International Journal of Mechanical Engineering and Technology (IJMET)
Volume 10, Issue 12, December 2019, pp. 85-93, Article ID: IJMET_10_12_010
Available online at http://www.iaeme.com/ijmet/issues.asp?JType=IJMET&VType=10&IType=12
ISSN Print: 0976-6340 and ISSN Online: 0976-6359

TEACHING STEM EDUCATION IN NIGERIA: CHALLENGES AND RECOMMENDATIONS

Dr Kehdinga George Fomunyam
Mangosuthu University of Technology, South Africa

ABSTRACT

STEM is an acronym for science, technology, engineering and mathematics. Recently, attention has been placed on STEM as a result of the employment gap in STEM-field and the need to meet the demand of technological development of this present time. STEM was earlier known as SMET meaning science mathematic engineering and technology before it was later changed in the 1990s by the National Science Foundation to promote and create awareness the direction technological development is taking us has created a need to prepare, sensitize, motivate and promote the study of STEM. However, the fundamental questions remain; how we teach STEM, what are the challenges with STEM education and what possibilities do the future hold. This paper seeks to explore the answer to these questions and how best to make STEM education effective in Nigeria. The paper does this by first of all exploring the literature on STEM education in Nigeria, then proceed to look at the challenges facing sciences, technology, engineering and mathematics education in Nigeria. It further looks at the possibilities available and how STEM education and improve the general welling being of both the people and the society in which they live in. the paper concludes that STEM education is necessary for the growth and development of the nation and if Nigeria will remain the giant of Africa, then more emphasis must be placed on STEM education.

Keywords: STEM education, challenges, Nigeria, recommendations

Cite this Article: Dr Kehdinga George Fomunyam, Teaching STEM Education in Nigeria: Challenges and Recommendations. *International Journal of Mechanical Engineering and Technology* 10(12), 2019, pp. 85-93.
http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=10&IType=12

1. INTRODUCTION

The education system of Nigeria is divided into four stages; the kindergarten, the primary education, secondary education and the tertiary education which is overseen by the Ministry of Education with the Minister of Education at the hem of affair. Kindergarten in Nigeria is like a preliminary in preparation for primary education, here, they are taught how to read numbers and letters of the alphabet and it usually begins from age 1 to 3. Primary education begins from age 3 to 11. Here, they are taught how to write and spell with subjects like mathematics, English introduction to technology, basic science, arts after which they are required to take a common entrance examination which qualifies them to be admitted into any

federal government, state government, public or private school and they graduate that level with the title of their certificate bearing; first school leaving certificate. After graduation from primary school, students are admitted into secondary school where they spend 3 years in the junior secondary school and another 3 years in the senior secondary school. They graduate from this level with a WASCE certificate or a NECO certificate which can admit them into any higher institution of choice. Tertiary education in Nigeria consists of universities (public and private), polytechnics and college of education which offers variety of courses for students to choose from and STEM courses are no exception.

STEM education is vital for improved economic development manifested in international competitiveness and job creation (African American Institute, 2015; Williams, 2011). This might be attributable to the fact that it ensures a multidisciplinary approach to developmental issues pertinent to each economy. With various countries developing at different paces, some are far ahead when compared to others taking evidences in dichotomy between countries in the Global North and Global South. There are marked differences between the two, the former characterized by huge technological development which has resulted to improved economic outcome and the latter characterized by technological backwardness, poverty, poor economic conditions. Leveraging on STEM education has been a key driver of development in countries of the global north hence the disconnect between them and the global south. There is a vital need for STEM education in the 21st century because the job market requires a new set of skills and there is a need for intensification of efforts on technological skills (Voogt & Robin, 20102). Hence, the imperative of teaching STEM education in developing countries which Nigeria is a part of. STEM education is lagging in Africa. A report by African American institute (2015) revealed that in 2012, only 6% of the total secondary school enrolment were in technical vocational education and training (TVET) and trends in international mathematics and science (TIMS) and UNESCO global monitoring reports revealed that the performance of African students in mathematics and sciences has always been on a low compared to international standards (Hooker, 2017). Hence the poor nature of STEM education in Africa.

The teacher is important in a nation for economic development as no nation can rise without good caliber of teachers (FRN, 2004). This typifies that the pace at which a nation develops is dependent on the quality of teachers present there. In Nigeria, the responsibility of teachers is more extensive now than in the past and this might be as a result of the various challenges bedeviling the nation. There is therefore a need to explore teaching STEM education in Nigeria and to critically address this, this study will consider STEM education in Nigeria, its challenges and possibilities.

