientific mindset, technical skills, and problem-solving capacity required for a resilient and prosperous society. In a nation striving to diversify its economy and build a sustainable future, physics education should be recognized not as a peripheral academic subject, but as a strategic national asset.

Why Physics Matters in Sustainable Development in Nigeria

Bybee, (2018) maintained that Physics provides the scientific language of modern development, especially in a country like Nigeria where sustainable progress depends heavily on solving practical challenges in energy, infrastructure, communication, and industry. At its core, physics explains how nature behaves how energy is generated, transferred, and transformed and these principles are exactly what underpin the technologies that drive sustainable development (Knight, 2023). In Nigeria's development context, physics is not abstract knowledge; it is directly connected to survival,



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economic growth, and technological independence. Many of the country's pressing challenges electricity shortages, weak industrial output, inefficient infrastructure, and environmental stress are fundamentally physics-based problems that require physics-informed solutions.

Physics as the Foundation of Sustainable Technologies

A sustainable society depends on efficient use of energy and materials. Physics provides the foundation for understanding and improving these systems:

1. Energy transfer and conservation explain how power is generated and distributed efficiently in national grids.
2. Electromagnetism is the principle behind electricity generation, transformers, motors, and transmission systems that power industries and households.
3. Wave physics underpins telecommunications, including mobile networks, internet systems, and broadcasting services that support Nigeria's digital economy.
4. Materials science and heat transfer are essential for designing sustainable buildings, reducing energy loss, and improving infrastructure durability in tropical climates.

Research in physics education by Brewe, (2011) Nordine et al., (2018) consistently shows that when learners understand energy as a system of transfers and transformations rather than isolated "forms," they are better able to apply physics knowledge to real-world problems.

Linking Physics Concepts to Nigeria's Real-World Needs

The relevance of physics becomes clearer when connected directly to everyday technologies and national challenges:

1. Solar energy systems: Nigeria's abundant sunlight makes solar power a major sustainable energy option. However, efficient solar panel design depends on semiconductor physics, which explains how light is converted into electrical energy.
2. Electric power generation and distribution: The entire national grid system is based on electromagnetic induction, resistance, and circuit theory. Understanding these principles is essential for improving Nigeria's unstable electricity supply.
3. Telecommunications and digital economy: Mobile networks, satellite communication, and internet systems rely on wave theory and signal transmission. Physics enables the expansion of Nigeria's digital infrastructure and innovation ecosystem.
4. Sustainable construction and urban development: Heat transfer, thermodynamics, and material properties are critical for designing energy-efficient buildings suited for Nigeria's hot climate, reducing cooling costs and energy consumption.
5. Environmental technology: Physics is essential in understanding climate systems, pollution control, and renewable environmental monitoring technologies that support sustainability planning.

These examples show that physics is not separate from development it is embedded within it.

Physics, Innovation, and National Competitiveness

Modern economies are driven by science-based innovation. Societies that invest in STEM education especially physics are more likely to develop technological solutions internally rather than depend on imported systems. As Bybee (2018) emphasizes, countries that prioritize STEM education are better positioned to innovate, adapt to change, and remain globally competitive in a rapidly evolving technological world. In Nigeria, this is particularly important because:

1. industrial growth depends on engineering and applied physics;
2. renewable energy expansion requires physics-trained professionals;
3. digital transformation relies on electronics and communication physics;



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4. local manufacturing depends on material science and mechanics

Without strong physics education, Nigeria risks remaining a consumer of foreign technology rather than a producer of indigenous innovation.

Physics Education as a Tool for Problem-Solving

Beyond technology, physics education develops thinking skills that are essential for sustainable development. These include: (i) analytical reasoning; (ii) quantitative problem-solving; (iii) systems thinking; (iv) modeling complex processes; (v) evidence-based decision-making

Studies in physics education show that learners trained through inquiry and conceptual understanding are better able to transfer knowledge to unfamiliar real-world situations (Freeman et al., 2014). This is especially important in Nigeria, where many societal problems require adaptable thinking rather than memorized solutions.

Humanizing the Importance of Physics

Physics becomes truly meaningful when students see it in their daily lives. In Nigeria:

1. the phone in a student's hand works through electromagnetic waves;
2. the fan at home operates through electric motor principles;
3. solar panels in rural areas rely on semiconductor physics;
4. even cooking energy efficiency relates to thermodynamics

When physics is taught in this way connected to live experiences it becomes less of a difficult subject and more of a practical tool for understanding and improving life.

Roles of Physics Education in Nigeria's Sustainable Development

Physics education according to Bybee, (2018) plays a central but often underutilized role in Nigeria's sustainable development agenda. Beyond being a school subject, it functions as a foundational knowledge system that connects scientific principles to real-world national challenges. In a developing economy like Nigeria, where development pressures intersect with rapid population growth and technological change, physics education becomes a strategic tool for building resilience, innovation capacity, and long-term sustainability (UNESCO, 2025).

