

## SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) EDUCATION: A TOOL FOR NATIONAL DEVELOPMENT.

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### ABSTRACT

*Development is generally perceived as a social transformation of the society, projected to bring economic, social and material improvement in the life of the majority of the people with a view to gaining control over the environment. This paper recognizes the fact that Science, Technology, Engineering and Mathematics (STEM) Education is an enabler of national development. It examined the role of STEM Education as a tool in national development. The paper highlighted some salient issues on STEM with the hope that the awareness therein will bring about the desired development and improvement of human life. Recommendations were made; it concluded that, with sound STEM Education, national development can be achieved.*

**Key words:** *Development, Education, Engineering, Mathematics, Science, Technology.*

### INTRODUCTION

The philosophy of education in Nigeria is geared towards social, cultural, economic, political, scientific and technological progress. Education is adjudged to be an instrument par excellence for effecting national development (FRN, 2014). Education is the process of receiving or giving systematic instruction especially at a school or university. According to Ategwu and Obia (2019), education is a process of discovering and living the truth, expanding one's vision of life and the world and of acquiring practical knowledge. Every educational policy has its aims and objectives to be carried out and resources to be utilized to achieve the expected goals. The purpose of education therefore is to equip one with self-transforming knowledge which can be used to change the environment and execute whatever task that may be assigned, hence the saying that in every formal education process, there is a transition from the home to the school, and there is a transformation from the school to the home. It is not gain saying that every facet of a society's life is affected by education in one way or the other especially education in Science, Technology, Engineering and Mathematics (STEM) It explains events in nature , helps people to think and reason in a logical manner, solves problems encountered on a day to day basis, develops social skills through proper handling of objects and equipment, develops social skills by establishing friendship while working cooperatively in groups and helps satisfy curiosity through opportunities in carrying out investigations (TESSA, 2011 & STAN, 2019). Technology is a process of practically applying knowledge and using the resources of matter, energy and natural phenomenon to solve human problems and making life easier. There are simple and common examples of technological products such as building of houses in different forms and shapes, using different materials. The construction of modern machines like cars, generators, aeroplanes, ships for commercial activities is done through STEM education. Several activities are carried out by STEM in our environment in order to make work easy for economic purposes which results to national development (Ismail, Sani & Abdulrahman, 2019).

Education is therefore needful in the development of the society. It is needful in the act of governance and can pave way for good governance. Education according to Muhammad, Yusha'u and Lawal (2018) is an instrument for social and economic reconstruction and a means of developing qualities that end up in building up a rich and fulfilled life. Education determines the worth of an individual and level of development of the society. Thus, educational development has become the major yardstick for measuring overall national development. What then is development?

### **DEVELOPMENT:**

The word development has been variously defined. The Longman Active study Dictionary (New Ed; 2016) defined development as the process of growing, changing or becoming better. According to Nkwocha (2016), development may be defined as the collective activities by any human society directed at reducing the totality of perceived obstacles to a higher standard of living, thus maximizing the quality of life of the citizens.

Development means growth integrated with economic, scientific, political and home based technological expansion. Charles – Ogan & Agomuo (2017) giving credence to Ambali (2014) pointed out that development is generally perceived as a social transformation of the society, projected to bring economic, social and material improvement in the life of the majority of the people with a view to gaining control over the environment. Some of the elements of a developed nation are: high standard of living, high agricultural productivity, high technological productivity, adequate exploration of the natural and mineral resources of the society, less dependence on imported materials, presence of heavy industries, high literacy and numeracy rate of the citizens, appropriate health care delivery and low unemployment (Ambali, 2014; Nkwocha, 2016; and Charles – Ogan & Agomuo, 2017).

According to Amokaha, Okah and Okaegbu (2017), development is growth in either size or way of doing things, improved living standard, style, equipment, facilities, ways of life, relationship among citizens. Development entails change in growth or improvement. It implies and describes the process of economic, political and social transformation. The development of any nation starts with the development of individuals within the society. This is because it is the knowledge, skills and competences of human resources that determine to a great extent the level of wealth and development of the nation. Education contributes to economic growth through manpower development which entails imparting knowledge, skills and competencies to individuals. Manpower development involves equipping people with appropriate knowledge and skills so as to be able to contribute to the development of the society. Knowledge, skills and competences translate people into human capital, but raw population does not translate into human capital until the process of knowledge or skills formation takes place. Human capital requires a conscious act of creation and stock of productive skills, competences and knowledge that will translate people into human capital. From the foregoing, it is evident that, a nation that is deficient in the right kind of education may not be able to meet up with the demand of the changing world. Thus, the appropriate type of education that could lead to the desired development is seen to be STEM education. (Muhammad et al, 2018). National Development is a process of societal advancement, where improvement in the well-being of people is generated through strong partnership between all sectors of government. So, national development is not only an economic exercise but involves both socio- economic and political issues of societal life. STEM education is one of the tools to bring about national development.