2. LITERATURE REVIEW

In Nigeria, there exists the public and private educational system but for the purpose of this study, much focus will be placed on the public education system in Nigeria. Before the colonial era, the educational pattern in Nigeria was rendered within the community by members who transferred special skills and abilities in various human endeavor. In various part of the country, children too after their father's craft and some were sent to other apprentices to learn certain vocation. This type of education was revealed to be comprehensive and it helped in developing social, physical, cultural intellectual abilities in children (Mkpa, 2012). Afterwards, Islamic education started before the missionaries came. Fafunwa (1974) opined that Islamic education was first accepted by a Kanem ruler named Umme Jilmi (1085-1097 and subsequently Dunama I and Dunama II in the 13th century. The missionaries brought Western education to Nigeria in the mid-19th century. The church missionary society and the Methodist missionary society were the notable British Christian organizations to set up schools in Nigeria (Nnamdi, 2002). At that time the missionaries in a

bid to convert Africans to adopt their religion and compel obedience, introduced western and the subsequent introduction of western education was to ensure ease of commerce, communication and transportation. The colonial education has a major aim which was to create a small group of technical and administrative function to encourage domination. Most parents were not educated and did not really see the need to motivate their children to get educated but with the establishment of church missionary society grammar school (CMS), the Roman Catholic missionary (RCM), African mission of south Baptist convention, the qua Ibo mission, the Wesleyan Methodist mission by the missionaries, led to the inclusion of arithmetic, algebra, geometry and physiology subjects in the school curriculum.

In Nigeria, there have been series of policies aimed at ensuring quality improvement in secondary education. According to Ogbonna (2010), the aim of the policy is to make government program specific as stated in the national laws. After the takeover of the educational system from the missionaries, government initiated the 7-5-2-3 (7 years of primary education, 5 years of secondary school, 2 years of higher school certificate and three years of university), 8 - 5 - 2 - 3 (8years of primary school, 5 years of secondary school, 2 years of higher school certificate and 3 years of university education), and 6-5-4 system involving 6 years of primary school, 5 years of secondary education and 4 years of university. The 6-3-3-4 system is composed of (6 year of primary school, 3 years of junior secondary school, 3 years of senior secondary school and 4 years of university education, and 9-3-4 UBE system which involves (9 years of universal compulsory schooling to be given as six years of primary education, 3 years of junior secondary education). At the termination of the compulsory nine years' education, all the students are required to write an external examination and graduate with Junior Secondary School Certificate and move forward to three years of senior secondary and 4 years of university education.

In Nigeria, the education sector is divided into the pre-school, primary, secondary, colleges and university (FGN, 2004). As time went on, the need to create a Post-Secondary institution arose which would help strengthen the student's academic knowledge. This marked the beginning of secondary school in Nigeria and the introduction of natural science in both primary and secondary school as a compulsory subject. From then onward, the first college of technology, Yaba College of Technology was established with courses like engineering, medicine, survey and agriculture. The first graduate from this college developed the science curriculum of the primary and secondary school. Again, the establishment of the College University of London paved the way for the creation of more universities and the introduction of courses like chemistry, biology and physics at higher level. Also, emphasis was made on laboratory work to meet the practical requirements of science subjects. College University of London was later changed to university of Ibadan and in 1962 was awarded the power to award degrees. With Nigeria's independence came the creation of National Policy on Education which was geared towards addressing the problems of educational relevance and the need to promote unity. The federal government created a policy whose aim was to embark on a universal free primary education programme which would provide free primary school education for children of age 6 to 12 and bursary/feeding program for students of higher learning. This will not just reduce illiteracy but also bridge the educational gap that existed in the country at that time. With the advent of a democratic system of government in 1999 came a reform of the education system of Nigeria and the establishment of more private polytechnics and universities. This changed the education system of Nigeria, students had more option on the course they wanted to study and the school they wanted to study in.

