



STEM EDUCATION AND ENTREPRENEURSHIP: PATHWAYS TO INNOVATION AND SELF-RELIANCE IN NIGERIA

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ABSTRACT

Nigeria's socio-economic development is increasingly constrained by high youth unemployment, low technological capacity, and an overdependence on imported goods and services. This paper explores the integration of Science, Technology, Engineering, and Mathematics (STEM) education with entrepreneurship as a strategic pathway toward fostering innovation and achieving national self-reliance. Drawing on national statistics, policy reviews, and case studies of successful STEM-driven ventures in Nigeria, the paper highlights how the STEM-entrepreneurship nexus can equip learners with both technical competence and entrepreneurial acumen in order that they may be self-reliant. Literature available reveals that despite the critical importance of this integration, significant challenges such as inadequate infrastructure, undertrained educators, outdated curricula, and poor industry-academia collaboration—hinder its effectiveness. The paper recommends a comprehensive reform agenda, including competency-based curriculum development, frequent teacher capacity building workshops, creation of institutional innovation hubs, and public-private partnerships. For educators and researchers, the study underscores the need to re-imagine STEM learning environments as incubators of innovation, positioning Nigerian youths not merely as job seekers but as creators of technology-based enterprises. The paper concludes that mainstreaming STEM entrepreneurship is essential for Nigeria's transition to a knowledge-based, self-sufficient economy.

Keywords: STEM education, entrepreneurship, innovation, self-reliance, Nigeria, curriculum reform, youth empowerment

1.0 Introduction

In recent decades, the global economy has witnessed a dramatic shift from resource-based systems to knowledge-driven models anchored on innovation, creativity, and technology (Al-Sulaiti, Hamouda, Al-Yafei & Abdella, 2024; Yaqub, Raha, Jell-Ojobor & Windsperger, 2024). The rise of the Fourth Industrial Revolution has intensified the demand for a workforce equipped with critical thinking skills, digital literacy, and problem-solving abilities. Thus, at the heart of this transformation lies STEM (Science, Technology, Engineering and Mathematics) education; which is an interdisciplinary approach that integrates science, technology, engineering, and mathematics (McDonald, 2016); to equip learners with the skills required to thrive in a complex, rapidly evolving world. In parallel, entrepreneurship has gained recognition as a vital engine for economic growth, job creation, and societal advancement (Zahra & Wright, 2016). Unlike traditional employment, entrepreneurship fosters self-employment, innovation, and the ability to generate solutions to socio-economic challenges through enterprise (Lim et al., 2024). Together, STEM education and entrepreneurship present a powerful combination: one that not only develops technical

competence but also nurtures a mindset for opportunity recognition, risk-taking, and value creation (Zaki, Al Muwali & Mahdi, 2021).

For Nigeria, a nation endowed with natural resources and a youthful population, yet plagued by high unemployment, underemployment, and over-dependence on imports (Nwosu, 2024), the integration of STEM and entrepreneurship holds transformative potential for the country (Okeke & Ramaila, 2025; Obiako, 2024). According to Adebisi et al (2024) and Oladeinde (2017), Over 60% of Nigeria's population is under the age of 25, making youth empowerment not just an educational priority but a national necessity. Unfortunately, the Nigerian educational system remains largely theoretical, exam-driven, and disconnected from industry needs (Sarumi, 2025). Graduates often emerge without the practical skills required to function effectively in a technology-driven economy or to create employment opportunities for themselves and others (Aluko, 2024; Guardian, 2023; Woods & Doherty, 2022). Moreover, Nigeria's continued reliance on foreign goods, services, and technologies undermine national development and economic sovereignty. Despite commendable policy documents and the existence of innovation hubs and incubation centers in selected urban areas, the widespread implementation of STEM-based entrepreneurial education remains weak and fragmented in the country.

Therefore, this paper argues that a strategic fusion of STEM education with entrepreneurial training offers a sustainable pathway to innovation, economic diversification, and self-reliance in Nigeria. By exploring current trends, national challenges, and case studies of successful STEM-driven ventures, the paper provides insights into how educational institutions, government agencies, and the private sector can collaborate to foster a generation of innovative, self-reliant Nigerians. It further proposes a set of actionable recommendations for curriculum development, teacher training, policy implementation, and institutional reform that are essential for mainstreaming STEM entrepreneurship in Nigeria's development agenda. In essence, this paper seeks to position STEM and entrepreneurship not merely as academic disciplines or economic strategies, but as catalysts for transforming Nigeria into a resilient, self-sufficient, and globally competitive nation.

