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THE USEFULNESS OF SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS EDUCATION (STEM) AS AN INSTRUMENT FOR SUSTAINABLE DEVELOPMENT IN NIGERIA

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Abstract
Education is the key to sustainable National Growth, Development and Productivity globally. This calls for the attention of teachers in all facets of Education due to their vital role of interpreting and implementing the curriculum in order to achieve the pre-determined goals, aims and objectives of education in Nigeria. The study focus on the usefulness of Science, Technology, Engineering and Mathematics (STEM) Education for sustainable Development in Nigeria. Four objectives and four research questions were formulated to guide the study. The researcher adopted descriptive research design. The main conclusion is that, improving STEM education in Nigeria is a multi-faceted and complex issue. To this end the need to embrace a range of new innovative teaching approaches is paramount. The major recommendation is that relevant stakeholders ie teachers, students and parents should be consciously encouraged to partner and combine informative and persuasive forces to tackle the challenges of STEM education such as facilities, interest, teaching methods via new innovations for the benefit of the state and Nigeria as a whole in enhancing economic development and the Nigeria government should develop a basic functional, responsive, STEM Education Curriculum which should include our life style, attitude to work, healthy life style, time consciousness, self reliance and self sustenance and Building STEM classrooms with specific focus on local entrepreneurship, good sitting arrangement, teaching materials, quality and enough resource persons among others.

Introduction

Today we live in a world that is troubled by many scientific and technological products such as nuclear weapons, ruthless terrorist using sophisticated weapons (created by science and technology). According to Nwagbo, (2008) qualitative and functional STEM Education aim at preparing students for a balanced development and also assisting them to attain a level of performance that meet their needs and that of the society at large. There is the need therefore to have a quality Science, Technology, Engineering and Mathematics Education (STEM) that will serve as change mechanism for a sustainable development since science and technology knowledge are not static. The Educational System most especially Science, Technology, Engineering and Mathematics (STEM) Education has always played an indispensable role in shaping the economic realities of any society, (Orukotan, 2007 and Ajewole *et al* 2006). For any nation to attain any sustainable development there is the need to recognize science, technology, engineering and mathematics education of her citizens (Usman, 2011).

Science is concerned with search for and understanding of knowledge about nature while Technology is concerned with the application of knowledge (science) in solving practical problems of everyday living. Science and Technology education by implication deals with inculcation in the citizenry, skills of searching for, and understanding nature. The level of success of a nation to exploit the potentials of its environment depends on the quality of Science and Technology education provided to the citizenry, and how well the citizenry have imbibed the culture of science and technology.

An examination of the activities of the United Nations Development Programme (UNDP) reveals that substantial investment in science and technology education stimulates growth, and empowers the citizenry to achieve victory over ignorance, poverty, unemployment, and other indices of under development. For any nation to achieve substantial success in exploiting the potentials of its citizens to facilitate development, and on a sustainable basis, it must equip them with skills to dominate and manoeuvre the resources for better living. In Nigeria, and indeed many other developing countries, the effort towards technological development has been more on transferred, borrowed, bought, or even stolen technology. Neither of these will lead a nation to attain an appreciable technological height. Technology is a culture that has to be developed from within. Development is an expression of change and growth. That there is development presupposes that change and growth have occurred. In view of the dynamic nature of societies, development should be an on-going process.

Statement of the Problem

It is unfortunate that it is no longer news to hear of poor performance of learners in sciences and mathematics tasks. It has however becomes worrisome for government, schools, parents and students as the consequences of failure in education system. Most of the educationists tend to ask questions as what should be taught and how it should be taught. As it was done during Sputnik-1 era in the 60's which brought about different curriculum reforms using science process approach. According to Usman (2011) that may not be out of place to say that our educational system and more specifically the curriculum that is in use is deficient. There is the need therefore to have an enriched and responsive STEM curriculum that is relevant, appropriate and which emphasizes transferable skills from the

classroom to the real world as a mechanism for a sustainable development. STEM Education has become an important area of focus in planning development all over the world because of its vital role in socio-economic and political needs of the citizenry.

Objective of the Study

The main objective of this study is to discuss the usefulness of Science, Technology, Engineering and Mathematics Education for Sustainable Development in Nigeria. Specifically to discuss on:

1. The Quality of STEM Education in Nigeria for sustainable development'
2. The need for change in STEM Education in Nigeria.
3. The indices for STEM Education in Nigeria and
4. The challenges of STEM Education in Nigeria.

