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Research Article

Integration of Innovative Technology Education for sustainable development into Nigerian university education system

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Abstract

Integrating Innovative Technology Education (ITE) for sustainable development (SD) into Nigerian university systems is a strategic and developmental necessity. As global demands for sustainability and digital transformation intensify, Nigerian universities need to align their curricula, pedagogy, and institutional structures with the (SDGs) and Fourth Industrial Revolution (4IR) technologies (emerging technologies) like Artificial Intelligence (AI), renewable energy, Internet of Things (IoT), and digital learning tools into teaching, research, and community engagement. This study explores existing gaps in policy, curriculum, and access, while proposing actionable strategies including curriculum reform, infrastructure development, faculty training, and public-private partnerships. Grounded in interdisciplinary perspectives and empirical insights, the study highlights barriers such as digital inequality and policy incoherence that hinder meaningful transformation. It argues that systematic and inclusive integration can reposition universities as hubs of sustainable innovation and national development. The recommendations offered will contribute to ongoing educational reform discourse, offering practical direction for policymakers and institutional stakeholders. Without a deliberate fusion of innovation and sustainability, Nigerian higher education risks falling behind in a fast-evolving global landscape.

Keywords: Innovative Technologies, Sustainable Development, Nigerian University Education, Digital Transformation, Fourth Industrial Revolution (4IR).

1. Introduction

Nigeria's higher education system stands at a pivotal moment where sustainability, innovation, and global competitiveness intersect. As climate change, digital transformation, and socio-economic inequalities intensify, universities are increasingly expected to drive innovation and capacity building for sustainable development (World Bank, 2020; Okebukola, 2021). Integrating innovative technology education into Nigerian universities is therefore both timely and essential for aligning with the SDGs and the demands of the 4IR UNESCO, 2019; Schwab, 2016). Globally, universities are adopting emerging technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), renewable energy systems, and digital platforms to transform teaching, research, and community engagement (Salmi, 2017; Marginson, 2022). Nigeria which is one of Africa's largest youth populations needs to strategise in adoption of such innovations to strengthen environmental resilience, curb graduate unemployment and foster inclusive growth

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(Akinwale, 2020; African Development Bank, 2022). However, systemic barriers remain as Nigerian universities continue to weak faculty capacity, face outdated curricula, infrastructural deficits, and policy incoherence (Olayinka, 2019; Adebayo & Ige, 2021). These challenges limit the production of sustainability-conscious graduates, digitally competent and undermine the relevance of higher education in the global landscape (Tertiary Education Trust Fund [TETFund], 2021). Without a deliberate framework to align technology education with educational sustainability, the digital divide will widen and weaken national competitiveness (Ogunyinka, 2020; United Nations Economic Commission for Africa, 2021).

In the face of mounting global environmental, economic, and societal challenges, there is increasing imperative for higher education systems to align with the principles of sustainable development. Most Universities in the developing countries like Nigeria, are expected to play a pivotal and transformative role in producing digitally skilled manpower that can foster innovation and advance national development goals. This calls for a strategic integration of innovative technology education that not only enhances academic outcomes but also supports the United Nations Sustainable Development Goals (SDGs), particularly Goal 4 (Quality Education) and Goal 9 (Industry, Innovation, and Infrastructure) (UNESCO, 2017; Schwab, 2016).

The UNESCO Education for Sustainable Development (ESD) framework advocates for reorienting education towards sustainability by embedding critical thinking, systems thinking and future-oriented technologies into curricula. In response to this global plight, higher institutions across the world are leveraging innovations such as IoT, AI, robotics, blockchain, virtual laboratories, and renewable energy systems to revolutionize learning, teaching, research and administration (Adeleke, Owolabi, & Jimoh, 2021). These innovations not only enhance digital competencies but also promote social inclusion, ecological sustainability, and economic opportunities. For instance, digital platforms facilitate remote learning, inclusive models of education, and data-driven decision-making. Subsequently, tools such as mobile learning applications, flipped classrooms, and AI-powered adaptive systems have shown to considerably improve engagement and accessibility in resource-constrained contexts in the developing nations like Nigeria (Oyelere, Suhonen, & Sutinen, 2020). Furthermore, university–industry collaborations through funding, internships and commercialization of student-led innovations are major tools in linking academic knowledge with real-world sustainability applications (Aina, 2020).

