2025

SciEd
SEAQIS Journal of Science Education

SEAQIS Journal of Science Education (SciEd)
ISSN: 2987-8101 | E-ISSN: 2964-7533
Vol: 5, No: 1, PP: 38-47
www.journal.qitepinscience.org

Research Paper Open Accsess

Relevance of Science Education for Self-reliance and National Economic Development

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Article history:
Received: November 11, 2024
Revised: March 28, 2025
Accepted: April 10, 2025

Abstract

This study investigates the role of science education as a catalyst for economic development and self-reliance by drawing on case studies from developed countries and synthesising key themes from a systematic literature review. Using qualitative content analysis of 15 selected studies, the review reveals that integrating rigorous theoretical instruction with practical, hands-on training, as exemplified by Germany's dual education system, South Korea's integrated science and technology approach, the innovation-driven environment in the United States, and Israel's agri-tech successes, can enhance workforce readiness, drive technological innovation, and stimulate entrepreneurial activity. These international examples provide valuable insights for Nigeria, suggesting that similar strategies could improve local economic competitiveness and reduce dependency on foreign expertise. However, the study also identifies significant challenges, including inadequate funding, outdated curricula, and insufficient infrastructural support, which hinder the full realisation of science education's potential. The findings underscore the need for targeted educational reforms and strategic investments to translate these benefits into sustainable economic growth and development.

Keywords: Economic Development; Entrepreneurship; Self-reliance; Science Education; Sustainable Economic Growth

Introduction

Science education, which is characterised by the organised teaching and learning of scientific disciplines, aims to cultivate a thorough comprehension of essential scientific concepts and promote critical thinking and analytical abilities. Science education is essential for establishing a basis for technological innovation, economic development, and societal improvement. In developing economies, especially in countries like Nigeria, science education plays a crucial role in promoting self-reliance, which is essential for minimising dependence on foreign expertise and resources (Okafor, 2018; Olofin et al., 2023). At the heart of economic development, self-reliance signifies a nation's capability to effectively harness its human and natural resources to achieve sustainable growth and

enhance the quality of life for its citizens (Ankeli, 2019; Shamsuddin et al., 2018).

Science education is increasingly recognised as a vital instrument for driving economic growth by fostering innovation and creativity among students, thereby developing a skilled workforce proficient in problem-solving (Mbanefo & Eboka, 2017). It functions as more than just an academic pursuit, offering a practical means to improve scientific literacy and technical expertise. Global trends reveal that countries that prioritise science education often achieve rapid technological advancements and economic expansion. Research by Umar (2019) and Adolphus (2020) highlights that science education is crucial in supporting key economic sectors, including agriculture, information technology, and manufacturing, indicating that it not only benefits individuals but also significantly boosts national economic performance through enhanced productivity and economic activity (Musa et al., 2016).

Science education has been recognised as a cornerstone for economic advancement and national self-reliance in many advanced countries. In these countries, robust science education systems have not only produced highly skilled workforces but also driven technological innovation and industrial growth. For instance, Germany's dual education model successfully integrates classroom learning with on-the-job training (Baethge & Wolter, 2015; Solga et al., 2014), while South Korea's strong focus on science and technology education has catalysed significant advancements in healthcare and technology (Kim, 2017; Lee et al., 2020). Similarly, China has leveraged extensive investments in science education to become a global leader in technological innovation and economic expansion (Fu & Zhang, 2011; Li, 2017; Williamson & Yin, 2014). Japan's emphasis on Science, Technology, Engineering and Mathematics (STEM) disciplines has maintained its competitive edge in high-tech manufacturing and innovation (Urbanova, 2018), and India's growing focus on science education has contributed to the emergence of its dynamic IT and pharmaceutical sectors (Guennif & Ramani, 2011; Jakovljevic et al., 2021; Sen et al., 2011). Furthermore, the United States continues to be a global leader in research and development, driven by a robust science education system that fosters critical thinking and creativity (Kutty et al., 2020; Lee & Haupt, 2019).