Research Questions

The following research questions were postulated in order to guide the study

1. What is the quality of STEM Education in Nigeria?
2. Is there any need for innovation in STEM Education in Nigeria?
3. What are the indices for STEM Education in Nigeria?
4. What is the challenges confronting STEM Education in Nigeria?

Historical Background to Stem Education in Nigeria

It is generally agreed that formal education into Nigeria by the Christian missions at about 1842. However, Science was first taught in Nigeria in 1859 in CMS Grammar School, Lagos. Science was taught inform of arithmetic, algebra, geometry and physiology. Between 1859 and 1929, teacher training institutions were established to cater for the training of teachers in other science subjects such as astronomy, chemistry, geology and botany. However, science Asia Pacific Journal of Education, teaching and learning had series of challenges that led to poor achievement at end of school programme.

During the 1920's, the Phelps-Stokes Education Commission visited West Africa and noted that the learning/teaching of science education was backward. The commission recommended and ensured that science subjects were included in the secondary school curriculum in Nigeria. Teaching of science was difficult due to lack of teachers; very few qualified science teachers were available in few schools. Besides that, unsatisfactory teaching methods affected the teaching of science in Nigeria. Before 1960, most secondary schools in Nigeria emphasized classics and art subjects with little emphasis on sciences. There was a remarkable improvement in the teaching and learning of science when Nigeria got her political independence in 1960. Before independence in 1960, science at the secondary school level was predominantly General Science since majority of the schools did not have academically qualified science teachers or even skilled personnel. In 1963, the first organized curriculum development effort took place at the Comprehensive High School, Ayetoro. The formation of Science Curriculum Development Committees in 1968 under a cooperative agreement between the Comparative Education Study and Adaptation Centre (CESAC) and the Science Teachers Association of Nigeria (STAN) contributed greatly to the development of science. The membership of these committees was drawn from both bodies, the Universities and Ministries of Education.

The Committees produced the first set of indigenous curriculums in Integrated Science, Biology, Chemistry and Physics. Following the production of these curriculums, both CESAC and STAN developed science projects which proposed radical changes in content, context and sequence of teaching science in secondary schools. These included STAN Nigeria Integrated Science Project (NISP), CESAC Basic Science for Nigeria Secondary Schools (BSNSS) and CESAC Nigeria Secondary Schools Science Project (NSSSP) for Biology, Chemistry and Physics. In September 1969, there was a National Curriculum Conference in Lagos which drew a lot of participants from diverse backgrounds who were eager to see Nigeria chart a new course in its educational system. At the primary school level, there were two pioneering projects developed between 1970 and 1977 by the Bendel State Ministry of Education and the Institute of Education, Ahmadu Bello University, Zaria. The projects had the support of UNESCO/UNICEF. The apparent success of these projects led to the production of a number of primary school courses by the State Ministries of Education, the Nigeria Educational Research and Development Council (NERDC) and individuals. A national curriculum in primary science was also developed with clearly stated objectives and activities.

The first major attempt at curriculum development in Africa which Nigeria participated was conceived in 1960 was the African Primary Science Programme (APSP). The programme which brought together educators and scientists from eleven English speaking African countries was the first of its kind. The APSP later metamorphosed into Science Education Programme for Africa (SEPA). The programme which was a research and development project was sponsored by the Educational Services Incorporated (ESI), which later became Education Development Centre (EDC), in Massachusetts, U.S.A in the 1960's. The broad goal of the APSP with respect to the African child was to ensure the development of first hand familiarity with a variety of biological, physical and man-made phenomena in the world around them; interest in further exploration of the world around them on their own initiative and; ability to find out for themselves, i.e. to see problems and be involved in problem solving. The program initially embarked on the production of science teaching materials which were mainly teachers' guide and to a lesser extent, pupil's books and a science library series for background reading. At a later stage, the program embarked on

formative evaluation of science teaching activities to ensure functional teaching of science at the primary school level.

The National Curriculum Conference of 1969 led to the formulation of the National Policy on Education. Curricula for primary and secondary science were designed by Nigerian educators from the conception that a curriculum be capable of anticipating future individual and societal needs and aspirations. Each of the science curriculum is a product of a multi-agency approach to curriculum development, the agencies that participated are: federal and State Ministries of education, science educators in Universities, Colleges of Education, Nigerian Educational Research and Development Council, National Teachers' Institute, West African examinations council and Science Teachers' Association of Nigeria.