Despite these opportunities, the Nigerian university system has not fully exploited them. While there are isolated instances of ICT adoption, such efforts are often lacking coherence, fragmented, strategic planning, and alignment with sustainable development imperatives. Most integrated curriculum that are interjected into pedagogic experiences are outdated, faculty capacity is limited, infrastructural development is slow and persistent in inconsistencies of implementation of educational policy (Obielodan, 2019; Yusuf & Onasanya, 2022). As a result, many graduates are ill or inadequately equipped with the digital and green skills needed to compete in a rapidly evolving global economy (Okonkwo & Ifeoma, 2020). Although growing attention has been directed towards both technology integration and sustainability in education, most existing studies approach these domains separately, without adequately exploring their interconnection in a unified and systemic manner. For example, Aina (2020) highlights the challenges of digital transformation, while Obielodan (2019) emphasizes curriculum reform for sustainability. However, very few empirical studies had investigated how these domains can synergistically be integrated to reform higher education system in Nigeria. This underscores major research gap that is needed for strategic and context-sensitive framework that aligns innovative technology education with sustainable development goals in Nigerian university context. The absence of such integration poses significant risks that may threaten to worsen the scenario surrounding graduate unemployment, widen the digital divide and reduce global relevance of Nigerian graduates (UNESCO, 2021; Okebukola, 2022). This may undermine higher education system's capacity to contribute meaningfully and effectively to national priorities such as environmental resilience, climate action and economic diversification. The integration of technology and sustainability is framed not as a mere academic reform, but as a developmental imperative for Nigeria's future. By strategically embedding innovative technology education into university systems, this study underscores the alignment of policies, curricula, and institutional practices as a pathway to fostering sustainable development, making the research both timely and essential. This study therefore, explores how Nigerian universities can embed innovative technology education into teaching, research, and institutional practices to drive sustainable development, while proposing strategies to reposition universities as hubs of sustainable innovation.

2. Literature Review

The integration of technology in higher education has become a global imperative for advancing quality, equity, and sustainability in learning. In Nigeria, however, the potential of technological innovations remains largely underutilized due to systemic barriers including infrastructural deficits, policy gaps, and human capital limitations (Bakare & Olaniyi, 2017). Scholars have consistently pointed to the uneven distribution of digital resources, limited faculty training, and poor institutional commitment as central factors hindering technology's

transformative capacity in Nigerian universities (Etim, 2023).

Technological adoption in Nigeria's tertiary institutions has progressed in pockets, yet many universities lack the systemic frameworks required to mainstream innovation. A systematic review conducted by Etim (2023) revealed that while there are efforts to digitize academic activities, the success of these efforts heavily depends on access to digital infrastructure, faculty readiness, and stable electricity. Similarly, Bakare and Olaniyi (2017) emphasize that most Nigerian institutions still operate in analog formats, with ICT tools used sparingly for administrative rather than pedagogical functions. This reflects a misalignment between technological availability and educational purpose, creating what Ezenwa et al. (2021) describe as a "digital stagnation trap" in national development discourse.

Education for Sustainable Development (ESD) has also emerged as a vital domain in reshaping university systems toward environmentally responsive goals. According to Ezenwa, Sadiq, and Onwuka (2021), integrating science, technology, and innovation (STI) into Nigerian education is essential for long-term national development. They assert that when STI is prioritized in university curricula and research, it can foster innovation ecosystems that address poverty, energy crises, and environmental degradation. Complementing this view, Ukhurebor et al. (2025) argue for a paradigm shift where universities serve not only as centers of knowledge creation but also as engines of socio-technical transformation through responsible innovation, emphasizing the need to restore the global relevance of Nigerian institutions through strategic innovation frameworks.