### **STEM EDUCATION:**

STEM is an acronym for: Science, Technology, Engineering and Mathematics. According to Olorundare (2010), the inclusion of engineering into STEM Education can be justified by the mere fact that young children tend to be engineers first; building, making and doing projects long before they can explore scientific principles that allow their buildings to stand or “canals” between puddles to carry water.

The important contribution of STEM as an enabler for sustainable national economic growth was affirmed at the World Summit on Sustainable Development (WSSD) in 2002. According to David, Dallatu & Yusuf (2018), it is in this regard that in the framework of the New Partnership for Africa’s Development (NEPAD), African leaders recognized that Science and Technology will play a major role in the economic transformation and sustainable development of any nation. STEM education is used in research, policy issues, teaching for innovation, problem-solving and prospects. STEM is needed towards globalization demands. The complexity of today’s world requires all people to be engaged with new set of core knowledge and skills, to solve difficult problems like novel coronavirus pandemic, gather and evaluate evidence and make sense of information they receive from varied print and increasingly digital media. It is therefore clear that the learning and doing of STEM help develop skills and prepare students for a workforce where success results not just from what one knows but what one is able to do with the knowledge. STEM had been the critical instruments used to uplift not only the standard of living but the economy of any nation. Developed nations such as USA, China, Japan and UK are not unconnected to the type of science and technology available to them ( Wasagu, 2019). STEM education is important in meeting societal needs like food, shelter, shelter, clothing, water, energy, employment, basic education, healthcare, defence and security, governance, etc.

Modern industries depend on basic science for its supply of innovations. The support of pure science is justifiable because it will lead eventually to economic benefits through improved industrial products or processes. This is why nations continue to invest huge amount of resources in research and development in STEM education and training. This investment is seen as strategic because of the importance of these disciplines to national development.

STEM global initiative has attracted several countries of the world for its development. These countries believe that with STEM knowledge, they can rise above over-dependence on developed countries technological prowess. Presently, countries in the world are classified as ; developed, developing and less / under developed. The difference between the developed , developing and under-developed countries however rests on the ability of the developed countries to convert scientific ideas to usable technology while the developing and under-developed countries are yet to do so effectively ( Sambo, Udofiak, & Okoko, 2018).

### **SCIENCE:**

Science is defined variously as:- knowledge about the physical world based on testing and providing facts, or work that results in gaining knowledge (Longman Active study Dictionary, 2006). According to Igboanugo & Egolum (2017), Science is universally regarded as an organized study of natural phenomena. To Sulai, Sulai & Kaluri (2018) Science is defined as an intellectual activity carried out by human, designed to discover the ways in which this information can be organized to benefit human race. A scientifically literate person should possess a body of scientific knowledge,

a set of scientific skills and behave scientifically in his or her day to day activities. Science holds a unique position among all aspects of school curriculum because it offers countless opportunities for students. It also helps in nation's development. One of the aim of science education is to bring about more scientifically literate citizenry and to develop more manpower to meet up with the world advancement in science and technology.

### **TECHNOLOGY:**

Technology is viewed as application of knowledge for development and improvement of human life. It is science of mechanical and industrial arts which involves application of science in solving human problems (Suleiman, Fagbemi, Oyebani & Suleiman, 2018). According to Alabede (2017), technology is a systematic approach of applying scientific or other organized knowledge to a particular task. It is about product and process. The process is the application, while the product is the outcome of application, which includes hardware and software materials. Technology is the practical application of knowledge especially in a particular area to achieve some results Technology simply means the practical application of scientific or other knowledge and a major source of economy expansion. Zakariyya & Bello (2018) and Adeniran & Odebode (2018), view technology as application of knowledge obtained from scientific discovery for development and improvement of human life. It is the mechanical and industrial arts which involves application of science and mathematics in solving human problems. All the definitions seem to be pointing to the development and improvement of human life. Technology therefore has economic, social, ethical and aesthetic dimensions which depends on the use to which it is put, where it is used and the circumstances that prevail at the time it is used. For example, education technology is used to help students apply scientific knowledge and concepts to better their environment, to use their brain and hands, make work easier, help them develop positive attitude towards work and productivity and to encourage critical thinking and creativity among them. Science, technology and mathematical knowledge are related in nature.