However, the full potential of science education in Nigeria has not yet been completely harnessed. Challenges such as inadequate funding, outdated curricula, and a misalignment between educational outcomes and labour market demands have hindered progress (Adeoye et al., 2023). There is often a significant gap between the expected competencies outlined in educational policies and the actual skills acquired by students. Innovations in curricula and teaching methodologies, focused on practical applications of scientific theory, are critical in enhancing the effectiveness of science education (Olofin et al., 2023). A well-structured education system aligned with the socio-economic goals of the country can play a transformative role in national development.

Self-reliance, in the context of national development, means enabling individuals to engage actively in economic activities without excessive reliance on external assistance (Shamsuddin et al., 2018). It is a multidimensional concept that includes achieving economic independence, optimising resources, and promoting innovation and entrepreneurship. For emerging economies like Nigeria, self-reliance is vital for lowering unemployment and improving competitiveness in the global arena (Ankeli, 2019). The interplay between self-reliance and science education is mutually reinforcing. By nurturing the entrepreneurial skills and competencies necessary for industrial and economic innovation, science education lays the groundwork for self-reliance (Okafor, 2018). Focused educational initiatives empower students with the capabilities to undertake projects that boost self-sufficiency, create job

opportunities, and drive widespread economic development.

Moreover, incorporating entrepreneurship into science education fosters an entrepreneurial mindset, enabling individuals to utilise local resources and address community-specific challenges. Programmes that merge entrepreneurship with science education have yielded positive results by strengthening innovation-driven enterprises and advancing industrial development (Shamsuddin et al., 2018; Obori, 2012). Thus, promoting self-reliance through science education is critical for enhancing national resilience and ensuring long-term economic stability.

Economic development is the process of improving the overall well-being of a nation's populace economically, politically, and socially, through various initiatives that increase productivity, efficiency, and economic diversification (Umar, 2019). Science education is central to this process as it provides the skilled workforce necessary for productive economic activities and underpins technological advancements that drive development. Numerous empirical studies consistently demonstrate a strong link between science education and key economic indicators, including Gross Domestic Product (GDP) growth, industrial output, and employment rates (Olofin et al., 2023; Adolphus, 2020). In Nigeria, where the youth demographic is substantial, science education plays a particularly significant role in spurring economic development. By investing in education systems that focus on STEM disciplines, Nigeria can leverage its demographic advantage to build a more dynamic and competitive economy (Aniashi et al., 2019; Mbanefo & Eboka, 2017).

Despite its potential, the contribution of science education to economic development in Nigeria is constrained by systemic challenges such as insufficient funding, inadequate infrastructure, and policy implementation gaps (Enemuo & Ozoemena, 2020). Addressing these obstacles necessitates a holistic approach, where government, industry, and educational institutions collaborate to reform curricula, enhance educational resources, and prioritise science education within national development strategies (Onyebuchi et al., 2024). This paper explores the link between science education, self-reliance, and national economic development, drawing on international experiences and local studies to argue that a strategically reformed science education system can provide Nigerian citizens with the essential skills for innovation and entrepreneurship. The analysis further outlines strategies for aligning educational outcomes with market demands and identifies the challenges that must be overcome to fully harness the benefits of science education in Nigeria.

Methodology

This study employed a Systematic Literature Review (SLR) combined with secondary data analysis to explore the relationship between science education, self-reliance, and national economic development in Nigeria. The SLR approach involves a rigorous process of identifying, selecting, and critically evaluating relevant academic papers, reports, and empirical studies that focus on the Nigerian context or provide pertinent insights into the role of science education in economic development. The literature search was conducted using academic databases such as Google Scholar, JSTOR, PubMed, and relevant educational and economic journals. Key search terms included "science education in Nigeria," "self-reliance," "economic development," "STEM education," and "entrepreneurship." The inclusion criteria were based on the relevance of the studies to the Nigerian context, publication within the last 10 years, and the provision of empirical data or theoretical insights related to science education and economic outcomes. The initial search yielded a large pool of studies, which were then screened for relevance based on titles and abstracts. Studies that did not directly address the Nigerian context or the role of science education in economic development were excluded.

