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The Role and Impact of STEM Education on Nigeria's Progress

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Most people regard advancement as a social change of society that aims to improve the economic, social, and material well-being of most individuals to achieve dominance. This article acknowledges that science, technology, engineering, and mathematics (STEM) education promotes national growth and advancement. It looked at STEM education's role and impact in advancing Nigeria. The article aimed to raise awareness of a few key STEM topics in the hopes that it would lead to the intended advancement and enhancement of human life. After recommendations, it was determined that national advancement in low-income and middle-income nations such as Nigeria could be accomplished with quality STEM education.

Keywords: Science; technology; engineering; mathematics; education; SDGs; Nigeria.

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1. INTRODUCTION

Nigeria's educational system is oriented toward the advancement of society, culture, economy, politics, science, and technology. It is believed that education is the best tool available for influencing national development [1]. The education process involves offering structured instruction, especially in schools or universities. Education, Salau and Salau [2], is the course of discovering and embracing truths, maturing as a person, and acquiring beneficial knowledge [2]. Most policies on education have requirements to be fulfilled to achieve the intended outcomes, including materials to be utilized. Consequently, education aims to provide learners with the information needed to change their environment and finish any assigned assignment. That's the reason for the adage that all formal education procedure requires moving from home to college and back again.

Education affects every aspect of humanity, but it greatly impacts education in STEM disciplines (science, technology, engineering, and math) [3]. Education in these fields helps people think logically, solve problems they face daily, develop social skills through safe handling of tools and objects, foster friendships through cooperative group work, and satiate curiosity by providing opportunities for investigation [4]. Technology is putting knowledge into practice, utilising matter, energy, and natural phenomena as resources to solve issues for people and improve their quality of life. Simple and everyday instances of technological products include the construction of dwellings in various shapes and sizes utilizing various materials [4,5]. STEM education is used in the building of contemporary machinery such as automobiles, generators, aeroplanes, and ships for commercial purposes. STEM professionals engage in a variety of tasks in our workplace to facilitate employment for financial gain, which promotes national growth [5].

Thus, education is essential to the advancement of civilization. It can lead to excellent governance and is necessary in governance. Akinsowon and Osisanwo contend that education can be used to develop the kind of character traits that result in the formation of an impactful and fulfilling life, alongside a means for socio-economic reforms [6]. A person's value and the state of societal development are determined by their education. As a result, the primary indicator of overall national development is now educational progress.

2. ADVANCEMENT

There are several definitions for the term "advancement". Advancement can be defined as expanding, altering, or improving. In addition, it could also refer to the collective efforts made by any human community to minimize all perceived barriers to a higher level of living to maximise residents' quality of life. Advancement also connotes growth that is combined with improvements in domestic technology, science, politics, and the economy [7]. According to Bawalla and Rufai, advancement is typically seen as a communal societal change aimed at improving the material and socioeconomic well-being of the vast majority of people to take control of the environment [7]. A developed nation has many attributes, such as high living standards, high agricultural and industrial production, appropriate exploration of its resources, little reliance on imports, the existence of businesses, increased literacy levels, a suitable healthcare system, and a reduced unemployment rate.

Advancement also refers to an increase in the scope or mode of operation, as well as an improvement in the standard of living, style, amenities, equipment, and interpersonal relationships among the populace. Change in growth or improvement leads to advancement and both suggest and explain the process of social, political, and economic change. Every country's progress begins with the personal growth of its citizens [8]. This is because the amount of income and development of a country is largely determined by the knowledge, skills, and competencies of its people and resources. Through the development of the labour force—which involves transferring knowledge, skills, and competencies to individuals—education promotes economic growth. Providing people with the necessary information and abilities to enable them to contribute to the advancement of society is known as manpower development [9].

People become human capital through their knowledge, abilities, and competencies; nevertheless, human capital is not formed from the raw populace till knowledge or skill creation takes place. To convert individuals into human capital, productive skills, competencies, and knowledge must be actively created and stored. The aforementioned makes it abundantly evident that a nation without the right form of education may lack the capacity to handle the demands of a dynamic global scene [7]. Therefore, STEM

education in Nigeria is thought to be the right kind of instruction that could result in the required advancement. National advancement is a course of societal growth in which strong collaboration between all branches of government results in an improvement in people's well-being [9]. Therefore, national advancement encompasses social, political, and economic aspects of daily life in addition to economic considerations, and educating STEM professionals is one way to promote national growth [10].