Addressing Energy Insecurity in Nigeria

Energy insecurity remains one of the most critical barriers to sustainable development in Nigeria. Despite being one of Africa's largest economies, the country continues to experience unstable electricity supply, frequent blackouts, and low per capita energy consumption. This has significant consequences for industrial productivity, education quality, healthcare delivery, and household welfare (International Energy Agency, 2025). From a physics perspective, energy systems are governed by principles of electromagnetism, thermodynamics, and energy conversion. Understanding these principles is essential for designing and improving national power systems. Physics education therefore provides the intellectual foundation for addressing energy challenges through renewable and efficient technologies. Akinyele & Rayudu, (2024) stated that Nigeria's high solar irradiance offers a major opportunity for solar energy development. However, the adoption of solar technologies remains limited due to insufficient technical expertise and weak local innovation capacity. Strengthening physics education can help bridge this gap by producing professionals skilled in photovoltaic system design, energy storage technologies, and smart grid management. In practical terms, physics-trained graduates can contribute to:

1. solar panel installation and optimization
2. battery storage and energy efficiency systems
3. rural electrification projects
4. hybrid energy system design



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A stronger physics education system therefore directly supports Nigeria's transition toward clean and decentralized energy systems.

Promoting Industrialization and Local Innovation

Industrialization remains a key pillar of Nigeria's economic transformation agenda, yet progress has been slow due to limited technological capacity and weak integration between education and industry. Physics education is central to reversing this trend because it develops the scientific and analytical foundation required for engineering, manufacturing, and technological production. Okebukola, (2023) maintained that Physics underpins virtually all industrial processes from mechanical systems and electronics to materials engineering and automation. However, Nigeria continues to rely heavily on imported machinery, foreign technical expertise, and external maintenance services. This dependence reflects a gap in applied scientific training and innovation capacity. A robust physics education system can contribute to industrial growth by:

1. strengthening local manufacturing capabilities
2. supporting electronics and instrumentation industries
3. enabling adaptation of imported technologies to local conditions
4. fostering research and development culture in universities and polytechnics

When foundational sciences like physics are strong, innovation ecosystems tend to emerge naturally, allowing countries to move from technology consumption to technology creation.

Enhancing Employment and Entrepreneurship Opportunities

Aina, (2024) stated that youth unemployment in Nigeria remains a major socio-economic challenge, with a large proportion of graduates struggling to find employment in formal sectors. This situation highlights the need for education systems that not only prepare learners for jobs but also equip them to create jobs. Physics education contributes to this shift by developing transferable skills such as analytical reasoning, problem-solving, quantitative literacy, and systems thinking. These competencies are highly valuable in emerging entrepreneurial sectors, particularly in technology-driven industries. Physics-informed entrepreneurship can emerge in areas such as:

1. renewable energy services (solar installation and maintenance)
2. electronics repair and innovation
3. ICT and hardware integration
4. instrumentation and measurement services
5. educational technology development

Through equipping learners with both conceptual understanding and practical problem-solving skills, physics education fosters self-reliance and innovation-oriented mindsets. This is particularly important in Nigeria's evolving labor market, where informal innovation and small-scale technical enterprises play a significant economic role.

Supporting Environmental Sustainability and Climate Adaptation

Nigeria is increasingly vulnerable to environmental challenges, including desertification in the northern regions, coastal erosion in the south, flooding in urban areas, and oil pollution in the Niger Delta. These challenges are intensified by climate change and unsustainable resource use patterns. Physics education provides essential scientific tools for understanding these environmental processes. Concepts such as thermodynamics, fluid dynamics, radiation, and energy conservation are directly applicable to climate systems, weather patterns, and environmental engineering solutions (IPCC, 2023). For example:

1. thermodynamics explains heat flow in buildings and ecosystems
2. fluid mechanics informs flood prediction and water management systems
3. radiation principles support climate modeling and solar energy optimization



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When physics education is contextualized within local environmental realities, it empowers learners to contribute to practical solutions such as:

1. flood-resistant infrastructure design
2. sustainable water systems
3. energy-efficient housing
4. environmental monitoring technologies

This makes physics education a critical contributor to climate adaptation and environmental resilience in Nigeria.

Strengthening Scientific Literacy and Civic Participation

Hodson, (2020) stated that scientific literacy is increasingly important in contemporary society, especially in an era characterized by rapid technological change, environmental uncertainty, and widespread misinformation. In Nigeria, public debates around energy policy, environmental management, and technological adoption require citizens who can interpret scientific information critically. Physics education plays a vital role in developing this capacity by promoting evidence-based reasoning, logical thinking, and data interpretation skills. A scientifically literate population is better able to:

1. evaluate claims about energy and climate issues
2. make informed decisions about technology use
3. participate meaningfully in policy discussions
4. resist misinformation and pseudoscience

In this way, physics education contributes not only to economic and technological development but also to democratic governance and societal stability. A population that understands basic scientific principles is more likely to support sustainable policies and responsible resource management.