The remaining studies underwent full-text review to assess their methodological rigour, relevance, and contributions to the research questions. In total, 15 studies were selected for in-depth analysis. The selected studies were analysed using qualitative content analysis to identify recurring themes, patterns, and insights related to the impact of science education on economic development and self-reliance. The analysis focused on understanding how science education contributes to four key aspects: skill development, innovation, entrepreneurship, and economic growth. To provide greater clarity, specific indicators were identified for each aspect. For skill development, indicators such as critical thinking assessments and vocational training outcomes were selected to reflect the immediate capacity of graduates to engage in problem-solving and technical tasks. For innovation, the number of patents filed and the level of research and development expenditure were considered, as these indicators demonstrate a nation's ability to generate novel solutions and products. For entrepreneurship, start-up rates and business incubator performance were chosen because they illustrate the dynamism of the entrepreneurial ecosystem and the capacity to translate ideas into viable business ventures. Finally, for economic growth, indicators such as sector-specific contributions to GDP and employment generation rates were used, directly capturing the economic impact of science education initiatives. The selection of these indicators is based on their ability to capture both the individual capabilities developed through science education and their broader economic outcomes.

Finally, the study examined the challenges hindering the effective implementation of science education in Nigeria, such as infrastructural deficiencies, policy gaps, and resource limitations, and how these challenges may impact the effectiveness of the aforementioned indicators. To ensure the robustness of the findings, data triangulation was employed by cross-referencing insights from multiple sources, including government reports and academic papers, including research articles, review papers, and empirical studies. This approach allowed for a comprehensive understanding of the current state of science education in Nigeria and its potential for driving economic development.

Ethical Considerations

Given that this study primarily involves the analysis of secondary data, there were no direct ethical concerns related to human subjects. However, in reviewing the literature, care was taken to ensure that all sources were properly cited and that the intellectual property of original authors was respected. The selection of studies was done transparently, with a focus on minimising bias and ensuring a fair representation of various viewpoints within the existing body of research.

Results and Discussion

Result of Findings

The findings from the qualitative content analysis were synthesised to draw connections between the themes identified in the literature and the broader economic context of Nigeria. This process involved categorising the impacts of science education into distinct areas, namely, skill development, innovation and technological advancement, entrepreneurship, economic contribution (GDP) & employment generation, self-reliance, and policy/infrastructure challenges, as summarised in Table 1. These categories were chosen based on their prominence in existing literature as key dimensions through which science education contributes to national economic development. For instance, the skill development aspect, which is captured by indicators such as critical thinking assessments and vocational training outcomes, demonstrates that science education enhances problem-solving abilities and technical competence. This finding is supported by studies such as Chinyere and Ndirika (2020), Mbanefo and Eboka (2017), and Okafor (2018).

Similarly, the innovation and technological advancement dimension is reflected by the number of patents and research and development expenditure. These indicators suggest that robust science education fosters the development of new technologies and increases overall productivity, as evidenced by research from Adolphus (2020), Kutty et al. (2020), and Olofin et al. (2023). The entrepreneurship category, measured through start-up rates and business incubator performance, indicates that science education plays a significant role in nurturing entrepreneurial initiatives and creating job opportunities (Ankeli, 2019; Obori, 2012; Shamsuddin et al., 2018).

In terms of economic contribution and employment generation, indicators such as sector-specific contributions to GDP and employment rates highlight that science-driven sectors are key to boosting the national economy, as reported by Aniashi et al. (2019), Nwafor and Okoi (2018), and Umar (2019). Additionally, the concept of self-reliance is reinforced by findings that demonstrate how science education supports economic independence by equipping individuals with the skills to develop local solutions, as shown by Shamsuddin et al. (2018) and Ankeli (2019).