### **MATHEMATICS:**

Mathematics is seen by Inweregbuh (2015) as a branch of science which deals with numbers and their operations which revealed hidden patterns that help us to understand the world around us. To Guwam (2017), the knowledge of Mathematics is very useful in our daily life. Its usefulness is seen in the enhancement of the development of a critical mind which enables man to circumvent problems like poverty, unemployment and recession that abound in the society. Lending credence to this, Usman & Ojo (2014) pointed out that mathematics is the only essential tool that is applicable in many fields like natural science, engineering, medicine, finance and social sciences, which can be relied on to generate think – tanks that can launch Nigeria on the path of sustainable economic growth and development.

Mathematics is commonly referred to as “the language of science” (Obafemi & Ogunkunle, 2013). Study Up (2009) pointed out that, the study of mathematics at all levels is the most pronounced tool to aid science. For example, scientists studying in all fields of science interweave equations into their everyday theories. The study of physics benefits from conceptual understanding in mathematics. Physics and mathematics are actually inseparable. Obafemi & Ogunkunle (2013), further noted that, physical sciences cannot do without mathematics. This is because many of the expressions used in these subjects are lent from mathematics.

Mathematics Education is considered as science of counting, measuring and describing the shapes of objects (Majasan, 1995; Augie, 2013; Suleiman & Abdullahi, 2018). The subject deals with logical reasoning and quantitative calculation and involves the science of structure, order and relation. The subject provides basis for scientific and technological advancement which is a necessary ingredient to the economic growth of any nation (Augie, 2013). Also, mathematics is the lynch pin in the task of national capacity building in science and technology. Therefore any shortcoming in the subject constitutes drawbacks to the achievement of science and technology objectives in today's technological globalization.

As viewed by Fitz (2013) and Idoezu (2018), STEM in its nature is interdisciplinary since it involves other disciplines. Shaughnessy (2013) however, approached STEM through a complementary view that draw from the individual discipline and described STEM Education as referring to problem-solving techniques that harness from the models and procedures in mathematics and science while amalgamating the collaboration and design approaches of engineering using relevant technology.

### **ENGINEERING:**

Engineering is the branch of science and technology concerned with the design, building and use of engines, machines and structures.

The features of the separate disciplines in STEM are in an interconnected manner.

From the foregoing explication, it is evident that STEM education has relevance in fostering national development. Salman & Adeniyi (2012), Amao (2002), Salman (2005), Adeyegbe (2008) and Opeyinka & Kehinde (2017). The world is rapidly developing technologically and of which mathematics is a required instrument because without mathematics there is no science and without science there is no technology and without technology there is no modern society.

### **RELEVANCE OF STEM EDUCATION IN FOSTERING NATIONAL DEVELOPMENT**

Mathematics is the core of science and technology, engineering inclusive. According to Charles-Ogan, Ekwueme & Agomuo (2017), every nation needs technology to develop its economic, human, material and natural resources. They posited that, if mathematics education is faulty, the basis for both scientific and technological development becomes faulty. A massive boost to national development is seen in the way mathematical concepts have facilitated the revolution in electronics which has changed the way we think and live. Information and Communication Technology (ICT) has changed the world into a global village. This advance in science and technology which has helped to sustain the development of our nations has been made possible through the application of mathematical concepts. Mathematics education ensures that the knowledge of the subject gained is applied to all areas of life, such as business, economics, finance, engineering, farming, sports, sciences, and arts and ensures that everybody excels in his/her area of specialization. Chado and Bala (2014)

Mathematics education has effectively been an agent of sustainable development and self-reliance. Mathematics is an effective tool for developing life-long skills which makes an individual self-reliant. Lending credence to this, Ogunkunle (2014) posited that mathematics is filled with unending skills and confidence that working with mathematics concepts will improve one's practice daily, which gives support and encouragement. Notable among these skills are communication, manipulative ability, estimation ability, computation and problem – solving skills. It pre-supposes therefore that an individual with the aforementioned skills will be able to build a good inter-personal

relationship which enhances unity and builds the nation. In the words of Abakpa & Agbo-Egwu (2014), mathematics education has the potential of developing life-long skills in an individual that will enable him to add significantly to the development of the society in which he lives. In the same vein, Momoh & Yusuf (2012) and Charles – Ogan et al (2017) stated that mathematics has been recognized as a tool for solving everyday’s challenges faced by individuals and ensures national stability. Branches of mathematics such as college algebra, trigonometry and statistics underscore the importance of truth and honesty and analytical thinking that can tackle the problem of bribery and corruption. That is why the need for promoting the subject and building students’ proficiency is urgent if we must ensure a better future for the nation and the next generation that will inherit it.