Artificial Intelligence (AI) and machine learning tools are beginning to redefine how personalized education and institutional management are executed. In their evaluation of AI-driven tutoring systems in Nigerian universities, Anyanwu, Okoroafor, and Ikedimma (2025) found that AI applications significantly enhanced student engagement, learning outcomes, and administrative efficiency. These findings underscore the role of AI in advancing sustainable education by optimizing learning delivery, automating feedback systems, and supporting data-driven decision-making in educational planning. Such AI-enabled interventions are increasingly essential in bridging pedagogical gaps and promoting inclusive learning ecosystems in resource-constrained contexts.

Moreover, the application of Information and Communication Technology (ICT) for climate education and sustainability adaptation is gaining scholarly attention in sub-Saharan Africa. Olaniyi, Perekunah, and Emeka (2025) demonstrate that integrating ICT into climate change education curricula has significantly improved students' awareness and adaptive capacities in several African nations. Their study highlights how digital platforms can foster knowledge sharing, real-time environmental monitoring, and community-level resilience planning. This has strong implications for Nigeria, where environmental education remains peripheral in most university programs, and where ICT integration could become a strategic pathway toward resilience and eco-literacy.

Beyond pedagogy, strategic collaborations and policy interventions have also been identified as crucial for scaling sustainable technology integration. Afuwoqi and Wu (2011) argue that robust industry-university partnerships can foster innovation while mitigating the high costs of research and development in low-income settings. Their model of public-private collaboration offers valuable insights into how Nigerian institutions might develop sustainable technology ecosystems by aligning university research agendas with local industry needs. Unfortunately, as Cortes et al. (2021) observe, such partnerships remain underdeveloped in much of the Global South, including Nigeria, where academic research is often disconnected from industry and policy applications. A critical dimension in this discussion is the persistent digital divide that affects the inclusivity of technology in higher education. Ige and Adefowope Luqman (2024) report that disparities in device ownership, digital skills, and internet access continue to marginalize students—particularly women and persons with disabilities—across Nigerian universities. Their findings reveal that even when digital tools are introduced, their accessibility and usability are not uniformly guaranteed, exacerbating existing educational inequalities. These concerns are echoed in broader regional literature on sub-Saharan Africa, which identifies infrastructural instability, weak ICT policies, and digital illiteracy as fundamental challenges to achieving education technology goals (Wikipedia, 2024).

Taken together, this body of literature provides a robust empirical and theoretical foundation for rethinking how technology and sustainability can be co-integrated in Nigerian higher education. However, a notable gap persists: while many studies address individual components, such as ICT adoption, AI in education, sustainability education, or industry partnerships - there remains a lack of integrated frameworks that combine these elements into a cohesive strategy for educational transformation. This study seeks to bridge that gap by proposing a holistic model that connects technological innovation, sustainable development, institutional reform, and inclusive policy design to reposition Nigerian universities as global leaders in innovation-driven education.

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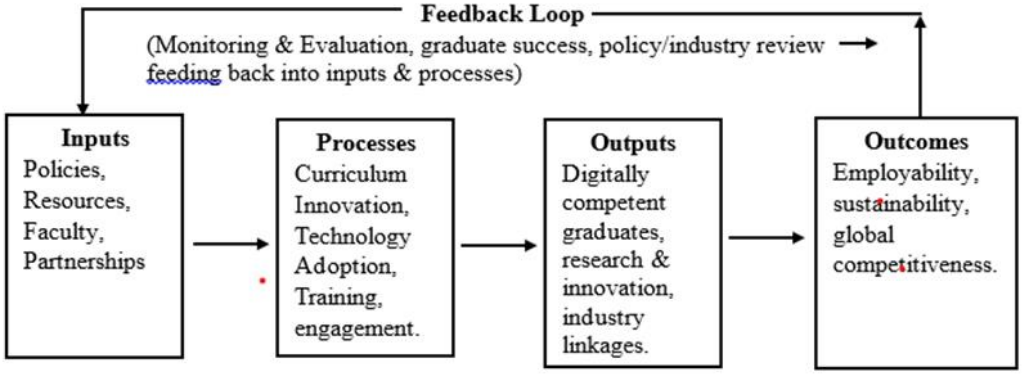