3. STEM EDUCATION

STEM stands for mathematics, science, technology, and engineering. As stated by Adadu (2016), integrating engineering into STEM education is justified by the simple reality that early learners are frequently engineers first—constructing, designing, and working on projects before studying the methodical ideas and mechanisms which allow them to work [11]. The 2002 World Summit on Sustainable Development (WSSD) confirmed STEM's significant role in facilitating sustainable national economic growth [12]. According to Umar (2019), African leaders must realize that science and technology are crucial to the sustainable growth and economic transformation of any country. Furthermore, effective and quality teaching, research, innovation, policies, and problem-solving all require and make use of STEM education [13].

STEM is required to meet the increasing demands and needs of globalization. Because of the complexity of today's world, everyone must acquire new sets of fundamental skills and abilities to answer complex issues such as the novel COVID-19 pandemic, obtain and assess evidence, and interpret the available data in a variety of media (digital or print) [10,12]. Thus, engaging in STEM education and activities helps students build their abilities and get ready for a workforce where success is determined by more than simply one's knowledge base. STEM fields have been vital to enhancing the living standards and economy of any nation [13]. Developed countries with access to science and technology, including the United States, China, Japan, and the United Kingdom, are not isolated from it. To provide society with necessities like food, clothes, shelter, electricity, water, jobs, basic education, healthcare, defence and security, and governance, among others, STEM education is crucial [2].

The innovation pipeline for modern industries is fueled by fundamental science. It is reasonable to promote pure research because it will eventually result in improved industrial processes or goods that will help the economy. For this reason, countries still devote enormous sums of money to the advancement of STEM education and training through research and development. The significance of these disciplines to the advancement of the country makes this investment regarded as strategic.

The worldwide STEM program has drawn interest from many nations for its advancement [4]. These nations think they can overcome their over-reliance on the technological superiority of developed nations by acquiring STEM knowledge. Currently, the world's countries are divided into three categories: the less developed, developing, and developed. Nevertheless, what separates developed from developing and underdeveloped nations is the former’s capacity to translate scientific concepts into practical technologies, whereas emerging and underdeveloped nations have not yet been able to do so successfully [5].

4. SCIENCE

There are several definitions of science, including knowledge of the physical world derived from experimentation and fact-finding, or research leading to new understanding. Science is generally accepted as a systematic investigation of natural events [14]. Science could also refer to a rational endeavour undertaken by humans to figure out how to arrange this knowledge for the good of the human race. A scientifically literate person will have a body of information and abilities related to science, as well as the ability to operate scientifically in daily life. Among all the subjects covered in the curriculum, science is special since it provides students with so many options [14]. It also aids in the development of the country. Increasing the number of scientifically knowledgeable citizens and producing more labour to keep up with global advances in science and technology are two goals of science education.

5. TECHNOLOGY

Technology entails applying knowledge to advance and enhance the quality of life in humans. It can be defined as a scientific art where science is applied to solve issues for people and systems [15]. Technology could be defined as the methodical application of

structured knowledge, such as science, to a given goal. It concerns the product and the method. The product, which comprises hardware and software components, is the result of the application, whereas the process is the application itself [14]. In addition, the term "technology" could mean a real-world utilization of knowledge, particularly in specific fields, to accomplish goals. Simply said, technology is the application of knowledge—scientific or otherwise—in real-world contexts and is a key driver of economic growth [16].

Furthermore, technology is the use of information gained from scientific discoveries for the advancement and betterment of human life. The mechanical and industrial arts are those that use mathematics and science to solve issues for people, and it appears that every description points toward the advancement and enhancement of human life. As a result, depending on how it is utilized, where it is employed, and the conditions at hand, technology can have economic, social, ethical, and aesthetic aspects. For instance, educational technology can be employed to assist learners in applying scientific ideas and knowledge to improve their surroundings, maximize potential and simplify their work [13]. More so, it will help them cultivate positive attitudes toward efficiency as well as foster thoughtfulness and ingenuity. Nature has a relationship between science, technology, and mathematical knowledge.

6. ENGINEERING

Engineering, as a field of science and technology, is focused on the production, operation, and maintenance of machinery, engines, and structures. Thus, there exist connections between the characteristics of the many STEM disciplines. It is clear from the explanation above that STEM education is important for promoting national growth [13]. More so, the world's technological advancement is happening very quickly, making mathematics a necessary tool for this since without it, science cannot exist; and without science, technology cannot exist. Hence, without technology or lack of it in our present-day world, contemporary society cannot exist [17].