3. CHALLENGES OF TEACHING STEM EDUCATION IN NIGERIA

Nigerians were not keen on educating their children in science and technology until recently when they saw its job potentials and its relevance in the 21st century. This realization made parents clamour and agitate for education that will enable their children to become doctors, engineers, scientist, technologist (Ojebiyi & Sunday, 2014). The introduction of education policies and programs has helped increase the enrolment of students into various levels. With this development came some challenges which has dwindled the quality of the educational system, which has reported differing educational outcome for students (Onwuameze, 2013). The status of the Nigerian educational system at the moment is below par. It is low in quality and standard, not widespread in terms of reach and might not ensure the future we desire (Kolawole & Olusola, 2010). The import of education has been revealed before and it was noted that the pace at which a society develops is a function of its educational system (Thom-otuya & Inko-tariah, 2016). Since education is a propeller of development in any society, it follows that the society influences its education system and the education system inturn influences the happenings in the country. STEM education in Nigeria has faced many challenges

Enrolment into the different arms of science in our educational institutions is characterized by disproportionality (Akpan & Umoh, 2012). This might be attributed to the poor performance of students in the Senior Secondary Certificate Examination (SSCE). A cursory look at the educational practices in Nigeria today reveals that the average science teacher sees the learner as a container to pour knowledge into rather than the receiver of knowledge which dwindles the potential for self-directed learning. This makes students passive learners in the teaching learning curve. Another challenge of STEM education in Nigeria is a divide between the teachers' education programme and the educational curriculum of students which has consequently resulted in deficiencies and gaps in some graduate teachers. Ovute in Ovute & Ugwanyi (2011) reported that the current minimum standard at the College of Education level seems not adequate for the 9 years Basic education curriculum. Since teachers teach the way they were trained (Mgbono, 2013), poor teacher education programs produce poor teachers who in turn teach students poorly. Inadequate supply of teachers is also a major challenge facing STEM education in Nigeria and this is more grievous in the rural areas (Akinsola, Lawaf & Oyedokun, 2007). There is also inadequate teaching equipment's that will facilitate effective teaching and learning (Mgbono, 2013)

The explosive enrolment due to the UBE programme has resulted in overcrowded classrooms. STEM education offers lots of practical activities for students which will help them have a hands-on approach to issues. Okoke and Chinwe (2006), emphasized that all learning in STEM must start and end in the laboratory. The laboratory is essential as it is a place where problems are explored, and solutions are proffered. As a result of inadequate facilities, it has resulted to overcrowded condition of the classes coupled with the absence of laboratory support staff, teachers in majority of cases carry out practical's only two or three weeks to external examinations such as SSCE because they are challenged with the burden of teaching and also attending to laboratory work.

The lack of educational infrastructure and facilities in Nigeria is also a major challenge since most schools lack proper structures that are suitable for academic work and in most cases; the school environment is not conducive for learning, hence, making the students of such schools uninterested in their school work. This is rampant, especially in rural areas as well as in Northern part of Nigeria. In some cases, students do not have access to up-to-date libraries, laboratories, technical workshops and ICT equipment which are necessities for learning. These marginalized students are denied necessary resources that should be made

available to them thereby causing schools under such community to suffer lack of quality education.

Another challenge is imbalance in school curriculum. Curriculum according to Ross (2000) is a definition of what is to be learned or a particular course of study in one subject. Curriculum in the broadest sense, is 'the educative process as a whole' and in the narrowest sense it is 'synonymous with the syllabus', a scheme of work (Middlewood and Burton, 2001). The purpose of curriculum in schools is to bring about knowledge and to enhance this purpose, schools have to adopt a rich curriculum. In Nigeria, there is uniformity in the curriculum in the public schools whereas there are differences in the private schools (Ross, 2000).

Another challenge of teaching STEM education in Nigeria is the continuous gap between Nigeria students and their international peers. This gap between Nigerian students and their international peers is exemplified as developed countries like U.S.A subject graduate of our schools to fresh training and examination in an attempt to ensure fitness into their own educational system (Kolawole & Olusola, I2010)

Also, the lack of digitalization of Nigeria education is another challenge. Digitalization is a process of converting analogue materials into digital format. The national objective of education in the current dispensation of global technology is to ensure that Nigeria cues into the world of technological advancement (Oni, 2012) and most public schools are lacking in this regard. Most public schools in Nigeria have not upgraded to the use of technology. Most times, things like this happen because schools do not have sufficient facilities for all students. Also, ignorance and illiteracy on the part of the parents can make them decide to withhold such privileges from their children. The federal government has included ICT education in the National Policy on Education, but its application has been discouraging. In this technology driven age, everyone requires ICT competence to succeed (Oni, 2012) and this can only be achieved if students are introduced to such technology on time. Again, Nigerian government's reluctance towards the education sector is another challenge. Most government owned schools have no government funded scholarship program in place to motivate or encourage learners to study STEM subjects, even when these scholarships and programs are available, most students are not informed or aware of its existence or what they can do to get it, especially those in rural areas. Education brings enlightenment, development and freedom and a nation can only achieve these through education (Oni, 2012). For a nation to develop, the government needs to commit to the education of students especially in STEM since that is the direction the world is going.