Figure 1: Conceptual Framework for Integrating Innovative Technology Education for Sustainable Development in Nigerian Universities

3. Conceptual Framework

Conceptual Framework for Integrating Innovative Technology Education for Sustainable Development in Nigerian Universities

Figure 1 illustrates a conceptual framework for integrating innovative technology education for sustainable development in Nigerian universities. It shows how the system of education operates as a cycle with clear stages and a feedback mechanism. The conceptual framework is anchored on the interrelationship between Innovative Technology Education (ITE) and Sustainable Development (SD) within the Nigerian higher education context. It underscores the role of universities as drivers of innovation, capacity building, and societal transformation when technology education is systematically aligned with sustainability goals and national priorities. The framework therefore integrates the concepts of innovative technology education, sustainable development, and higher education reforms into a coherent system that highlights cause-effect linkages and future-oriented impacts. The structured constructs around three interrelated conceptual pillars are briefly discussed hereunder:

1. Sustainable Development Paradigm: Rooted in the United Nations Sustainable Development Goals (SDGs), particularly Goal 4 (Quality Education), Goal 8 (Decent Work and Economic Growth), Goal 9 (Industry, Innovation, and Infrastructure), and Goal 13 (Climate Action), this pillar emphasizes education as a means of equipping graduates with competencies to address economic, environmental, and social challenges (UNESCO, 2019).

2. Innovative Technology Education (ITE): Is defined as the integration of emerging technologies (AI, IoT, blockchain, digital platforms, renewable energy, and virtual labs) into pedagogy, research, and institutional management. This is grounded in the Fourth Industrial Revolution (4IR) theory (Schwab, 2016), which positions technology as the core driver of competitiveness, productivity, and transformative capacity.

3. Nigeria's Higher Education System Context: This pillar reflects the realities of Nigerian universities that is characterized by outdated curricula, infrastructural deficits, limited digital literacy, and weak policy alignment (Okebukola, 2021; Adebayo & Ige, 2021). At the same time, it recognizes the opportunities presented by Nigeria's youthful population, alongside the urgent need to address graduate unemployment, digital divides, and global competitiveness (African Development Bank, 2022).

This study therefore develops a framework (Figure 1) that illustrates how Nigerian universities can strategically integrate innovative technology education to foster sustainable development, which will be anchored on the interplay between inputs, processes, outputs, and outcomes while engaging multiple stakeholders:

1. Inputs: These are foundational resources that should be procured for integrating innovative technology education for sustainable development in Nigerian universities. These resources should include funding, policies, human capital (faculty), and institutional/industry partnerships. They are to provide an enabling environment for technology-driven education in Nigerian universities.

2. Processes: These represent the actual activities and mechanisms through which inputs are transformed. They include curriculum innovation, adoption of emerging technologies, staff and student training, and active engagement in teaching and learning practices.

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3. Outputs: The direct products of the processes, such as graduates equipped with digital competence, research and innovation outcomes, and stronger university–industry linkages.

4. Outcomes: The broader, long-term impacts of the outputs, which include improved graduate employability, contribution to sustainable development, and enhanced global competitiveness of Nigerian universities.

5. Feedback Loop (Monitoring & Evaluation): A vital component of the framework that ensures continuous improvement. Through monitoring, evaluation, policy review, and industry feedback, information flows back into the system to refine inputs and processes. This ensures adaptability, sustainability, and alignment with both national development goals and global trends.

Figure 1 is explicitly discussed to demonstrate a systemic and cyclical model where education inputs are transformed into sustainable outcomes, with feedback mechanisms ensuring continuous improvement and relevance. The integration of ITE into Nigerian universities is presented through a systemic framework built on Inputs, Processes, Outputs, Outcomes, and Feedback Loops. This framework highlights the dynamic and interactive role of higher education in driving sustainable development and competitiveness.

