

SCIENCE, TECHNOLOGY, ENGINEERING, ART, AND MATHEMATICS EDUCATION FOR TECHNOLOGICAL BREAKTHROUGH IN NIGERIA

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Abstract

The paper focuses on harnessing opportunities in STEAM education for technological breakthroughs. STEAM education encompasses an interdisciplinary approach to learning, wherein real-world problems are tackled through the combined application of science, technology, engineering, art, and mathematics. Before the integration of art, STEM education, which encompasses science, technology, engineering, and mathematics, already existed. By incorporating art into the equation, STEAM education fosters creativity and provides students with valuable skills in collaboration, inquiry, problem-solving, and critical thinking. Moreover, STEAM education plays a pivotal role in generating employment opportunities by emphasizing entrepreneurship education, thereby addressing the persistently high unemployment rates prevalent in the country. The article underscores the possibility of leveraging STEAM education for technological advancement, provided certain issues are addressed effectively. Key problem areas include the availability of qualified teachers, adequate IT resources, well-designed STEAM curricula, and sufficient funding. To overcome these challenges, the article suggests practical recommendations. One such recommendation is the recruitment of trained STEAM instructors who possess proficiency in information and communication technology (ICT) for Nigerian classrooms. By implementing these measures, the potential of STEAM education can be harnessed to propel technological breakthroughs.

Keywords: Creativity, Entrepreneurship Education, STEAM, STEM, Technological breakthrough, Sustainable Development Goal 4

Introduction

Modern societies face numerous challenges that demand diverse approaches for effective solutions. The integration of technology into education has provided relief for humanity. However, addressing real-life problems requires problem-solving skills, creativity, and critical thinking, which can be facilitated by Science Technology Engineering Art and Mathematics (STEAM). STEAM education emphasizes the practical application of theoretical knowledge, promoting trans-formative learning experiences (Taylor, 2016). It is a comprehensive

interdisciplinary model that combines science, technology, engineering, art, and mathematics (Monkeviciene, O., Autukeviciene, B., Kaminskiene, L., & Monkevicius, J. (2020). Scholars argue that graduates struggle to apply their knowledge to meet the growing demands of the modern era (Singh, 2021). To address this challenge, creative thinking, which can be fostered through STEAM, is crucial (Monkeviciene, et al., 2020).

While STEM (Science Technology Engineering and Mathematics) was the focus decades ago, the inclusion of art in STEAM emphasizes creativity (Singh, 2021). The emergence of STEAM is vital for the economic growth of any nation. It equips students with teamwork, inquiry, problem-solving, and critical thinking skills (Singh, 2021). Numerous countries worldwide have embraced STEAM as a means to solve local and global issues. Similarly, Nigeria faces diverse challenges, including high youth unemployment and insecurity. Moreover, despite available opportunities, Nigeria lags in technological advancement. This article explores various ways in which STEAM can foster technological breakthroughs in Nigeria.

Concept of STEAM

The integration of Arts into STEM was as a result of non-inclusion of Arts discipline into STEM. It is now accepted as STEAM from the initial STEM. However, the inclusion of art gave rise to the concept of STEAM. By encompassing the arts subjects, STEAM provides students with creativity, artistic abilities, and knowledge about the world of art. This interdisciplinary approach in education enhances collaboration, creativity, and digital skills among students. It is essential for learning today to equip students with a wide range of skills that do not restrict their future opportunities. In the past, specific subjects were associated with particular skills, such as science and mathematics being linked to computational abilities. This limited graduates in these fields to certain careers, requiring additional training to pursue jobs outside their domain. Conversely, graduates in the arts are believed to possess better managerial skills and creativity. The STEAM concept aims to integrate all these skills into a single interdisciplinary model, preparing 21st-century graduates with comprehensive knowledge. STEAM education plays a crucial role in preparing individuals to become innovators, leaders, educators, and learners in the 21st century. In Nigeria, the STEAM model allows graduates from fields like history or religious studies to work in financial corporations where computational skills are prioritized. Consequently, STEAM has made entrepreneurship more accessible in the 21st century.

STEAM and Entrepreneurship Education

Entrepreneurship Education serves as a tool for developing understanding, abilities, and skills to support a diverse society, provide job opportunities, foster personal growth, and encourage community involvement. Unfortunately, many courses in Nigerian institutions lack creativity and critical thinking, which hinders the production of graduates capable of independent work outside of government jobs. Creativity and critical thinking are crucial for problem-solving and job creation, which explains the high percentage of youth unemployment in Nigeria. As more graduates enter the workforce from universities, polytechnics, and Colleges of Education each year, the issue of unemployment in Nigeria becomes increasingly alarming and prevalent as shown in Table 1 on the unemployment rate from in Nigeria.