A. Quality Stem Education

STEM is an acronym for "Science, Technology, Engineering and Mathematics". 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 building to stand or "canals" between puddles to carry water (Olorundare, 2010). The important contribution of Science Technology, Engineering and Mathematics Education (STEM) as an enabler for sustainable development was affirmed at the World Summit on Sustainable Development (WSSD) in 2002. It is in this regard that in the framework of the New partnership for Africa's Development (NEPAD) African leaders recognize that science and technology will play a major role in the economic transformation and sustainable development of the continent.

A variety of pedagogical approaches based on constructivism can be used to stimulate STEM Education in the classroom. The pedagogies used in STEM classroom need to take students through different levels of understanding to develop their abilities and confidence to critically examine issues and take responsible action. Activity-based approaches and project methods should be adopted in teaching STEM education curricula.

The teaching approach for STEM education should be such that students be given the opportunity to experience the heurestic or interpretative STEM education. This should be in the context of their formal education experiences that are self-involving transformative, qualitative and emancipator (Kyle, 2006).

Other pedagogies that can be used to make STEM education qualitative are:

1. **Knowledge approach (knowledge about science).** The emphasis here is to enable learners understand about natural systems and processes and the scientific, technical, economic, social and political factors that influence decisions about how people use science and technology.
2. **The needs of the society approach**: This is more of a learner-centered approach using learner's direct and background experiences of their environment as a medium of education.
3. **The critical inquiry approach**: This is education in science for sustainable development. It involves developing informed concerns for sustainable develop-ment, a sense of responsibility, active participation in resolving problems and the communication and participation skills that are needed if we are to guarantee environment and restoration (Onwu, 2009).

Sustainable Development

The term sustainable development is a complex, multi-faceted concept, which according to Ratcliffe (2003) and Usman (2011) combines aspect of environmental protection with social equity and the quality of human life. Indeed there are practitioners in the fields, with over 65 definitions of the term in circulation (Usman, 2011). "Sustainable development" means improving the quality of human life while living within the carrying capacity of supporting ecosystems. Holbrook (2005). Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (Onwu 2009). Also Sustainable development according to Holbrook (2009) is essentially about the simultaneous struggle for balance for harmony between environmental protection and economic development.

Therefore, sustainable development in STEM Education may be believed as education that is contributing towards providing learners with the scientific knowledge, skills and values to participate effectively in society, in decision making in trying to solve science-related and environmental problems that will improve the quality of life without damaging the environment for the future.

Education for Sustainable Development

Education for sustainable development enables people to develop the knowledge, values and skills to participate in decisions about the way we do things individually and collectively both locally and globally that will improve the quality of life now without damaging the planet for the future (Onwu 2009). Thus, a relevant STEM education for sustainable development is that which is intended within the school curriculum to broaden the goals and maximize the socio-cultural relevance of science teaching in helping learners to achieve the goals of sustainable development as stipulated by society. Our STEM Education classrooms ought to be permeated by the curriculum that linked STEM Education to the goals of sustainable development. If we wish to prepare future citizens that will be able to deal with complex everyday issues especially when confronted with future scientific and technological advancement, there is need for effective STEM education.

Also the most important ingredients in quality STEM education change mechanism for sustainable development is quality, experience and behavior of teachers, who are to carry out the implementation of any quality STEM Education and Curriculum that will serve as a mechanism for Sustainable development.

B. Need for Change in Stem Education

Curriculum being all of the educative processes, Afe (2006) believes that curriculum enrichment is a daunting tasks. It includes radical approaches to the development of all possible inputs into a qualitative education, programme, most especially those dealing with qualitatively improve teaching and learning. It also emphasizes language of instruction, curriculum content and organization, curriculum materials, teachers, school organization, school community linkages and diversification of educational opportunities. Curriculum enrichment should be carried out so as to improve the quality of STEM curriculum so that it can serve as a change mechanism for sustainable development. The quality of STEM education can be reflected in the scourge of dismal performance in STEM examinations as documented in the reports of Ojerinde (2006) and Uzoigwe (2007). In our educational institutions, the qualities of students, curriculum and teachers are no doubt threatening the foundation and the quality of STEM education for sustainable development. Since the quality of a nations education will define the nature of its development and its sustainability. The present state of education in Nigeria should be a source of concern for all of us. Hence, the need for a change which should provide more responsive STEM education for sustainable development.