7. MATHEMATICS

According to Okonkwo (2014), mathematics is a scientific field involving figures and their functions, revealing concealed designs which aid in our understanding of the outside world [15]. Thus, knowing mathematics is very helpful in day-to-day living. Its value may be observed in the way it strengthens the growth of man's creativity helping him avoid social difficulties including unemployment, financial downturn, and poverty. To support this, [18]. Fomunyam (2019) noted that mathematics is the only fundamental tool that applies to a wide range of disciplines, such as social sciences, medicine, and engineering [18]. This means that mathematicians are among the potential think tanks capable of setting Nigeria's path to long-term economic advancement.

Furthermore, mathematics could be referred to as "the language of science", as the study of mathematics at all levels is arguably the most important instrument for assisting science. For instance, equations are frequently incorporated into the common beliefs of scientists working in all branches of science, and mathematical conceptual understanding is useful in the study of physics [19].

More so, mathematics is regarded as the discipline of measuring, counting, and characterizing object shapes, and includes the science of structure, order, and relation in addition to logical thinking and quantitative computation. It offers the foundation for scientific and technical progress, which is essential for every country's economy to thrive [18]. Additionally, the challenge of establishing national competence in science and technology revolves around mathematics. Consequently, in the current technological globalization, any weakness in the field is a hindrance to the accomplishment of science and technology objectives [13].

Hence, STEM is defined as being multidisciplinary because it encompasses a variety of academic fields. Conversely, Odigiri et al., (2020) took a complementary approach to STEM, drawing from each discipline separately, and defined STEM education as problem-solving methods that combine engineering's design and collaborative approaches with science's models and procedures [17].

8. ROLE AND IMPACT OF STEM EDUCATION TO NIGERIA'S ADVANCEMENT

All nations of the world need technology and STEM education to improve their human,

material, and economic resources. Many educationists have proposed that flawed mathematics education will lead to flawed scientific and technical foundations. The manner that mathematical ideas have aided in the electronic revolution that has transformed the way we live and think has greatly aided in the development of our nation [18]. With the advent of information and communication technology, the globe has become a global village. The application of mathematical concepts has further enabled the drastic development in science and technology, thereby supporting the growth of nations [3].

STEM education guarantees that acquired knowledge in specific subject areas is employed in every life facet, including sports, finance, and agriculture, such that each student succeeds in their chosen field. Effectively promoting self-reliance and sustainable development has been the role of mathematics education [2]. Self-reliance is achieved through the effective development of lifelong skills through mathematics, because of its limitless talents and the assurance that practising with mathematical ideas will enhance one's practice daily, providing support and encouragement. Among these abilities are the capacities for communication, manipulation, estimate, computation, and problem-solving. Therefore, someone possessing the aforementioned abilities must be able to forge positive interpersonal relationships, which strengthen national unity [4].

STEM education can provide individuals with the appropriate skills needed to be used throughout their lives, enabling them to make a substantial contribution to the advancement of their community and nation. In the same spirit, STEM is highly acknowledged to be a veritable tool to resolve personal problems and ensure stability within the country [5]. Mathematical disciplines like statistics, trigonometry, and collegiate algebra highlight the value of honesty, truth, and critical thinking in addressing the issue of bribery and corruption. Therefore, if we want to guarantee a greater tomorrow for any given country and its future generations, we must promote STEM education and increase students' proficiency in it [6].

Due to the importance of STEM education for Nigeria’s advancement, mathematics was made a core subject in primary and secondary schools by the Nigerian government. Thus, learners must pass mathematics as a prerequisite for continuing their education because of the subject's significance and the dynamic role it plays in contemporary society [11]. In addition, mathematics is essential to practical labour and serves as the primary means of natural observation for scientific discovery. Because critical thinking is essential to scientific discovery, mathematics has been defined as a means of organizing and discerning experience and asserted as a skill enhancer [15].

In this way, critical thinking fosters the development of skills, which in turn foster a viable economy.

In addition, STEM education may offer the essential foundations for understanding economics and other social sciences, while it remains highly indispensable in other physical sciences disciplines and ICT domains. More so, the majority of scientific and commercial research and development is also based on STEM. In the 21st century, STEM is effectively employed in advancing science and technology and remains the foundation of several fields, including artificial satellites, rockets, digital imaging, biotechnology, nanotechnology, and advanced semiconductor devices [5].