Inputs (Foundational Resources and Drivers)*:* The inputs, which represent the foundational resources and drivers of innovative technology education in Nigeria's higher education system, are multifaceted and interdependent. At the policy level, government and regulatory frameworks provide the overarching direction through ICT-in-Education strategies, national education policies, and alignment with global goals such as the SDGs. These frameworks are important in ensuring mobilizing funding, governance, supporting infrastructural development and driving curriculum reforms (Okebukola, 2021). At the institutional level, universities require strong resource bases that include renewable energy systems, ICT infrastructure, smart classrooms, e-learning platforms and research funding. These resources are to establish the digital and physical backbone for delivering technology-driven and future-oriented education (Adegbija & Bola, 2020). However, procurement of infrastructure facilities alone will not be insufficient without adequate human capacity building. Faculty competence in technological literacy, digital pedagogy, and willingness to embrace innovation is central to ensuring that the deployment of technology translates into meaningful teaching, learning, and research outcomes (Salmi, 2017). Finally, strong collaboration with industry and communities, guided by the Triple Helix Model of university-industry-government relations is essential. Such partnerships will ensure that training aligns with labour market demands, enhances graduate employability and fosters innovation environments that is capable of addressing societal needs (Etzkowitz & Leydesdorff, 2000) .These inputs will form the foundational pillars that will enable Nigerian universities to harness innovative technology education as a driver of sustainable development.

Processes (Implementation Pathways): The successful integration of innovative technology education in Nigeria universities system should depend on clearly defined implementation pathways that will translate foundational instructional resources into tangible outcomes. A key pathway should be curriculum innovation, where academic programs should be restructured to incorporate emerging fields such as Artificial Intelligence (AI), the Internet of Things (IoT), renewable energy technologies, data science and sustainability studies. This would ensure that students acquire future-ready knowledge and competencies that are locally relevant and globally competitive. Technology adoption is equally important as it involves the deployment of virtual laboratories, green technologies, e-learning systems, and cloud-based platforms. These tools should not only transform teaching and research practices but to expand access to quality education and foster environmentally sustainable operations. In a similar vein, capacity building serves as the human engine of innovation that offers continuous professional development opportunities to faculty and students; in order to digital literacy, strengthen problem-solving abilities, and entrepreneurial mindsets. This empowers stakeholders to use technology creatively and adaptively in addressing educational and societal challenges. The engagement of stakeholder is to ensure that these processes remain responsive to societal needs. Collaboration between government agencies, universities, industries, and communities through models of co-creation and shared responsibility would anchor the alignment of training with labour market demands, education in real-world contexts, and supports innovation ecosystems. These pathways will establish an iterative and dynamic framework for implementing technology-driven education, thereby positioning Nigerian universities as critical drivers of sustainable national development.

Outputs (Immediate Results): The implementation of innovative technology education in Nigerian universities will yield immediate and tangible outcomes through production of digitally competent graduates that are equipped with 21st-century skills in creativity, problem-solving, innovation, and entrepreneurship. These graduates are better-of prepared to navigate through the demands of the 4IR and contribute meaningfully to the knowledge economy. Also, universities will generate innovative research and solutions that will be directed towards Nigeria's environmental realities and socio-economic. By leveraging technology, institutions of learning will create applied and context-specific innovations that addresses pressing national challenges such as energy, health, climate change, and food security. The system fosters strengthened university–industry linkages where collaboration with industries leads to internship opportunities, applied research and job creation. These partnerships would

improve graduate employability and position universities as hubs of innovation and drivers of sustainable development.

Outcomes (Long-Term Impacts): The integration of ITE within Nigerian universities in the long run will generate transformative impacts on individuals, society, and the nation at large. A major outcome is to enhance graduate employability as students emerge with job-ready digital skills with entrepreneurial capacities that would reduce unemployment and drive new creation of businesses. Also, universities would contribute directly to sustainable development by producing graduates and research outputs that foster inclusive economic growth, address environmental challenges and support poverty reduction. These contributions align with both national priorities and global sustainability goals (UNESCO, 2022), thereby reinforcing higher education's role as a driver of equity and resilience. These outcomes would strengthen national and global competitiveness, by enabling Nigerian universities to improve institutional resilience, close the wide gap of digital divide and secure stronger presence in the global knowledge economy. This would position Nigeria as an active participant in shaping the future of education, innovation, and sustainable development worldwide.