Brain drain and gain is also one of the challenges Nigeria schools suffer in the teaching of STEM. Nigerian schools suffer brain drain to other developed countries like Canada, USA, Australia, and so on, especially in the science subjects, a lot of doctors, nurses, engineers and mathematicians have migrated from Nigeria to developed countries. These countries are enjoying and utilizing these immigrant's skills thereby leaving their home country lacking and in need. As Baldwin (1998) cited in Oni (2012) puts it countries in the developed world derive benefits from brains from developing countries. Brain drain threatens the very foundations of a country's higher education and science systems which is said to be the case in a number of developing countries (Oni, 2012). Nigeria is not an exemption; the challenge is that Nigeria government have not yet realized the damage of this phenomenon. Furthermore, incessant disruptions of academic programmes which is majorly specific to government owned schools (Kolawole & Olusola, 2010) has created low research productivity. Most strike action is as a result of lack of fund or the inability of the government to provide the allocated revenue meant for education. Most times, these strike actions are as a result of lecturers demanding salary increment or failure of the Nigerian Federal Government to pay

academic staff. Students also indulge in this action to advocate a better learning environment or decrease in school fees, which keep students out of class for weeks, months or even an academic session. This has made students loose time and created an imbalance in the academic session which might not be gotten back thereby making their peers in neighbouring universities ahead of them. Also, the misappropriation of funds by education officials has also contributed to the disruption of academic programmes.

It is no wonder Nigerians seem to have lost confidence in their teacher's ability to deliver quality education which is a determinant in deciding who can become a teacher, how long they should be trained and what their training should consist of. In an educational system like Nigeria's that needs both adequate number of teachers, teachers need to be well trained while some others need to be retrained to become more professional in their job. Training programmes for pre-service and in-service teachers is one major deciding quality of school education (Oni, 2012) which should be adopted.

Corruption in Nigeria education system is also a factor. Ministries and government agencies entrusted with overseeing the day to day affairs of the education industry in the form of procuring necessary equipment and teaching materials, construction of buildings, supply of teaching aid etc easily inflate vouchers and in most cases claim monies when nothing has been supplied or provided (Nwaokugha & Ezeugwu, 2017). his has in many ways crippled the educational system in general as this same corrupt practices have crept into the schools' governing bodies, thereby resulting to a stunted growth in the educational system nationwide. STEM education requires much financial input and situation where the finances have been mismanaged as a result of selfish interest by people, STEM education is affected.

Low salaries and lack of incentives for teachers is another challenge, teachers are not given proper compensation, incentives and reward to motivate them for example, if students under a particular teacher does well, the teacher should be rewarded, also, professional developmental workshop and seminars should be organized for teachers to keep them abreast with change in the education sector. The inadequacy and neglect of teachers has made it difficult for professional and quality teachers to be retained, as these teachers are not willing to stay since there is no job satisfaction; so we have promising teachers finding ways to breakthrough into other fields outside education where they can earn more and even get the reward and incentives they deserve. Teacher salary is imperative as a determinant of student's achievement because it has the propensity to improve teacher quality. If a teacher gets a suitable salary that covers the basic living costs, he may be able to live comfortably and thus be more effective as he is motivated to use his abilities, competencies and skills. Poor remuneration affects the morale of teachers, distracts and hinders their commitment and effectiveness.

4. RECOMMENDATIONS

Workshops, seminars and professional training exercise should be conducted regularly to help teachers update their knowledge content since the quality of teachers a nation possesses determines to a large extent the social, economic, political and technical development of the country (Oni, 2012). Again, the supply of teachers into the system is clearly inadequate especially in the rural area, one teacher is made to teach all subjects, this not only exhaust him or her but also makes him or her unable to give his best. Ingersoll (2002) confirms this when he argues that teachers in areas with high poverty rate are likely to leave school and the teaching profession. To ensure this doesn't happen workshops and training exercise needs to be provided to these teachers to ensure they remain resilient.

