# STEM Education as a Catalyst for National Development: Problems and Prospects in Nigeria

Yaro Umar[1#]

[1]Department of Education, College of Vocational and Technical Education
Hassan Usman Katsina Polytechnic Katsina, Nigeria

[#]corresponding author <umaryaro20@gmail.com> , <yaroumar82@yahoo.com>

**Received** first draft 15 July, 2019. Received reports from first reviewer (23 September, 2019); Second and third reviewers (23 October, 2019 and 10 November, 2019). Received revised draft 21 December. **Accepted** to publish 22 December 2019.

## Abstract

*The development of any country depends largely on the considerable attention given to Science, Technology, Engineering and Mathematics (STEM) education. This is because rapid economic growth is achieved through utilisation of scientific research as well as application of STEM knowledge and skills in the real life situations. This article therefore, discusses STEM education in the light of Nigerian context, its vital role for promoting national development. The paper is guided by four objectives and research questions. Systematic review approach was adopted for the review of the literature relevant to the research questions raised on problems in educational system related to low enrolment and poor achievements in science subjects. From the analysis of various studies, it was found that teaching methods, workload, language, resource utilisation and poor teacher quality constitute major challenges which hinder effective STEM Education delivery in Nigeria. The paper concludes that it is necessary for stakeholders to rise up to the challenges faced in the 21st century in terms of STEM education delivery. Teachers trained with pedagogical approaches related to STEM education must be ready to create or provide situations where students can learn effectively and by themselves. Among the recommendations include resource utilisation should be ensured, laboratory assistants should be employed to assist teachers with large class size during practical, workshop and seminars should be organised periodically to upgrade teachers' knowledge possession and language should be simple for ease of understanding.*

***Keywords***: STEM education; National development; Problems; Prospects

## Introduction

### Background and Rationale

STEM is an abbreviation for Science, Technology, Engineering and Mathematics Education. STEM Education is instrumental for the development of any nation. Advancement in technology in today's world revolves around good STEM Education. The contribution of STEM to social, industrial and economic life of the world as well as Nigeria in particular have

been felt on all phases of human life (Ikeobi, 2010). It has become an energizing elixir and necessary substance that create spirit of economic, technological and sustainable development across Nigeria. The provision of good water supply, quality food and health care delivery, as well as various materials for construction in industries, roads, and automobiles are byproducts of STEM Education.

In actual sense, graduates from STEM education must to be equipped with sufficient skills that would make them self-dependent, prepare them to enter into job markets and progress well. STEM education should prepare individuals to be self-reliant in various occupations. The teaching of Science, Technology and Mathematics Education should therefore, be done practically, but in some countries it is theorized because teachers are not professionally competent coupled with paucity of materials, equipment to impart knowledge. Hence, students graduate without any hands-on skills and minds-on experience (Offorma, 2005).

In spite of the significant role STEM related subjects played to the development of the society, achievements of students in science subjects as measured by their scores in Senior Secondary School Certificate Examination (SSCE) as those implemented in Nigeria have been very poor. The current state of STEM Education in Nigeria should be a matter of priority and concern to all science teachers and stakeholders.

**Statement of the Problem**

In Nigeria today students' performance in STEM subjects have been a source of concern to stakeholders in the educational sector. Frightening figures has continued to resurface on yearly basis. For instance, the statistical data of West African Examinations Council (WAEC) in May/June 2015 showed that achievements in STEM subjects are less than 50% average (WAEC, 2015). Interestingly, over the years, effort has been on top gear by educational policy leaders working to strengthen STEM education throughout the states in Nigeria with no avail. It is hope that the aims of STEM education are to enhance the proficiency of students in STEM and add the number of students who pursue STEM careers in advanced levels. This is because economic growth and innovations are driven by STEM occupations.

Considering yearly budgetary allocation for education in Nigeria particularly Science Education, the country is still left behind in the critical area of development especially in Science and Technology. This ugly situation has surfaced due to the ineffective functioning of STEM education. Oriafo (2002) argued that STEM Education in Nigeria is grossly characterized by content inadequacy, poor teaching methodology by teachers, paucity of facilities, equipment and materials in our laboratories, as well as dominated socio-cultural lapses. These flaws have to be properly addressed for our STEM education to produce graduates with sufficient skills capable for self-reliant life activities.

The present level of massive unemployment in Nigeria has proven that STEM subjects being taught in schools do not prepare Nigerian graduates to function well in their respective places of work. Looking closely at our school system today depict that something is wrong in many ways. Enrolment into the different disciplines of science in our tertiary institutions is highly disproportionate (Akpan & Umoh, 2012). This may be due to the declining performance of students in the Senior Secondary Certificate Examination (SSCE).