Table 1:

Unemployment Rate in Nigeria for 2017

Group	1 st Quarter (%)	2 nd Quarter (%)	3 rd Quarter (%)
Never attended school	14.8	16.0	18.6
Below primary school	14.9	20.0	23.2
Primary school	10.3	11.4	13.5
Secondary school	15.4	13.9	16.2
Post-secondary school	16.7	28.0	31.8

Source: National Bureau of Statistics (2017)

The STEAM as an Educational Model, Cultivates Twenty-first-century Graduates by Incorporating Entrepreneurship Education. In contemporary Nigeria, Possessing a certificate in poultry farming is no longer a prerequisite for establishing a successful venture in that field. Similarly, individuals who utilize their computer knowledge to earn a living are not necessarily equipped with certificates in computer science. The crux of the matter is that many of these essential skills fall under the purview of STEAM. Entrepreneurship education has been seamlessly integrated into STEAM to bolster job creation in the current era. Through the amalgamation of entrepreneurship education, a new model called STEAME emerges. This model, characterized by research, creativity, and critical thinking, offers a fresh perspective on entrepreneurial skills (Kovatcheva & Koleva, 2021). Even in nations with low unemployment rates, such as Malaysia, entrepreneurial education has proven to be a global tool for tackling joblessness (Prabhu, 2019).

Importance of STEAM Education

Creativity is critical to innovation, which makes it important to students learning. STEM education helps students develop problem-solving skills, thinking and digital skills; however, the addition of the art is for creativity (Taylor, 2016). Therefore, this provides students with creative talent, a vision for future works, and a digital mind. Art inclusion helps both teachers and students to develop communication skills and expression and other skills such as imagination, observation and perception (Taylor, 2016). Taylor thinks STEAM encourages children to study in a revolutionary way. Success in any field of endeavour depends on these skills. Many companies and agencies today are not only looking for graduates who have fantastic grades but those with good communication skills and the ability to express their own opinions (Muthiah, 2012). In the 21st century, passive graduates who are not proactive and imaginative would find it challenging to do anything well. STEAM education produces problem solvers, critical thinkers and inventors for the future generation. It unifies as it brings the four science-oriented disciplines with the art of creativity. For instance, it was the general opinion that these courses (science, engineering and mathematics) are not related to the art. However, with STEAM, research studies show that artistic talent makes students creative (Singh, 2021). Communication skill is a critical repertoire needed by every graduate irrespective of the field of study. However, most science-oriented graduates lack the skill. With STEAM education, the challenge of communication skills would be overcome.

STEAM education as an interdisciplinary approach to learning encourages learners to incorporate creativity into knowledge for solving real-world problems (Dahal, 2022). A significant feat has been achieved in the area of job creation with the aid of STEAM education in recent times. There are cases of entrepreneurs making progress in areas outside their primary disciplines of creativity because they embraced STEAM education. This is one fundamental function of STEAM in promoting the entrepreneurial skills of learners. STEAM education is critical to the growth of the economy of any nation.

STEAM Education on the Economy of Nations

Studies have shown how important STEAM education is to the development of any country. Therefore, developing countries must prioritize their development. Below are some of its effects on the economies of various countries.

- a. **Workforce Development:** STEAM education equips students with the knowledge and skills needed for a wide range of careers in growing industries such as technology, engineering, healthcare, and advanced manufacturing. By fostering a deep understanding of these subjects and promoting hands-on, practical learning experiences, STEAM education helps create a skilled and adaptable workforce that can drive economic growth.
- b. **Innovation and Entrepreneurship:** The integration of arts and creativity in STEAM education (Monkeviciene et al., 2020) encourages students to think outside the box, develop innovative solutions, and become entrepreneurs. By nurturing an entrepreneurial mind-set and providing opportunities for students to explore their ideas, STEAM education contributes to the creation of new businesses, products, and services, leading to job creation and economic expansion.
- c. **Global Competitiveness:** In an increasingly interconnected and technology-driven world, nations that prioritize STEAM education gain a competitive edge. By producing a workforce proficient in science, technology, engineering, and mathematics, countries can attract investment, foster research and development, and remain at the forefront of technological advancements. This, in turn, contributes to economic competitiveness and positions the nation as a leader in innovation.
- d. **Industry Collaboration:** STEAM education often involves partnerships between educational institutions and industries. These collaborations provide students with real-world exposure, internships, and hands-on experiences that align with industry needs (Talan, 2021). By fostering strong ties between academia and industry, STEAM education promotes the transfer of knowledge, facilitates technology adoption, and supports economic sectors in driving productivity and efficiency.
- e. **Economic Diversification:** STEAM education encourages students to explore diverse career pathways beyond traditional fields. By fostering interdisciplinary skills and knowledge, students are prepared to engage in emerging sectors such as renewable energy, biotechnology, artificial intelligence, and data science. This diversification of

skills and industries helps nations reduce dependence on a single sector and builds resilience in the face of economic changes.