Finally, the analysis also reveals policy and infrastructure challenges using indicators such as funding adequacy, curriculum relevance, and infrastructural support, which identify critical systemic gaps that hinder the effective implementation of science education (Adeoye et al., 2023; Enemuo & Ozoemena, 2020; Onyebuchi et al., 2024). The summary of the findings is presented in Table 1 below:

Table 1. Summary of Key Findings on the Role of Science Education in Promoting Self-Reliance and Economic Development in Nigeria

S/N	Theme	Indicators	Key Findings	References
1.	Skill Development and Workforce Readiness	Critical thinking assessments and vocational training outcomes	Science education enhances both analytical (academic) and practical/technical skills, enabling graduates to address real-world challenges in sectors such as manufacturing, technology, healthcare, and agriculture.	Chinyere & Ndirika (2020); Mbanefo & Eboka (2017); Okafor (2018)
2.	Innovation and Technological Advancement	Patent counts, research and development expenditure	Science education stimulates the creation of new technologies and innovative solutions that boost industrial productivity and economic growth.	Adolphus (2020); Kutty et al. (2020); Olofin et al. (2023)
3.	Entrepreneurship	Start-up rates and business incubator performance	Science education fosters entrepreneurial initiatives and job creation, facilitating economic diversification through the practical application of science education.	Ankeli (2019); Obori (2012); Shamsuddin et al. (2018)
4.	Economic Contribution (GDP) & Employment Generation	Sector-specific GDP contributions and employment rates	Science education drives national economic output and diversified employment while promoting self-reliance by reducing dependency on	Aniashi et al. (2019); Nwafor & Okoi (2018); Umar (2019)

			imported technologies and foreign expertise.	
5.	Policy & Infrastructure Challenges / Educational Reform Needs	Funding adequacy, curriculum relevance, and infrastructural support	Identifies systemic barriers that hinder the effective implementation of science education, underscoring the need for comprehensive reforms and targeted investments.	Adeoye et al. (2023); Enemuo & Ozoemena (2020); Onyebuchi et al. (2024)

Discussion of Findings

The findings from this study highlight the critical role that science education plays in fostering economic development and national self-reliance in Nigeria. Science education is not only a means of acquiring academic knowledge but also a powerful driver of practical skills, innovation, and economic progress. The following themes, as reflected in Table 1, are discussed in detail below:

Skill Development and Workforce Readiness

The study finds that science education is crucial in developing a skilled workforce capable of meeting the demands of Nigeria's growing economy. Science education develops both academic (analytical) skills, such as critical thinking and theoretical understanding, and practical or technical skills, which include hands-on training and vocational competencies (Chinyere & Ndirika, 2020; Mbanefo & Eboka, 2017; Okafor, 2018). For example, in manufacturing, students trained through practical apprenticeships (similar to Germany's dual education system) are better equipped to operate complex machinery and improve production processes (Baethge & Wolter, 2015). In technology, practical training in coding and hardware maintenance directly supports innovation and the creation of tech startups (Kutty et al., 2020). In healthcare, hands-on laboratory work complements academic study, leading to breakthroughs in medical research as observed in South Korea (Kim, 2017; Lee et al., 2020). In agriculture, practical modules on modern farming techniques enable graduates to implement sustainable practices, echoing the successes seen in Israel's agri-tech innovations (Urbanova, 2018). These real-world examples underscore how the balanced development of analytical and practical skills through science education enhances workforce readiness and supports self-reliance by enabling individuals to apply their knowledge to solve local challenges.

Innovation and Technological Advancement

The findings indicate that a robust science education system is closely linked to technological innovation. Indicators such as patent counts and research and development expenditure demonstrate that graduates who receive both theoretical instruction and practical training are more likely to engage in research and development activities. For instance, in countries with strong science education systems like the United States, the blend of academic rigour with hands-on innovation has led to a thriving tech startup ecosystem (Kutty et al., 2020; Lee & Haupt, 2019). However, in Nigeria, gaps such as insufficient funding for R&D, limited access to advanced equipment, and weak collaboration between academia and industry hinder innovation. Addressing these gaps through targeted reforms can enhance Nigeria's capacity for technological advancement, enabling the development of indigenous solutions that drive economic growth and self-reliance.