Educational levels in the 21st century remain low and disappointing due to neglect and disruption of the educational sector and as a result, the country has continued to maintain

bottom rank position (Obanya, 2002) especially in STEM subjects. Therefore, STEM practices and contents should be re-taught. Student curriculum must go beyond content knowledge which should include skills of the 21st century, like critical thinking, creative skill, analytic skills and so on, since these skills are at the centre of the fourth industrial revolution. Also, Curriculum should be taught with an integrated approach that will unite and harmonize each STEM subject and cut across stem disciplines, though science and mathematics are the most recognized fields in STEM education and most educators in these areas feel comfortable teaching them (White, 2014) yet, teachers of each STEM field should harmonized other STEM subjects into their curriculum when teaching then, the students can easily learn to do same. STEM education awareness especially in Nigeria is very low and so far not enough, school authority should build career awareness from primary school onwards by exposing the children to role models like professional scientists, engineers and technologists (Christine, at el (2015) who they can look up to and aspire to become. Also, information about STEM education and its benefits should be publicized and spread across various state government because, early introduction of STEM subjects to student can spark interest and motivate students to study STEM.

Parents and teachers in addition, have a big influence on student's orientation and interest in STEM. Teachers can help with hands-on-learning and teaching programs to attract the interest of students by making them more interested in what is being taught and parents can direct the students on the career path to follow by exposing them to STEM at an early age. Also, multimedia should be used as a tool for learning STEM, for example video games, audio games, movies, cartoons, social media etc. According to Li (2014) researchers in various STEM disciplines have pursued work from their own point of view. Now is the time to emphasize the need for a united front for STEM researchers to have a journal dedicated to STEM educational issues which will cuts across all discipline.

Salaries of teachers should be increased most STEM teachers have left the academic filed because of the low salary and lack of incentives and reward. Teachers of STEM should be adequately compensated and given incentives and rewarded to encourage and motivate them, also training programs should be organized for teachers periodically. Reward and award for excellence should be practiced to motivate students of STEM. Government should invest more in the education of its citizen by providing scholarships, facilities and funds that will aid the smooth educational process.

5. CONCLUSION

STEM education reframes the goals and interest of our society therefore, our aim not just as a nation but as individuals should be about how to bring about better education outcome in teaching STEM and how these outcomes can help us live better lives. Therefore, STEM Education is a necessity for growth and development in any country as well as her educational system. This is because the future of this country lies in the knowledge and practice of STEM. Therefore, all hands should be on deck to ensure that effective STEM Educational practices are taught to both STEM and non-STEM professionals. Again, government should encourage the Federal Ministry of Education to collaborate with International Agencies, like UNICEF, the World Bank to address educational concerns and challenges facing the study of STEM. Also, random checks should be carried out to ensure educational policies are implemented and adhered to nationwide. STEM education cannot be successful unless it is accompanied by ideological and cultural change within schools.

REFERENCES

[1] African American Institute. (2015). State of Education in Africa Report 2015. Retrieved from www.aaionline.org/wp-content/uploads/2015/09/AAI-SOE-report-2015-final.pdf

[2] Akinsola, A. T., Lawal, J., Oyedokun, M. R. (2007): The Quality of Human Resources for Teaching Science in Primary Schools in Nigeria. Implication for Sustainable National Development. STAN 50th Annual Conference Proceedings Pp. 15-18.

[3] Akpan, A. E., Umoh, S. W. (2012): Innovative Techniques in the Teaching and Learning of Science in Post-Primary School. National Journal of Science and Technology, 3 (1), pp 60-64.

[4] Baldwin 1998 cited in Oni, S. (2012). Revitalizing Nigerian Education in Digital Age. London: Trafford Publishing.

[5] Chesky Z. N & Wolfmeyer R. M (2015). Philosophy of STEM Education A Critical Investigation. New York: Palgrave.

[6] Chinwe, N. (2008): Science, Technology and Mathematics (STM) Curriculum Development: Focus on Problems and Prospects of Biology Curriculum Delivery. Proceedings of the 49th Annual Conference of STAN. Pp. 77-81.

[7] Christine, A. at el (2015) The Nigeria Child, Science and Technology Education, Current Challenges and Possible solutions in *International Journal of Education, learning and development*, 4(1), 68-76

[8] Clark V. J (2014) Closing the achievement gap from an international perspective transforming STEM for effective education. London: Springer.

[9] Federal Republic of Nigeria (2004). National Policy on education. Lagos. NERC press.

[10] Federal Republic of Nigeria (2010). Nigeria's National Policy on Education and University Curriculum in History: Implications for Nation Building. Lagos. NERC press.

[11] Hodson D. (2004). Time for action: science education for an alternative future. *International Journal of Science Education*. 25(6), 3-11.