Overall, STEAM education plays a crucial role in preparing the workforce of the future, promoting innovation and entrepreneurship, enhancing global competitiveness, fostering industry collaboration, and driving economic growth. Through strategic investments in STEAM education, nations can forge a sustainable and prosperous economy that excels in the knowledge-driven era, catalysing technological breakthroughs.

Harnessing STEAM Opportunities for Technological Breakthrough

STEAM has several opportunities if properly harnessed could help the nation to achieve a breakthrough technologically. However, several issues about STEAM require attention to make the breakthrough seamless.

The first is the issue of the curriculum. Presently in the Nigerian educational system, there is no workable STEAM curriculum. There are curricula for science and technology, engineering, art and mathematics at various educational levels. In a country like Nigeria, where there is so much noise about STEM education there has not been a particular curriculum for STEM education not to talk about STEAM. STEAM would not work well without a particular curriculum for it. Many countries like the US, Korea and China have STEAM curricula (Taylor, 2016), which might inform the level of their breakthrough in technology. Nigerian government could also bring teachers in the various subjects that make up STEAM together to draft curricula for all levels of education. One thing that should be put in mind in drafting a curriculum is that STEAM goes beyond the classroom. It provides opportunities that determine how we think and behave (Singh, 2021). The curriculum must embrace creativity, critical thinking, collaboration and communication, which some scholars called the 4Cs of twenty-first-century skills (Singh, 2021).

Secondly, STEAM education requires lots of modern-day learning resources. Learning resources in Nigerian schools are obsolete for technological breakthroughs. The world is in education 4.0 being a driver of the fourth industrial revolution (4IR). Nigeria is yet to leave education 2.0 and the second industrial revolution (Aina, 2022). Nigerian schools still depend on analogue resources for learning and the world has migrated to digital. STEAM education cannot lead to any breakthrough if classroom teaching is mainly through chalkboards and in confined locations. Besides, the roles of teachers in STEAM are expected to be coaching and scaffolding, which allow students to learn by themselves. Students learning in this digital age are not teacher-dependent; rather students are allowed to seek learning information by themselves. Many schools and homes lack functional internet access in Nigeria, which is a serious drawback to technological breakthroughs through STEAM.

Besides, several scholars have shown concern about a lack of qualified teachers to teach STEAM not only in Nigeria (Li, Zhao, Zhu, Ma & Liao., 2022). Qualified teachers are critical in students' learning because they are considered a crucial variable in all educational systems (Lawal & Braimoh, 2018). Presently, there is a scanty specialised qualified teacher to teach

STEAM in Nigerian schools. However, there are teachers in subject domains constituting STEAM. The greatest challenge about these teachers is that significant numbers of them are not computer literate (Agormedah *et al.*, 2020). However, Sumathi and Selvarani (2020) argued that technology in the classroom makes teaching easy and all teachers must make use of the benefit. Similarly, Talan (2021) observed the importance of computers in collaborative learning, which gives support to STEAM education being a collaborative interdisciplinary model. Moreover, a majority of the literate among these teachers do not have a personal computer (Aina & Abdulazeez, 2022). Qualified teachers are critical to STEAM education for a technological breakthrough. Competencies in Technology are vital to STEAM and most teachers are not competent in this domain (Şen-Akbulut & Öner, 2021). The heart of STEAM is the ability to interact with ICT. It is the core of education in this century (Ifinedo *et al.*, 2019). Studies show that there are great advantages to combining digital learning with STEAM (Özer & Demirbatır, 2023). Therefore, to use STEAM for a breakthrough in technology requires the availability of ICT resources and teachers' ability to use them.

The Success of STEAM in any nation heavily relies on adequate funding. In Nigeria, accomplishing technological breakthroughs through STEAM may present challenges due to the yearly allocation of funds to the education sector. The table provided depicts the budgetary allocation for Nigeria's education over ten years.