Entrepreneurship

Science education fosters entrepreneurial skills that are crucial for job creation and

economic diversification. By providing practical training and nurturing problem-solving abilities, science education empowers graduates to develop and launch innovative business ventures. For example, in sectors like biotechnology and renewable energy, hands-on training equips graduates with the skills needed to convert ideas into viable start-ups (Ankeli, 2019). Similarly, programmes that support business incubators offer the necessary environment for entrepreneurship to flourish, creating new employment opportunities and reducing reliance on traditional industries (Obori, 2012; Shamsuddin et al., 2018). These entrepreneurial activities are essential for diversifying the economy and building a resilient national industry.

Economic Diversification and Employment Generation

Science education significantly contributes to employment generation and economic diversification by equipping graduates with the skills needed in various sectors beyond the traditional oil and gas industry. For example, in renewable energy and biotechnology, practical training enables graduates to innovate and launch start-ups that create new jobs and reduce the country's reliance on fossil fuels. This diversification is essential for building a resilient economy. However, the study finds that misalignment between educational outcomes and labour market demands often leads to unemployment among science graduates. Improving the curriculum to better integrate practical training with academic learning can address this misalignment, ensuring that graduates are capable of contributing effectively to sectors such as manufacturing, technology, healthcare, and agriculture (Chinyere & Ndirika, 2020; Onyebuchi et al., 2024).

Contribution to Gross Domestic Product (GDP)

The analysis reveals that science education indirectly boosts Nigeria's GDP by supporting high-value sectors. Graduates from science education programmes drive productivity and innovation in key sectors. For example, in healthcare, improved research capabilities lead to better medical technologies, and in agriculture, modern farming techniques increase crop yields. These contributions, measured through sector-specific GDP and employment rates, underscore the role of science education in promoting economic self-reliance. However, to fully capitalise on this potential, strategic investments in educational infrastructure and curriculum enhancements are necessary (Nwafor & Okoi, 2018).

Self-Reliance and National Development

The findings reveal that science education is fundamental to achieving national self-reliance. By equipping individuals with both analytical and practical skills, science education enables the development of local solutions tailored to Nigeria's unique challenges, such as improving agricultural productivity through modern techniques or advancing healthcare through indigenous research initiatives. This reduces the country's reliance on foreign expertise and imports, fostering economic independence (Ankeli, 2019). For instance, countries like South Korea and Israel have demonstrated that investment in science education can lead to breakthroughs that not only improve domestic capacities but also position them as global leaders in specific sectors (Kim, 2017; Urbanova, 2018). Thus, for Nigeria, strengthening science education across all levels from primary to tertiary, coupled with supportive policies and adequate funding, is essential for sustainable development and long-term economic stability.

Policy and Infrastructure Challenges / Educational Reform Needs

Systemic challenges hinder the full realisation of science education's potential in Nigeria. Despite the evident benefits, the effective implementation of science education is constrained by inadequate funding, outdated curricula, and insufficient

infrastructural support. Studies have identified these policy and infrastructure gaps as critical barriers that prevent the optimal translation of academic and practical skills into economic outcomes (Adeoye et al., 2023; Enemuo & Ozoemena, 2002; Onyebuchi et al., 2024). Addressing these challenges through comprehensive educational reforms and targeted investments is essential to create an enabling environment where science education can fully contribute to national development.

Conclusion

This study investigates the role of science education in fostering economic development and self-reliance. Through a systematic literature review, the study draws on case studies from developed countries and analyses of key themes from the literature. The review shows that combining rigorous theoretical instruction with practical, hands-on training, as demonstrated by Germany's dual education system, South Korea's integrated approach, the innovation-driven environment in the United States, and Israel's success in agri-tech, can enhance workforce readiness, drive technological innovation, and stimulate entrepreneurial activities. These practices offer valuable lessons for Nigeria, suggesting that similar strategies could reduce dependency on foreign expertise and strengthen local economic competitiveness. However, the study also reveals that challenges such as inadequate funding, outdated curricula, and insufficient infrastructure must be addressed. Targeted educational reforms and strategic investments are essential to fully realise the potential of science education as a catalyst for sustainable economic growth and development.