C. What can make STEM Education to have quality that can serve as a change mechanism for sustainable development, according to Usman (2011) these indices are:

1. Quality or enriched curriculum
2. Quality human resources
3. Quality material resources

1. Enriched Curriculum:

The existing curricula in many African countries have well conceived goals and objectives (Mulemwa, 2002). In 2004, the Nigeria National Planning Commission described the country's educational system as "dysfunctional. According to Obioma (2006) and NCP (2004) STEM Education curriculum could be enriched in the following ways:

1. Introduce entrepreneurial skills
2. Including and integrating technology in Basic Science.
3. Developing appropriate curricula
4. Vocationalization of the senior educative curriculum.
5. Upgrading informal apprenticeship and introduction of industrial training.

Focus must be on stimulating STEM education in Nigeria starting from the primary school level; and build an army of quality STEM graduates at various level of our educational pyramid (Mobolaji, 2006).

In order to make STEM Education have the quality to serve as a change mechanism for sustainable development, there is the need to widen our vision beyond the content and process aim of STEM teaching and learning and expand our view of the goals of STEM education. What is needed is a paradigm shift of emphasis of STEM education from one bound by subject matter, that is from learning science as a body of knowledge to learning science that is linked to contextual realities of life and living. (Holbrook, 2005; Kyle, 2006 and Olagunj, 2014). Quality STEM Education curriculum can thus change the values, attitudes and modes of thinking of people. It is therefore one of the main engines of economic growth. The teaching approach that is preferred is one that emphasizes context in which a variety of interpretations of "CONTEXT" is possible they include psycho-social, economic, environmental, technological and industrial applications of STEM Education. As science educators, we must design and develop STEM curriculum that will enable our students to fit into the modern society for a sustainable development. They must possess a level of quality STEM Education, literacy in the science disciplines and that will enable them to fit into the era of 21st century sustainable development.

2. Quality Human Resources

This is refer to the teacher as facilitator of learning, his status, subject mastering ability to use instructional techniques and instructional materials, dedication to duty, teacher-students relationship and interest of the teachers in the profession (Adedayo, 2012). So far, if STEM Education is to serve as a change mechanism for sustainable development, there is the need for competent STEM teachers in the schools, with good teaching methods and proper use of instructional materials, facilities, skills and innovative strategies. And also have ability in teaching for self overall development rather than passing the examination. According to Okeke (2012), achievement of goals and objectives of quality STEM Education or any educational system largely depends on the job performance of the teachers who are to implement the programme. Bello (2004), agreed that STEM teachers have crucial roles to play in achieving vibrant STEM education as the quality of STEM hinges on the quality of STEM teachers. STEM teachers also need to use human resources to facilitate teaching and learning of STEM at all levels of education. Among the innovations in teaching strategy, teachers need to learn the use of computer in their teaching and learning and other educational functions such as record keeping, statistical analysis. Therefore, STEM teachers should be computer literates in order to blend with global ICT awareness.

3. Quality Material Resources

Science teaching in Nigeria has been faulted for many reasons one of which is the non-utilization of instructional resources by teachers, (Nwagbo, 2006). Modern science and technology teaching and learning however stress students participation in the learning process through activities both within and outside the classroom. The use of teaching aids/instructional materials within and outside the school will provide appropriate medium for interaction. These will provide students with concrete experiences which students need in order to have quality Science, Technology, Engineering and Mathematics Education (STEM) so as to serve as a change mechanism for sustainable development (Usman, 2012 and Olagundale, 2010).

D. Challenges of Stem Education

There are a lot of challenges facing STEM education in Nigeria and making it difficult for quality education that can serve as a change mechanism for sustainable development (Usman, 2011).

Some of the challenges are:

1. Funding
2. Teacher's challenges
3. Class size
4. Nature of the Curriculum
5. The Pedagogy
6. Politics and Policy and others

The greatest challenges perhaps facing education STEM education is inadequate funding by Federal, states and local governments, to the external that funding has been in response to conditionality imposed by International Financial Institutions (IFIs). Statistics show that the Federal, State and local government allocation to education generally has never reached the UNESCO recommendation of 26% of National, State or local government budgets.

Teacher's challenges

The competence of most STEM teachers in the subject content delivery is a matter of concern. Many unqualified teachers are still found in our schools. Many of those that qualified lack the appropriate content knowledge skills and attitudes for effective teaching so as the make STEM a quality change **mechanism** for sustainable development. The STEM teacher should first and foremost recognize that every normal class is a mixed ability class which should be treated as such by using variety of approaches for teaching STEM Education, Recognizing the individual differences among others, is the beginning of effective STEM teaching. Teachers are also poorly motivated as compare to other professions, compared to the job they do.