2.0 Literature Review

2.1 Conceptual Review

Concepts that are central in paper have been demystified, and explained in detail; in order that the thrust of the paper is fully extolled. STEM education in Nigeria has been, as a foundational area in science and engineering, been looked into and what the policy had provided for regarding the need for teaching Nigerian students and preparing them for future industry responsibilities, been thoroughly amplified. Other areas covered include but not limited to evolution of STEM education in Nigeria, pedagogical approaches to the teaching of STEM related disciplines, as well as the relevance of STEM education to entrepreneurship in the context of Nigeria.

STEM Education in Nigeria

STEM education refers to an interdisciplinary approach that integrates Science, Technology, Engineering, and Mathematics into cohesive learning based on real-world applications (Eugenijus, 2023). Globally, STEM education is viewed as a driver of innovation, technological advancement, and economic competitiveness (Bybee, 2010). Countries like the USA, China, and South Korea have embedded STEM deeply into national policy to build skilled workforces and sustain industrial leadership. STEM education encompasses an interdisciplinary, inquiry-based approach that combines four foundational disciplines Science, Technology, Engineering, and Mathematics (Lai, 2018; Kelly & Knowles, 2016). Its

core philosophy is to foster critical thinking, collaboration, innovation, and digital literacy among learners. According to the United Nations Educational, Scientific and Cultural Organization (Panda & Kaur, 2024; UNESCO, 2021), countries with robust STEM education frameworks have higher innovation indices and stronger human capital development. In Nigeria, however, STEM education has struggled with inadequate curriculum integration, lack of qualified personnel, and poor infrastructural support (Aina, 2022). For instance, the Universal Basic Education Commission (Preciousgift-Nwaeze, 2025; UBEC, 2023) reported that less than 30% of Nigerian secondary schools have functional science laboratories. This limitation undermines the experiential learning necessary to develop scientific and engineering competencies.

Evolution and Policy Development of STEM in Nigeria

Nigeria has made several efforts to integrate STEM into the national curriculum, notably through: The National Policy on Education (2013), which emphasized science and technology education. The Revised Senior Secondary Education Curriculum (2011) by the Nigerian Educational Research and Development Council (NERDC), which includes entrepreneurship components. The STEM Education Strategic Plan (2018–2023) proposed by the Federal Ministry of Education in partnership with UNESCO, though implementation has been limited. However, Okebukola (2021) notes that policy articulation has not translated into systemic classroom practice, mainly due to insufficient investment and lack of coherent national frameworks.

Challenges of STEM Education in Nigeria

Numerous studies have outlined persistent barriers to effective STEM education in Nigeria: **Infrastructural Deficiency:** According to Aina (2013), most public schools lack basic laboratory equipment, ICT facilities, and access to electricity, especially in rural areas. This limits practical learning and problem-based instruction. **Shortage of Qualified Teachers:** As reported by Olayemi and Ogunyemi (2019), fewer than 50% of STEM teachers in secondary schools hold degrees in their subject areas. The quality of teacher training remains a concern. **Gender Disparities in STEM Participation:** United Nations Educational, Scientific and Cultural Organization, [UNESCO] (2017) reported that only 30% of STEM students in Nigerian universities are female. Cultural biases and lack of role models deter girls from pursuing STEM careers. **Curriculum Rigidity and Fragmentation:** a study by Yusuf and Adigun (2020) emphasize the disconnect between the STEM curriculum and 21st-century skills like coding, robotics, and computational thinking. The absence of interdisciplinary learning limits creativity.

Pedagogical Approaches in Nigerian Class Rooms

Traditional pedagogies in Nigeria focus heavily on rote learning and theoretical instruction. However, emerging models include: **Inquiry-Based Learning (IBL):** Encourages students to explore and investigate scientific concepts through guided questions. Ofoha (2022) found improved learning outcomes among students exposed to IBL in physics classes. **Problem-Based Learning (PBL):** This student-centered approach introduces real-life challenges to develop analytical and collaborative skills. Adebayo and Aladejana (2017) showed that PBL improved retention and engagement in mathematics. **Blended and Digital Learning Tools:** COVID-19 catalyzed a shift toward e-learning platforms like uLesson, Roducate, and virtual laboratories. However, accessibility remains unequal due to digital poverty.

Relevance of STEM education to National Development

Several studies have linked STEM education to national development outcomes: Human Capital Development: Olatunji (2016) links STEM skills to workforce readiness and productivity. The mismatch between graduates' skills and labor market needs underlines the urgency for STEM reforms. Innovation and Entrepreneurship: Adepoju and Oyefuga (2020) argue that combining STEM with entrepreneurial education leads to job creation and local innovations. This supports Nigeria's diversification agenda away from oil dependence. Sustainable Development Goals (SDGs): STEM contributes directly to SDG 4 (Quality Education), SDG 8 (Decent Work), and SDG 9 (Industry, Innovation and Infrastructure). Nigeria's STEM capacity is thus central to achieving Agenda 2030.