References

Adeoye, M. A., Mahmud, M. A., Ehindero, R. E., Ajape, R. O., Yahaya, A. K., & Jolaoye, J. D. (2023). From flawed to Flourishing: Reshaping the Nigerian curriculum for sustainable national development. *Journal of Education Action Research*, *7*(4), 621–627. https://doi.org/10.23887/jear.v7i4.67812

Adolphus, T. (2020). The role of science education in skills acquisition and youth empowerment in Nigeria. *International Journal of Research Publications, 65*(1), 9-18. https://doi.org/10.47119/ijrp1006511120201546

Aniashi, O., Okaba, A., Anake, U., & Akomaye, U. (2019). Classroom science with everyday life: A means for improving performance in sciences and national development in Nigeria. *International Journal of Science and Technology Educational Research*, *10*(3), 25–29. https://doi.org/10.5897/ijster2019.0457

Ankeli, G. O. (2019). Acquisition of Entrepreneurial and Scientific Skills for Youth Self-Sustainability and Job Creation towards National Development in Nigeria. *World Journal of Entrepreneurial Development Studies, 3*(1), 24-31.

Baethge, M., & Wolter, A. (2015). The German skill formation model in transition: from dual system of VET to higher education? *Journal for Labour Market Research*, *48*(2), 97–112. https://doi.org/10.1007/s12651-015-0181-x

Chinyere, A. P., & Ndirika, M. C. (2020). Promoting Innovation, creativity and entrepreneurship Skills in science Education Students: A Panacea for Employability. *Journal of Education and Practice*, *4*(3), 44–55. https://doi.org/10.47941/jep.477

Enemuo, N. K., & Ozoemena, L. E. (2020). Repositioning of secondary education for economic empowerment through innovation, creativity and entrepreneurship skills in Nigeria. *International Journal of Studies in*

Education, 16(2), 175-186. Retrieved from https://ijose.unn.edu.ng/wp-content/uploads/sites/224/2020/07/pp-175-186-Vol.16-No.-2.pdf

Fu, X., & Zhang, J. (2011). Technology transfer, indigenous innovation and leapfrogging in green technology: the solar-PV industry in China and India. *Journal of Chinese Economic and Business Studies*, *9*(4), 329–347. https://doi.org/10.1080/14765284.2011.618590

Guennif, S., & Ramani, S. V. (2011). Explaining divergence in catching-up in pharma between India and Brazil using the NSI framework. *Research Policy*, *41*(2), 430–441. https://doi.org/10.1016/j.respol.2011.09.005

Jakovljevic, M., Liu, Y., Cerda, A., Simonyan, M., Correia, T., Mariita, R. M., Kumara, A. S., Garcia, L., Krstic, K., Osabohien, R., Toan, T. K., Adhikari, C., Chuc, N. T. K., Khatri, R. B., Chattu, V. K., Wang, L., Wijeratne, T., Kouassi, E., Khan, H. N., & Varjacic, M. (2021). The Global South political economy of health financing and spending landscape – history and presence. *Journal of Medical Economics*, *24*(sup1), 25–33. https://doi.org/10.1080/13696998.2021.2007691

Kim, E. (2017). Sociotechnical imaginaries and the globalization of converging Technology Policy: Technological Developmentalism in South Korea. *Science as Culture*, *27*(2), 175–197. https://doi.org/10.1080/09505431.2017.1354844

Kutty, A. A., Abdella, G. M., Kucukvar, M., Onat, N. C., & Bulu, M. (2020). A system thinking approach for harmonizing smart and sustainable city initiatives with United Nations sustainable development goals. *Sustainable Development*, *28*(5), 1347–1365. https://doi.org/10.1002/sd.2088