Mathematics is an important part of Nigerian education curriculum (FRN, 2013), due to its significance in national development, the Federal Government of Nigeria made the subject compulsory from primary through secondary schools, and students are required to pass it as part of the minimum requirement for further education, this is because of its importance and the dynamic role played by the subject in modern – day society, this is affirmed by Bassey (2010) and Charles – Ogan (2014).

Mathematics also plays an important role in practical work and observation of nature as main source of scientific discoveries. Scientific discovery depends on critical thinking that is why Lappan & Schram (1998) and Charles – Ogan et al (2017) defined mathematics as a way of thinking about and organizing one’s experience. According to Adeniran & Odebode (2017), mathematics is a skill developer. Seen as such, critical thinking develops skills, and skills build up viable economy. Mathematics therefore provides the vital underpinning of the knowledge of economy. It is essential in the physical sciences, technology, business, financial services and many areas of ICT. Mathematics forms the basis of most scientific and industrial research and development. Mathematics has been successfully used in the development of science and technology in 20<sup>th</sup> and 21<sup>st</sup> century. The areas like advanced semi-conductor devices, bio-technology, digital image technology, Nan-technology, artificial satellites, and rockets are all based on mathematical concepts. Mathematics enhances career development, mathematics enhances security, etc. The knowledge of science, technology, engineering and mathematics combine together lends to economic and national development. The knowledge is used to harness the forces of nature and to transform the raw resources with which nature endows man into goods and services for better quality of life. The knowledge, skills and competences in STEM affects people’s lifestyles. It affects the way people eat, drink, travel, work, lead, play and sleep. It also carries along with environmental implications such as pollution (Olaitan, 2007) science, technology and mathematical knowledge are related to life in the community. Everyone in the society sees, hears, touches or uses various objects in the course of a single day. Such objects include soap, tooth paste, broom, knife, safety razors, hot water, mobile phones, cars, buses, train and objects in the offices, factories, homes, schools, restaurants and theatres in addition to all these, one is likely to touch and use such devices designed to save physical labour, as tractors, those designed to help in communication, entertainment, transportation, high – speed computers and medicines. All these and many more are called products of technology (Awachie, 2001). Goods and services are products and processes of STEM. Advance in STEM is central to any nation’s ability to manufacture better and qualitative products, improve health care services, develop cleaner and more efficient domestic energy sources, preserve the environment, safeguard national security and grow the economy.

Studies have shown that many national leaders have acknowledged the significance of STEM (Ideozu, 2018). For instance, former President of the United States of America, George Bush hurled the American Competitiveness Initiative, whose aim was to improve STEM education and in turn grew the number of working scientists. According to Izeodu (2018), advanced economics need a continuous training of scientists and engineers who are critical in driving the innovations. The innovations, in turn have a crucial role in the growth of the Gross Domestic product (GDP) of countries. Former President Barrack Obama also frequently acknowledged the significance of STEM and also, initiated the “Educate to Innovate” campaign in support of the STEM education. Many studies agree that only innovation compelled development has the perspective to generate value – added jobs and industries (OECD, 2010 in Ideozu, 2018). Nevertheless, innovation is mostly as a result of advances in the STEM disciplines, and as a result, there has been a rise in employment at all levels requiring STEM skills, which triggered research on the subject and the impacts of STEM education on economic growth.

STEM education produces scientifically, technologically and mathematically literate citizens. It also promotes all round development of basic skills and the effective use of these skills in the development of the individual and the society.

## **CONCLUSION**

The paper examined the role of Science, Technology, Engineering and Mathematics education as a tool in national development. From the discourse, it can be seen that:

- (i) Life-long skills in individuals that can enable them to add significantly to the development of the society are inherent in the learning of mathematics;
- (ii) the application of mathematical concepts has helped in advancing science, technology and engineering, thus sustaining the development of our nation;
- (iii) the more the number of individuals having STEM education, the more the worth of the individuals and the level of development of the society and the result is overall national development.

It is therefore concluded that with sound STEM education, national development can be achieved. For education to achieve all ends, it has to be carefully planned, the plan must take into consideration the needs of the society, the political, socio- cultural, economic, military, scientific and technological realities of the environment are very important to its development.

## **RECOMMENDATION**

1. There is need to improve on the quality of Science, technology, engineering and mathematics teaching in schools so that learners can gain knowledge, skills and competencies needed for the gradual but lasting national development.
2. The Government should avail the general populace with sound STEM education, for in that; national development can be achieved.

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