Interventions and Best Practices in STEM Education in Nigeria

Tertiary Education Trust Fund, [TETFund] and Education Tax Fund, [ETF]-Funded STEM Projects: Investments in STEM research and laboratory equipment in federal universities have shown some promise, though impact assessment is limited. National Science, Technology and Innovation Roadmap (2017-2030): This roadmap, developed by the Federal Ministry of Science and Technology, outlines Nigeria's goals to become a science-driven economy. Implementation gaps remain a major hurdle. Private Sector and Non-governmental Organizations, NGOs: Organizations like Leadership Effectiveness, Accountability and Professionalism, [LEAP], Africa, Ingressive for Good, and Tech4Dev are bridging STEM education gaps through boot camps, scholarships, and coding workshops targeting underserved youth.

Entrepreneurship in Nigeria

Entrepreneurship is defined as the process of identifying, developing, and managing a business venture in order to gain profit while taking risks. For educators, entrepreneurship education is not solely about business creation; it includes fostering an entrepreneurial mindset creativity, initiative, leadership, and resilience which is essential for innovation-driven economies. In Nigeria, the National Policy on Education mandates entrepreneurship education at the tertiary level. Yet, a World Bank (2023) study found that only about 38% of Nigerian graduates feel adequately prepared to start their own business due to lack of practical exposure. Entrepreneurship is widely recognized as a critical engine of economic development, job creation, innovation, and poverty alleviation. In Nigeria, where over 60% of the population is under the age of 30 and youth unemployment rates exceed 40% (Adeniji, 2024; NBS, 2023; Ochayi, 2022), entrepreneurship is not just a career path but a necessity. It plays a pivotal role in reducing dependency on public sector employment and catalyzing economic diversification beyond oil (Mukhtar, Gwazawa & Jega, 2018). The Nigerian government, private sector, and international development agencies have increasingly embraced entrepreneurship as a strategy for sustainable development. Despite progress, the entrepreneurial landscape in Nigeria remains constrained by several structural, cultural, and institutional challenges (Egere, Maas & Jones, 2022).

Entrepreneurship involves the identification of business opportunities, mobilization of resources, innovation, and risk-taking to create value. It includes a broad spectrum: Necessity Entrepreneurship: Driven by lack of alternative employment. Opportunity Entrepreneurship: Motivated by innovation, self-actualization, or market opportunities. Nigeria has a mix of both, with a dominant share of informal necessity entrepreneurship, particularly in urban centers and rural markets. According to the Global Entrepreneurship Monitor, [GEM], (GEM, 2022; 2013): Nigeria ranks among the top 10 countries globally in terms of Total Early-stage Entrepreneurial Activity (TEA). However, it scores low on entrepreneurial ecosystem quality especially access to finance, infrastructure, and policy support. Entrepreneurs and Micro,

Small, and Medium Enterprises (MSMEs) contribute: 48% to Nigeria's GDP Account for 96% of businesses and about 84% of employment in the country (National Bureau of Statistics, [NBS], 2021).

STEM Entrepreneurship Nexus in Nigeria

The intersection of STEM and entrepreneurship has produced global icons like Elon Musk, Steve Jobs, and Nigeria's Iyinoluwa Aboyeji (co-founder of Flutterwave). These individuals applied scientific knowledge to create scalable enterprises. For Nigeria, integrating this nexus into education systems is a necessary strategy for national transformation. STEM-entrepreneurship education focuses on applying scientific and technological solutions to real-world problems through innovative business ventures. In Nigerian contexts, this may include:

- Using drone technology in agriculture (e.g., precision farming),
- Renewable energy for rural electrification,
- Mobile health diagnostics and digital medicine.

The convergence of Science, Technology, Engineering, and Mathematics (STEM) education with entrepreneurship represents a dynamic frontier for economic transformation in Nigeria. In a global economy increasingly shaped by knowledge and innovation, the STEM entrepreneurship nexus provides the foundation for building technological solutions to socio-economic problems while fostering job creation and self-reliance. In the Nigerian context characterized by a youthful population, high unemployment, and low industrial capacity (Oyebode, 2018) – harnessing this nexus is not just a strategic imperative, but a developmental necessity. It enables the cultivation of human capital capable of creating value-added products, scalable businesses, and indigenous technologies that align with national priorities, such as economic diversification, inclusive growth, and digital transformation.