Table 2
Nigeria's Education Budgetary Allocation from 2010 to 2019

Year	Budget (₦ Trillion)	Education Budget (₦ Billion)
2010	5.160	249.09
2011	4.972	306.30
2012	4.877	400.15
2013	4.987	426.53
2014	4.962	493.00
2015	5.068	392.20
2016	6.061	369.60
2017	7.444	550.00
2018	8.612	605.80
2019	8.830	620.50
Total	60.973	4413.17

Source: Adoye, Adanikin and Adanikin (2020).

Table 2 above reveals that the annual education budget for ten consecutive years is severely inadequate and falls well below the stipulation set by UNESCO. Insufficient funding for education has hindered the attainment of a technological breakthrough, necessitating an increase in the yearly education budget at all levels by the government.

Problems of STEAM Opportunities for Technological Breakthrough in Nigeria

Introducing Science, Technology, Engineering, Arts, and Mathematics education in Nigeria offers several prospects for technical advancements, although it also encounters notable obstacles. Presented below are three primary challenges along with their prospective resolutions;

i. Insufficient Infrastructure

Many schools in Nigeria, particularly in rural regions, lack the critical infrastructure to facilitate STEAM education. This encompasses the limited availability of laboratories, computers, internet connectivity, and other essential resources for practical learning and experimentation.

Solutions

- **Enhanced Government and Private Sector Investment:** Augmented investment from both the government and private sector is necessary. Public-private partnerships can be established to finance the construction and improvement of school infrastructure.
- **Mobile STEAM Labs:** Presenting portable STEAM laboratories that can be transported to various schools, particularly in remote regions, to offer pupils the opportunity to utilize essential tools and resources.
- **Digital Learning Platforms:** Creating and advocating for online educational platforms that provide STEAM courses and materials can assist address the deficiency in physical infrastructure.

ii. Inadequate Teacher Training;

A significant number of instructors in Nigeria lack the training to effectively teach STEAM courses. This encompasses a deficiency in ongoing professional growth and limited access to current pedagogical approaches and technological advancements.

Solutions

- **Professional Development Programmes:** Implementing extensive professional development programmes that specifically target STEAM education. This may encompass workshops, courses, and certifications specifically designed for educators.
- **Teacher Exchange Programmes:** Implementing teacher exchange programmes with nations that possess sophisticated STEAM education systems, enabling Nigerian educators to acquire optimal strategies and pioneering pedagogical approaches.

- **Promoting STEAM Education with Incentives:** Implementing a system that provides bonuses or career progression prospects to educators who specialize in STEAM subjects and engage in continuous professional development.

iii. **Cultural-and-Societal-Obstacles;**

Various cultural and sociological obstacles exist that deter girls and young women from engaging in STEAM subjects, particularly in terms of participation. This encompasses preconceived notions, prejudices based on gender, and a general lack of understanding regarding the significance and possibilities of STEAM professions.

Solutions

- **Awareness Campaigns:** Implementing nationwide awareness campaigns to advocate for the significance of STEAM education and professions, showcasing accomplished role models from many backgrounds.
- **Gender-Inclusive Policies:** Enforcing policies that promote and facilitate the involvement of females, including girls and young women, in STEAM education. These can encompass scholarships, mentorship programmes, and the establishment of secure and encouraging learning settings.
- **Community Engagement:** Actively involving communities to change cultural perspectives and promote parental endorsement for children's participation in STEAM education, irrespective of gender. Nigeria can establish a strong STEAM education system that promotes technological innovation and equips the next generation to meet the needs of a swiftly evolving world by tackling these difficulties.

Conclusion

In conclusion, STEAM education embodies an interdisciplinary learning approach where students integrate creativity with knowledge to innovate and address human problems. It serves as a means to develop crucial 4C skills (creativity, critical thinking, collaboration, and communication). Furthermore, STEAM education fosters entrepreneurial skills that play a vital role in job creation. However, to achieve a technological breakthrough in STEAM in Nigeria, practical curricula tailored for all educational levels are indispensable. Additionally, given that STEAM education relies on contemporary ICT resources, it is imperative to have qualified teachers who possess technological expertise. Lastly, the current annual budget allocated to the Nigerian education system is inadequate to support the objective of achieving technological advancement through STEAM education.

Suggestions

Considering the aforementioned points, the following suggestions are crucial:

- i. Implement STEAM curricula across all levels of education in Nigeria.
- ii. Recruit proficient STEAM educators who are well-versed in utilizing ICT in the classroom.

- iii. Ensure the availability of ICT resources for teaching and learning in Nigerian schools.
- iv. Assign high priority to education funding in the nation's annual budget.

By taking these suggested ideas into account, Nigeria can make significant strides in achieving a technological breakthrough through the implementation of STEAM education.

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