Challenges Facing Physics Education in Nigeria

Despite its strong potential to drive sustainable development, physics education in Nigeria is constrained by a range of structural, pedagogical, institutional, and socio-cultural challenges. These challenges are deeply interconnected and reflect broader issues within the Nigerian education system, including underfunding, inequality of access, and weak alignment between education and national development priorities (Adewale, Musa, & Bello, 2024). A critical understanding of these barriers is essential for designing realistic reforms that can reposition physics education as a tool for sustainable development.

Inadequate Infrastructure and Learning Resources

According to Adesoji and Olatunbosun, (2024) one of the most persistent challenges facing physics education in Nigeria is the lack of adequate infrastructure. Many secondary schools and tertiary institutions operate without fully functional laboratories, up-to-date experimental equipment, or digital learning technologies. As a result, physics is often taught as a purely theoretical subject rather than an experimental and inquiry-based discipline. This situation significantly undermines students' conceptual understanding of physics principles. Without hands-on experimentation, learners struggle to connect abstract concepts such as forces, energy, electricity, and waves to real-world phenomena. In addition, the absence of modern instructional tools such as simulations, virtual laboratories, and digital sensors further limits engagement and reduces the quality of teaching and learning. Studies have shown that practical engagement is essential for deep learning in physics, particularly in developing countries where exposure to real-life technological applications is limited (UNESCO, 2025). Consequently, students often perceive physics as difficult and disconnected from everyday life, leading to low interest and poor academic performance.



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Shortage of Qualified Teachers and Professional Development Gaps

Nworgu and Ugwuanyi, (2024) stated that the effectiveness of any education system depends largely on the quality of its teachers. In Nigeria, there is a significant shortage of well-trained physics teachers, particularly in rural and underserved regions. This uneven distribution creates disparities in learning outcomes between urban and rural schools. Furthermore, many existing physics teachers lack continuous professional development opportunities that would expose them to modern pedagogical approaches such as inquiry-based learning, problem-based learning, and technology-enhanced instruction. In many cases, teachers rely on traditional lecture-based methods that emphasize memorization rather than conceptual understanding. This limits students' ability to develop critical thinking and problem-solving skills, which are essential for sustainable development. Globally, teacher capacity development has been identified as a key factor in improving STEM education quality. Without sustained investment in teacher training, curriculum reforms and infrastructure improvements alone cannot yield meaningful results (OECD, 2023).

Curriculum Misalignment with National Development Needs

Okebukola, (2023) says that another major challenge is the disconnection between physics curricula and Nigeria's socio-economic realities. Although physics as a discipline is inherently applicable to real-world problems, the way it is currently taught in many institutions often lacks contextual relevance. Topics such as renewable energy systems, climate change adaptation, sustainable technologies, and entrepreneurship are either underrepresented or treated superficially. This weakens students' understanding of how physics relates to national development priorities such as energy security, industrialization, and environmental sustainability. A curriculum that is heavily theoretical and examination-oriented limits students' ability to apply knowledge in practical situations. It also reduces motivation and engagement, as learners struggle to see the relevance of physics to their lives and future careers. International education reforms emphasize the importance of contextualized and competency-based curricula that connect science learning to real-world challenges (Bybee, 2018; UNESCO, 2025).

Negative Perceptions and Low Student Participation

Freeman et al., (2014) maintained that Physics is widely perceived among Nigerian students as one of the most difficult and abstract subjects in the science curriculum. This perception is often reinforced by poor teaching methods, lack of practical experiences, and overemphasis on mathematical derivations without meaningful context. As a result, many students avoid physics at higher levels of education, especially female students who are already underrepresented in STEM fields. Gender disparities in physics participation remain a global concern, but they are particularly pronounced in developing countries where cultural and institutional barriers persist (Aikenhead, 2021). This negative perception has long-term consequences, including a reduced pipeline of future scientists, engineers, and innovators. It also limits Nigeria's ability to build a strong knowledge economy driven by science and technology. Research shows that when students are exposed to engaging, real-life applications of physics, their attitudes toward the subject improve significantly.

Policy Weaknesses and Insufficient Funding

Education financing remains a critical constraint in Nigeria. Despite repeated policy commitments, funding for education consistently falls below the recommended international benchmark of 15–20% of national budgets. This underinvestment affects nearly every aspect of physics education, including:

1. laboratory construction and maintenance
2. procurement of instructional materials
3. teacher recruitment and training



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4. curriculum development and innovation
5. research and development in science education

According to UNICEF (2025), inadequate funding contributes to inequities in access to quality education and limits the effectiveness of reform initiatives. Moreover, policy implementation is often inconsistent, with gaps between national education plans and actual classroom realities. Without sustained financial and institutional commitment, even well-designed policies struggle to achieve meaningful impact.