Feedback Loops (Continuous Improvement): Sustaining innovation in higher education requires structured feedback mechanisms that would enable continuous improvement. Graduate outcomes will provide critical lens for assessing labour market performance, with evidence of employability and entrepreneurial success guiding curriculum redesign and set priorities for graduate training. This ensures that programs remain aligned with the realities of the Fourth Industrial Revolution 4IR. Feedback from industry and community is equally important, which guarantees that academic offerings remain relevant and responsive to evolving societal needs. Conduction of dialogue with industries, employers and local communities among Nigerian universities can foster refining of teaching, research, and service delivery on addressing real-world challenges. At the systemic level, reviewing of the national policy and adaptation form the pillar of strength of governance and sustainability. Therefore, continuous policy evaluation will go a very long way in supporting effective resource allocation, strengthening institutional resilience, and reinforcing the ability of higher education to contribute meaningfully to long-term national development goals.

Summarily, this framework demonstrates that integrating ITE in Nigerian universities is systemic and interactive approach; which requires robust institutional capacity, multi-stakeholder collaboration and adaptive policies. Overcoming structural barriers and leveraging innovation in Nigerian universities can develop to strength for sustainable development and global competitiveness.

4. Justifiable Strategies and Interventions for Integration of Innovative Technology Education for Sustainable Development into Nigerian University Education System

To confront the identified challenges in integrating innovative technology education for sustainable development into Nigerian university education and to facilitate growth and national development the following strategies and interventions should be adopted.

1. Strategic Policy Reforms and Institutional Frameworks: Addressing the gap between higher education and sustainable development in Nigeria requires strategic policy and institutional alignment. The Federal Ministry of Education, working with the NUC and NBTE, should enact a national policy that mandates the integration of emerging technologies and sustainability across tertiary institutions. Universities, in turn, should develop ICT and sustainability masterplans to embed digital innovation and environmental responsibility into teaching, administration, and infrastructure. Together, these frameworks provide a unified roadmap for technology-driven sustainability, strengthening national development and boosting Nigeria's global competitiveness (Okebukola, 2022).

2. Curriculum Redesign and Pedagogical Innovation: Nigerian universities should embed emerging technologies and SDGs such as climate change, AI, circular economy, and ethics into all programs to equip students with relevant competencies (UNESCO, 2017). Adopting problem-based and interdisciplinary learning models will shift focus from theory to real-world problem-solving, environmental awareness, technological innovation, and entrepreneurship, thereby producing critical, solution-oriented graduates.

3. Faculty Capacity Building and Digital Competence: Nigerian universities should institutionalize continuous professional development through regular training and certification in instructional design, technology-enhanced teaching, and sustainability education (Aina, 2020). Incentives such as awards, grants, and promotions should reward faculty who excel in integrating sustainability with emerging technologies, thereby fostering innovative pedagogy and advancing national development goals.

4. Infrastructure and Technology Investment: Universities must upgrade digital infrastructure to ensure reliable connectivity, advanced virtual platforms, and laboratories equipped for renewable energy, IoT, and digital simulations (Yusuf & Onasanya, 2022). Adoption of solar power and eco-smart designs will cut costs, align with global sustainability goals, and model sustainable practices for students and staff.

5. Student Empowerment and Digital-Sustainability Literacy: Embedding digital and sustainability skills into General Studies curricula - covering AI, digital ethics, environmental stewardship, and entrepreneurship will prepare all graduates for 21st-century challenges (Oyelere et

al., 2020). Supporting hubs, incubators, and hackathons will drive student-led innovation and foster solutions for sustainable development.

6. University-Industry-Government Linkages: Strengthening partnerships with industry, NGOs, and government through PPPs will unlock funding, expertise, and real-world platforms for sustainability-driven projects. Industrial internships and field-based learning will bridge theory-practice gaps, boost employability, and align higher education outputs with national development needs.