Class Size

The Nigeria population has grown to about 200 million. The growth of Nigerian population has influenced student population and class size. Most secondary schools within Abuja Federal Capital Territory (FCT) and Zaria metropolis in Kaduna state have a teacher-student ratio between 1:100 and 1:130 per class against a teacher-student ratio of 1:35 as recommended by UNESCO. Large class size does not allow free movement in the classroom resulting in ineffective classroom management and control. Also individual students are denied close classroom interaction and prompt attention from the teacher. Where students cannot get the attention they require for effective learning, they get frustrated and discouraged. All these contribute to low performance in Science, Technology, Engineering and Mathematics subjects. In addition, when there are large class sizes the weak students tend to hide under the cover of the brilliant ones. Therefore large class has been a challenge to quality STEM education as a change mechanism for sustainable development in Nigeria.

Nature of the Curriculum

Although the federal government advocates an entrepreneurial educational system where school leavers at all level can acquire appropriate knowledge and skills to enable them engage in gainful employment and even employ others. But the nature of our curriculum is still emphasis on education for 'white collar jobs'. These are due to problem of insufficient facilities, teachers' capability among others to properly implement the curriculum. Some educationist still belief that the Science, Technology, Engineering and Mathematics curricular are over loaded (Ajewole, 2007; Nwagbo, 2008; Usman, 2011).

The Pedagogy

The students were taught using didactic methods by teachers, resulting in memorization and regurgitation of facts. It has however come to light that he graduates from these schools tend to quickly forget all the context learnt, even when they passed, with good grades. They have further been found to be lacking in self-reliance skills and quickly degenerate into almost illiteracy (UNICEF, 2003). The teaching approach that is preferred is one that emphasizes context, in which a variety of interpretations of "context" is possible they include social, economic, environmental, technological and industrial applications of science. Learners in our STEM classroom ought to be afforded the opportunity to exercise that freedom in the process of learning STEM education. Teachers should make use of three

educational domains (Cognitive, Psychomotor and Affective) in teaching STEM education so as to make them to serve as change mechanism for sustainable development. Ability levels of Nigerian children like children of other societies are of mixed abilities and disabilities as well as level of normality and abnormality(such as slow learners). It is this case that many children especially the subnormal ones who enroll in our schools are unable to maximally benefit from the STEM education learning procedure. Whatever is the nature of mixing among the children either they are normal or abnormal, slow learners or fast learners, convergent or divergent, impulsive or reflective all of them deserve to acquire some basic scientific literacy in accordance with their potentialities for effective and efficient living. To effectively teach, STEM education to these children with special learning needs, the teacher would have to identify such children in the class in order to give them the peculiar attention which they deserve.

Politics and Policy

Politics and Policy are the other variables that affect quality Science, Technology, Engineering and Mathematics (STEM) Education as a change mechanism for sustainable development. Government policy is developed for various aspects of governmental organizations one of which is the National Policy on Education. The policy is meant for the purpose of developing and improving quality of education at all levels of institutions. Because of the constant political changes in the Country, the policy most of the times, were not implemented properly as expected. Also the policy changes from time to time without achieving the benefit of such policies. This has adverse effect on the quality of education given in Science, Technology, Engineering and Mathematics Education (STEM). These usually affect teachers' development and result orientation.

Conclusion and Recommendations

The discussion shows that mind-set/interest rather than skills is the major impediment on the side of students and teachers in improving the study of STEM related subjects. Student, Teacher and the Government related problems have been identified. Improving STEM education in Nigeria is a multi-faceted and complex issue. To this end the need to embrace a range of new approaches to teaching highly recommended. The relevant stakeholders such as teachers, students and parents should be consciously encouraged to partner and combine informative and persuasive force to tackle the challenges of STEM education such as facilities, interest and teaching methods.

The supervisory agencies such as Ministry of Education, Science and Technology, Teaching Service Board, State Universal Basic education Board, Education Resource Centre, etc should as a matter of urgency be proactive in supervision.

Science Teachers should learn to improvise teaching materials in situations where the authorities fail provide.

Regular training in form of workshops and seminars should be organized for Science Teachers should so that they can meet up with new challenges. Funds should be made available to sponsor teachers to local and international conferences. These would help them to rub minds together with counterparts in other parts of the world.

Science educational facilities (science and computer laboratories, workshops and libraries etc) should be upgraded to modern standards while teaching facilities should be adequately provided.

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