[12] Hooker, M. (2017). *A Study on the Implementation of the Strengthening Innovation and Practice in Secondary Education Initiative for the preparation of Science, Technology, English and Mathematics (STEM) Teachers in Kenya to integrate Information and Communication Technology (ICT) in Teaching and Learning* (PhD Thesis). Belfast: Queen's University Belfast.

[13] Ifeoma, E. O. (2013). Inequalities in Nigerian Education Sector: Some Perspectives for Improvement in IOS. Journal of Research &Method in Education, 3(6), 7-15.

[14] Imam, H. (2012). Educational Policy in Nigeria from the Colonial Era to the Post-Independence period. In *Italian journal of Sociology of Education*, 1(1), 183-194.

[15] Ingersoll, R. M. (2002). The teacher shortage: A case of wrong diagnosis and wrong prescription. *NASSP Bulletin*, *86*(631), 16–31

[16] Kolawole, K &Olusola, I. (2010). Redressing the Growing concern of the education Sector *in Nigeria in Edo Journal of Counselling*, 3(1), 40- 45.

[17] Li, Y. (2014). International Journal of STEM education-a platform to promote STEM education and research worldwide. International journal of STEM education 1(1), 2-13.

[18] Mgbono, T. (2013): Empowerment of Science, Technology and Mathematics (STM) Teachers: A Strategy for the Realization of the Millennium Development Goals, Proceedings of the 54th Annual Conference of STAN, Pp. 69-73.

[19] Middlewood. D, Burton, N. (2001) Managing the Curriculum. London: Sage Publication.

[20] Nwaokugha, O. D & Ezeugwu, C. M (2017). Corruption in the Education Industry in Nigeria Implication for National Development in *European Journal of Training and Development Studies*, 3(2), 13-29.

[21] Ogbonna, N.O. (2010). Principle and Applications of Educational Policies in Nigeria. Enugu: University Trust Publishers.

[22] Ojebiyi, O. A, & Sunday, L. F. (2014). An Historical Survey of the Development of Science and Technology Education in *Nigeria. Academic Journal of Interdisciplinary Studies*, 3(6), 286-301.

[23] Okoke U. A., Chinwe, E. N. (2006): Analysis of Human Resource for STM Instruction in Awka Educational Zone, Anamabra State. Proceedings of the 47th Annual Conference of STAN. Pp. 58-61.

[24] Okoke U. A., Chinwe, E. N. (2006): Analysis of Human Resource for STM Instruction in Awka Educational Zone, Anamabra State. Proceedings of the 47th Annual Conference of STAN. Pp. 58-61.

[25] Oni, S. (2012). Revitalizing Nigerian Education in Digital Age. London: Trafford Publishing.

[26] Onwuameze. C. N. (2013). Educational Opportunity and Inequality in Nigeria: Assessing Social Background Gender and Regional effects. University of Iowa Institutional Repository.

[27] Ovute, 0. A. Ugwuanyi, C. S. (2011): Specialization within Specialization: The Case of Subject Combination in Junior Secondary Education (JSE) in Colleges of Education. Proceedings of 52nd Annual Conference of STAN. Pp. 48-53.

[28] Ozigi, A. &Ocho, L. (1981). *Education in Northern Nigeria*. London: George Allen and Unwin Publishers Ltd

[29] Ross Alister (2000) curriculum construction and critique. London: Falmer press.

[30] Rotherhham, J.A &Willingham, D. (2009). 21st century Skills: The Challenges ahead in Educational Leadership.

[31] Stigler J. &Hiebert. J (2004) Improving mathematics teaching. Educational leadership, 61(5). P. 15-26.

[32] Thom-otuya E. N. B, Inko-tariah. C. D. (2016). Quality Education for National Development: The Nigerian Experience. In *Afican Education Research Journal*.Vol. 4(3), 101

[33] Umoh, W. S. (2016) Problems and Prospcts of Effective Science, Technology, Engineering and Mathematics (STEM) Education Delivery in Nigeria. *Knowledge Review*, 35(1), 2-13.

[34] Voogt, J., & Roblin, N. P. (2012). A comparative analysis of international frameworks for 21st century competences: Implications for national curriculum policies. *Journal of Curriculum Studies*, *44*(3), 299–321.

[35] White W. D. 2014 What is stem education and why is it important? Florida association of teacher education journal, 1(1), 5-25.

[36] Williams, J. (2011). STEM education: Proceed with caution. *Design and Technology Education: An International Journal*, *16*(1), 34-40.