7. Research, Monitoring, and Data-Driven Decision Making: Establishing research centers for sustainable technology integration will drive interdisciplinary, context-relevant innovations. Robust EMIS adoption will enable tracking of technology use, energy consumption, and sustainability impacts, ensuring data-driven accountability and informed institutional decision-making.

8. Equity and Inclusiveness Measures: Targeted interventions subsidized devices, connectivity support, and assistive technologies must close digital divides for women, low-income students, and persons with disabilities. Community outreach on sustainability and technology will extend impact beyond campuses, fostering grassroots participation and strengthening universities' civic responsibility.

5. Conclusion

The integration of innovative technology education for sustainable development into Nigerian university education stands as both a strategic imperative and a developmental necessity. This study highlights the pressing need to align higher education with global sustainability objectives and digital transformation trajectories. By undertaking curriculum reform, fostering interdisciplinary research, enhancing capacity, improving infrastructure, and ensuring inclusive access, universities can serve as vital catalysts for national advancement and global relevance. Moreover, the transformative potential of this integration is further strengthened through public-private partnerships, experiential learning opportunities, and robust community engagement. Ultimately, equipping both students and institutions with the requisite knowledge, competencies, and values in sustainability and technological innovation will bridge existing educational gaps and position Nigeria to confront the emerging challenges and leverage the opportunities of the 21st century. Effectively addressing the current disconnect between innovative technology and sustainable development within Nigerian university education demands coordinated, multi-level systemic interventions. If these strategies are holistically implemented, they will significantly enhance the relevance, quality, and international competitiveness of Nigerian higher education, while empowering the nation's youth to become active agents of inclusive growth, environmental sustainability, and digital transformation.

Recommendations:

The following recommendations are proffered:

1. National Universities Commission should be encouraged to embed Artificial Intelligence (AI), Virtual Reality, Internet of Things (IoT), renewable energy, and sustainability studies across disciplines, with emphasis on problem-based and interdisciplinary learning.

2. Students in Nigeria should be encouraged undergo compulsory digital and sustainability literacy modules while being supported through innovation hubs, hackathons and incubators that will foster creativity and entrepreneurship.

3. The Federal Ministry of Education, in collaboration with NUC should review and harmonize existing ICT-in-Education and sustainability policies to ensure consistency and alignment with Nigeria's National Policy on Education and the SDGs.

4. Universities stakeholders should invest in renewable energy systems (e.g., solar), internet connectivity, reliable and digital laboratories to reduce infrastructural bottlenecks that hinder technology-driven learning and sustainability practices.

5. National Universities Commission should redesigned curricula to encourage sustainable development, digital literacy and problem-solving skills across disciplines, in order ensure that graduates are industry-relevant and globally competitive.

6. Regular training and re-training of ICT staff, lecturers, and administrators on engagement of emerging technologies and sustainability applications should be institutionalized through partnerships, workshops and certifications,

7. Government, non-governmental organizations and universities stakeholders should actively pursue grants, private sector partnerships, and international donor funding to support sustainable technology initiatives in Nigeria.

8. Special provisions should be made to ensure that students from rural communities, marginalized backgrounds and those with disabilities have equitable access to technology-driven resources through assistive technologies, subsidized devices and open educational resources.

9. Locally relevant innovations that need to be integrated into cultural values, indigenous knowledge and Nigeria-specific sustainability challenges should be encouraged to ensure that imported technologies are adapted to local realities.

10. Stronger linkages should be built between industries, universities and communities to encourage applied re-

search, innovation and extension of sustainable technology solutions beyond campuses.

Abbreviations

ITE	Innovative Technology Education
4IR	Fourth Industrial Revolution
SDGs	Sustainable Development Goals
EMIS	Educational Management Information System

Author Contributions

N. Samuel: Conceptualization, writing- original draft of the paper, Writing-Review and Editing.

A. Y. Karimu: Writing-Review and Editing.

O. O. Olalude: Writing-Review and Editing..

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Conflicts of Interest

The author(s) declare that they have no known competing financial interests, professional affiliations or personal relationships that could have appeared to influence the work reported in this paper.

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