Future Directions for Physics Education in Nigeria

The future of physics education in Nigeria according to Bybee, (2018) must be intentionally redesigned to respond to the country's urgent sustainable development needs. Current evidence shows a persistent mismatch between physics classroom practices and the scientific, technological, and socio-economic realities of Nigerian society. Bridging this gap requires reforms that reposition physics as a practical, contextual, and innovation-driven discipline rather than a purely theoretical subject (; UNESCO, 2025). Aikenhead, (2021) opined that a major future direction is the curriculum reorientation toward contextual and problem-based learning. Physics content should be explicitly connected to Nigeria's development challenges such as energy insecurity, flooding, environmental degradation, transportation systems, and industrial growth. Study in science education by Okebukola, (2023) emphasize that students learn more effectively when concepts are linked to real-life contexts and local problems. In the Nigerian context, this means integrating renewable energy systems, basic electronics, climate-related physics, and locally relevant technologies into teaching and learning experiences.

(Adesoji & Olatunbosun, (2024) stated that another key direction is the strengthening of inquiry-based and practical-oriented instruction. Research has consistently shown that active learning approaches significantly improve student achievement and retention in science subjects compared to traditional lecture-based methods. In physics education specifically, laboratory engagement and hands-on experimentation are essential for developing conceptual understanding. Future reforms should therefore prioritize low-cost experimental materials, school-based innovation projects, and structured laboratory activities even in resource-constrained environments (Freeman et al., 2014). The integration of educational technology and digital learning tools also represents a critical future pathway. Virtual laboratories, simulations, and interactive physics software can help address the persistent problem of inadequate physical laboratory infrastructure in Nigerian schools. Digital learning environments have been shown to enhance conceptual visualization and improve student engagement in abstract scientific topics (UNESCO, 2025). Expanding access to ICT-based physics instruction will be particularly beneficial for rural and underserved schools.

In addition, Nworgu and Ugwuanyi, (2024) stated that the continuous professional development of physics teachers is essential for sustainable improvement. Teacher quality remains one of the strongest predictors of student achievement in science education (OECD, 2023). Nigerian physics teachers require regular training in modern pedagogical approaches such as inquiry-based learning, STEM integration, and technology-enhanced instruction. Strengthening teacher education institutions and establishing structured in-service training programs will help ensure that teachers remain competent and adaptable to evolving educational demands. Future physics education must also strengthen collaboration between educational institutions and industry. Linkages with energy companies, telecommunications firms, manufacturing industries, and environmental agencies can provide students with exposure to real-world applications of physics. Such partnerships help bridge



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the gap between theory and practice while also supporting innovation and employability (World Bank, 2025). Finally, physics education should be repositioned as a driver of innovation, entrepreneurship, and sustainable livelihoods. Rather than focusing solely on academic progression, physics should be taught as a tool for problem-solving and value creation. This aligns with global STEM education reforms that emphasize creativity, innovation, and entrepreneurship as key outcomes of science education (Bybee, 2018). In Nigeria, this shift is essential for addressing youth unemployment and building a knowledge-based economy.

Conclusion

Physics education is a key but underutilized driver of Nigeria's sustainable development. It supports critical sectors such as energy, industry, environment, entrepreneurship, and innovation by developing scientific literacy, problem-solving skills, and technological competence. However, its impact is limited by challenges such as poor infrastructure, inadequate teacher capacity, outdated curricula, weak policy implementation, and negative student perceptions. These issues reduce its relevance and prevent learners from fully connecting physics to real-life and national development needs. To unlock its full potential, physics education in Nigeria must be reformed to become more practical, contextual, and aligned with national priorities like renewable energy, industrialization, and environmental sustainability. It should move away from being seen as an abstract subject and instead be positioned as a real-world, problem-solving discipline. In conclusion, investing in physics education is essential not optional for Nigeria's transition toward a sustainable, innovative, and self-reliant future.

Recommendations

1. Physics curricula should reflect Nigerian realities by integrating renewable energy, agricultural technology, environmental sustainability, and local engineering challenges. This makes learning more relevant and socially meaningful.
2. Government and institutions should prioritize laboratories, simulations, and low-cost digital tools. Practical engagement must become central, not optional.
3. Continuous training in inquiry-based teaching, sustainability integration, and educational technology is essential. Teacher motivation and retention strategies should also be strengthened.
4. Collaboration with industries, research centers, and local communities can provide internships, mentorship, and applied learning opportunities. Such partnerships bridge theory and practice.
5. Scholarships, outreach programs, and mentorship initiatives should target girls and underserved populations. Broadening participation strengthens national talent pools.

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