STEM could also help to improve security and professional development, as the integration of knowledge in STEM can promote both national and economic growth. By using this knowledge, man can better utilize natural forces and convert raw (natural) materials into services and finished products that enhance quality lives [4]. People's lifestyles are impacted by their STEM knowledge, abilities, and competencies, as it has an impact on how people travel, eat, drink, lead, play, and sleep. Additionally, STEM education has direct consequences for the environment, such as pollution and climate change, and the knowledge of STEM is connected to daily living in the community and society. In a typical day, every member of our society sees, hears, touches, or utilizes a variety of objects including dental paste, knives, cell phones, automobiles, and fixtures found in homes, and workplaces amongst others [12].

STEM education plays a crucial role in the development and achievement of the Sustainable Development Goals (SDGs). STEM education can help learners acquire the knowledge, skills, and attitudes that are essential for achieving the SDGs, such as critical thinking, problem-solving, creativity, innovation,

collaboration, communication, and ethical awareness [3]. By using the SDGs as a framework for designing projects and activities, STEM educators and learners can investigate the causes and effects of global challenges, and develop innovative solutions to address them [2]. The design thinking method, which is often used in STEM education, encourages students to address specific challenges, making it a suitable approach for addressing the subjects of the SDGs [3]. Additionally, STEM education equips students with the soft and hard skills needed to succeed in the world and can improve their school performance and cultivate their interests in various fields [4]. Overall, STEM education not only prepares students for the future but also contributes to the advancement of the SDGs by fostering a generation of problem-solvers and innovators [5].

Furthermore, one may come into contact with and utilize other products and services which STEM produces including tractors, high-speed computers, medications, and technologies that facilitate communication, entertainment, and transportation, alongside those designed to reduce physical labour. These and a ton more are referred to as technological products [7]. Hence, any country's capacity to produce higher-quality goods, enhance healthcare, create more sustainable and effective domestic energy sources, protect national security, maintain the environment, and expand its economy is largely dependent on its levels of advancements in STEM. Globally, numerous leaders continue to acknowledge the importance of STEM and its education to its citizens [20,21]. For example, the Nigerian government aim to increase STEM education among its citizens and, consequently, the number of active researchers, as sophisticated economics requires ongoing education for scientists and engineers, who are essential in advancing innovations [20].

The growth of a nation's gross domestic product (GDP) directly relates to its innovations, thus, there is need to promote STEM education and regularly recognized the importance of STEM globally. Though many studies concur that the only way to create value-added employment and industries is through innovation-driven development, however, the majority of innovation comes from advancements in the STEM fields [2-5,10,13]. For instance, in Nigeria, there has been a recent increase in STEM-related employment at all levels, leading to more research on the roles and impacts of STEM education on Nigeria's economic advancement [[w12,13]. Thus, Nigerian citizens who receive a STEM education will become literate in math, science, and technology. Additionally, STEM education in Nigeria will encourage the holistic development of fundamental skills and their efficient application to the advancement of both the individual and the Nigerian society.

9. CONCLUSION

The article examined the role and impact of STEM education on Nigeria's advancement, and how it can be used to further its development. Our findings showed that STEM education imparts lifelong knowledge and skills in people which enhance their capacity to significantly contribute to developing and advancing society. More so, applying STEM concepts and education can advance and sustain Nigeria's socioeconomic growth and development. In addition, our findings showed that the greater the proportion of people educated in STEM, the more valuable those people are to society and the higher the level of development that results in our overall national development. Thus, it may be inferred that Nigeria's advancement and growth will be achievable with high-quality STEM education. Therefore, for STEM education to fulfil its full potential, it must be meticulously designed, taking into account the demands of the community and society, as well as the political, sociocultural, economic, and technological realisms of Nigerian society.

10. RECOMMENDATION

1. For students to acquire the knowledge, skills, and competencies required for the slow but steady development and advancement of Nigeria, there is a need to increase the quality of STEM education in all our schools from primary to tertiary levels. This requires and includes the mandatory teaching of mathematics, science, engineering, and technology.

2. To accomplish national growth and advancement, the government and major national stakeholders should make high-quality STEM education freely available and accessible to the general public and citizenry.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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