Strategic Importance of the Nexus in Nigeria

Addressing Youth Unemployment: Nigeria's youth unemployment rate remains above 40% (NBS, 2023). Traditional white-collar job markets are saturated, and vocational education alone lacks the transformative power needed in the digital age. STEM entrepreneurship training empowers youths to: design ICT solutions (e.g., Financial Technology [fintech], Educational Technology [edtech], Agricultural Technology [agritech]); launch startups based on scientific innovations; engage in freelance or remote digital work. **Accelerating Economic Diversification:** Nigeria's overreliance on oil revenue has made the economy vulnerable to global price shocks. STEM-driven entrepreneurship can boost sectors like: **Renewable Energy:** Local development of solar and waste-to-energy technologies; **Agriculture:** Precision farming, drone use, and supply chain automation; **HealthTech:** Mobile diagnostics, AI-based patient monitoring; **Fostering Indigenous Innovation:** currently, Nigeria ranks low in global innovation indexes, largely due to weak commercialization of research. Integrating STEM with entrepreneurship bridges this gap by turning academic discoveries into viable products. Universities and polytechnics, when properly funded and restructured, can become innovation hubs instead of purely academic institutions.

Strategic Importance of the Nexus in Nigeria

The following are some of the challenges of implementing STEM and Entrepreneurship policies and initiatives in Nigeria:

- **Infrastructural Deficiencies:** Only 23.5% of secondary schools in Nigeria have fully equipped science laboratories (NERDC, 2022). Limited access to electricity and

internet further constrains digital literacy and STEM experimentation, especially in rural schools.

- **Inadequate Teacher Training:** UNESCO (2020) reports that fewer than 40% of Nigerian STEM teachers have professional development opportunities annually. Many educators lack practical knowledge of entrepreneurship and industrial applications of STEM.
- **Outdated Curriculum:** The current curriculum is heavily theory-based, with minimal focus on skills acquisition, entrepreneurship, or real-world application.
- **Funding Gaps:** R&D investment in Nigeria is less than 0.2% of GDP, far below the UNESCO-recommended 1% minimum for developing countries.
- **Weak Industry-Academia Linkages:** Less than 15% of tertiary institutions have active partnerships with industries or innovation hubs, reducing experiential learning and job placement opportunities (TETFund, 2023).
- **Access to Finance:** Over 70% of Nigerian MSMEs report limited or no access to credit facilities. High interest rates (often above 25%) and lack of collateral deter many potential entrepreneurs.
- **Infrastructural Deficits:** Poor electricity supply, road networks, and internet connectivity raise the cost of doing business. According to the World Bank's Ease of Doing Business Index (2020), Nigeria ranked 131 out of 190, with infrastructure being a major constraint.
- **Regulatory and Bureaucratic Bottlenecks:** Long delays in business registration, multiple taxation, and weak property rights undermine business sustainability.
- **Entrepreneurial Education and Skill Gap:** Despite entrepreneurship being introduced into the Nigerian school curriculum, many graduates still lack: Practical business skills; Financial literacy; Innovation capacity (Yatu et al., 2018; MDPI, 2023)
- **Socio-Cultural Barriers:** Gender norms, fear of failure, and family expectations can discourage risk-taking, particularly among women and young people.

3.0 Recommendations

Based on what has been discussed, the paper offers the following recommendations:-

- i. **Curriculum Overhaul:** Develop a competency-based curriculum that blends STEM content with entrepreneurial thinking, emphasizing design thinking, innovation, and product development.
- ii. **Professional Development for Educators:** Establish national training institutes for STEM and entrepreneurship education. Mandate continuous learning programs and sabbaticals in industry for lecturers and teachers.
- iii. **Investment in Infrastructure:** Build and equip STEM innovation labs in all public schools and tertiary institutions, with solar power and broadband internet. Promote mobile and modular labs for rural communities.
- iv. **Institutional and Policy Reform:** Develop a National STEM-Entrepreneurship Framework with clearly defined KPIs and funding mechanisms. Strengthen regulatory agencies to enforce minimum standards in STEM education delivery.
- v. **Incentivize Public-Private Partnerships:** Offer tax relief and matching grants to companies that collaborate with educational institutions on R&D, internships, and product innovation.

3.1 Conclusion

In a world increasingly shaped by digital innovation and knowledge economies, Nigeria must position its youth not just as consumers of global technology but as creators of indigenous solutions. The integration of STEM education and entrepreneurship offers a realistic and

scalable pathway toward economic diversification, industrialization, and inclusive growth. For educators and researchers, the challenge lies in driving curriculum transformation, adopting learner-centered pedagogies, and fostering linkages with industry to turn classrooms into innovation ecosystems. A strategic focus on this nexus will not only reduce unemployment and dependence but also ignite the kind of homegrown innovation required for true national self-reliance.

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