Lee, H., Ham, H., & Kwon, H. (2020). Research trends of integrative technology education in South Korea: a literature review of journal papers. *International Journal of Technology and Design Education*, *32*(2), 791–804. https://doi.org/10.1007/s10798-020-09625-7

Lee, J. J., & Haupt, J. P. (2019). Winners and losers in US-China scientific research collaborations. *Higher Education*, *80*(1), 57–74. https://doi.org/10.1007/s10734-019-00464-7

Li, L. (2017). China's manufacturing locus in 2025: With a comparison of "Made-in-China 2025" and "Industry 4.0." *Technological Forecasting and Social Change*, *135*, 66–74. https://doi.org/10.1016/j.techfore.2017.05.028

Mbanefo, M. C., & Eboka, O. C. (2017). Acquisition of Innovative and Entrepreneurial Skills in Basic Science Education for Job Creation in Nigeria. *Science Education International, 28*(3), 207-213. https://doi.org/10.33828/sei.v28.i3.4

Musa, A., Victor, B., & Ali, H. (2016). Education, Science and Technology: a triadic process for promoting socio-economic skills in Nigeria. *Issues in Scientific Research, 1*(4), 52-60. https://doi.org/10.15739/isr.16.006

Nwafor, C. E., & Okoi, O. O. (2018). Science and Technical Education Beyond the Classroom: A Case Study of Mechanic Village, Abakaliki, Ebonyi State, Nigeria. *Middle-East Journal of Scientific Research, 26*(7), 688–697. https://doi.org/10.5829/idosi.mejsr.2018.688.697

Obori, I. A. O. (2012). Re-Engineering Science Education for Employment and Self-productivity in Nigeria.

African Education Indices, 4(1), 119-128.

Okafor, C. F. (2018). Science education: A tool for skill acquisition and entrepreneurship development of Nigerian students. *Nnadiebube Journal Education in Africa, 3*(2), 19–38.

Olofin, S. O., Ogunjobi, A.O., Falemu, F.A., & Akinwumi, I. O. (2023). Science education as a tool for achieving socio-economic development in Nigeria. *International Journal of Development and Economic Sustainability 11*(4), 33-44. Retrieved from https://doi.org/10.37745/ijdes.13/vol11n43344

Onyebuchi, N. C., Unachukwu, C. C., & Osawaru, B. (2024). STEM education advancements in African contexts: A comprehensive review. *World Journal of Advanced Research and Reviews*, *21*(1), 145–160. https://doi.org/10.30574/wjarr.2024.21.1.2719

Sen, S., Chakraborty, R., & De, B. (2011). Challenges and opportunities in the advancement of herbal medicine: India's position and role in a global context. *Journal of Herbal Medicine*, *1*(3–4), 67–75. https://doi.org/10.1016/j.hermed.2011.11.001

Shamsuddin, I. M., Arome, A. T., & Aminu, I. (2018). Entrepreneurship, Science and Technology Education for Self-Reliance and Economic *Diversification. International Journal of Engineering Management, 2*(1), 1-7. https://doi.org/10.11648/j.ijem.20180201.11

Solga, H., Protsch, P., Ebner, C., & Brzinsky-Fay, C. (2014). *The German vocational education and training system: Its institutional configuration, strengths, and challenges*. ECONSTOR. Retrieved March 27, 2025, from https://www.econstor.eu/handle/10419/104536

Umar, Y. (2019). STEM Education as a Catalyst for National Development: Problems and Prospects in Nigeria. *Learning Science and Mathematics, 14*, 48–59.

Urbanova, M. (2018). *Japan's Legacy of Technology in the Digital Era : A Mixed Methods Analysis of the Competitive Advantage of the IoT Sector in Japan*. LUP Student Papers. http://lup.lub.lu.se/student-papers/record/8953276

Williamson, P. J., & Yin, E. (2014). *Accelerated Innovation: the new challenge from China*. MIT Sloan Management Review. Retrieved March 28, 2025, from https://sloanreview.mit.edu/article/accelerated-innovation-the-new-challenge-from-china/