An examination into the educational practices in Nigeria today reveals that the average science teacher sees the learner as a vessel for knowledge to be poured, thus relegating the potentials for self-directed learning to the background. In this approach, the emphasis is on understanding

and regurgitation of facts. This makes students mere on-lookers, learning about science and not learning science (Umoh, Akpan & Udongwo, 2013). Classroom activities are still characterized by the memorization of factual knowledge with the teacher as an informer and controller of the learning process (Akpan & Umoh, 2012). Learners are not provided the opportunity to express their understanding of concepts. This type of learning according to Ajewale (1997), is one of the major factors opposing effective Science teaching and learning in Nigeria.

Despite all the great things STEM Education and in particular Science education can be accomplished for the national development of a nation, there are still problems hindering its effective delivery especially in Nigeria. This paper therefore, focused on identifying the importance of STEM Education as an instrument for national development, its problems and prospects in Nigeria.

**Objectives of the Study**

The paper is guided by the following objectives:

1. To discuss the importance of STEM Education for national Development in Nigeria
2. To highlight the major challenges faced in militating against effective STEM Education Delivery in Nigeria.
3. To examine secondary data evidences on Science students' achievement in some sample states of Nigeria.
4. To suggest solutions through which the problems of STEM Education could be addressed for sustainable development.

**Research Questions**

The following Research Questions (RQs) are set in line with the abovementioned objectives:

1. To what extent is STEM education important for National development?
2. What are the major problems hindering effective STEM Education delivery in Nigeria?
3. What evidence can justify science achievements from secondary data analysis?
4. How could the problems of STEM education be addressed?

## Methodology and Implementation

**Research Design**

This paper employs systematic review method incorporating qualitative framework analysis approach that allows critical appraisal of research studies and synthesis of findings to be done qualitatively. The systematic review method also allows the researcher to formulate research questions that are narrow in scope and to effectively synthesize studies that directly related to the topic under consideration. The idea behind the use of this method was to provide summary of the current evidences relevant to the research questions formulated. The systematic review approach had considered Google Scholar indexed journals and articles that were from 2016 backwards. Therefore, secondary data available from Senior Secondary Certificate Examinations (SSCE) precisely WEAC/NECO (2009 through 2013 results) for Science achievements were analyzed in relation to the problem under consideration. Google scholar was used as a tool for searching and narrowing the topic based on quick access to it.

**Review on STEM Education as Framework of Practice and Implementation**

Science, Technology, Engineering and Mathematics (STEM) education is an integrated concept in which students critical thinking, analysis is embedded into a single approach called STEM Education with focus on real world problems. The goal is to nurture the development of skills as well as competencies for career and lifelong learning generally. Science,

Technology, Engineering and Mathematics (STEM) have been called a meta-discipline, i.e. the study of how something is studied (Sailus, 2019). STEM is also the creation of a discipline based on the integration of other disciplinary knowledge into a new whole. This interdisciplinary knowledge bridging among discrete disciplines is now treated as an entity known as STEM Education (Morrison, 2006). Thus, STEM education creates best opportunities for students to make sense of the world holistically, rather than understanding it in pieces. It should be noted, however, that STEM Education is an interdisciplinary approach to learning; where rigorous academic concepts are coupled with real world lessons as students apply STEM in the context that make connections among schools, community, work and the global enterprises enabling the development of STEM literacy as well as self-reliance skills, and with it, the ability to compete in the new economy (Tsupros & Hallinen, 2009).

## Data Analysis

This section elaborates on the analysis of data from systematic review on related literature selected past few years in response to Research Question (RQ) 1 to RQ4.

The following Table 1 summarizes the research framework emphasizing STEM education with analysis from systematic review reflecting on the objectives and focus with discussions in the subsequent sections.

Table 1
*Literature Reviewed Reflecting on the objectives and Focus of this Study*

| RQ | Focus | Literature Reviewed |
|---|---|---|
| RQ1 | Importance of STEM Education to National Development | ● Digital Economy by Tsupros and Hallinen (2009)<br>● Employment Potential by Ben, John and Audrey (2011)<br>● Employment Security by Ross, Armen, Kevin and Candice (2010) |
| RQ2 | Issues and Challenges associated with teaching and learning of STEM Education | ● Class size by UNESCO (2009)<br>● Teacher as a factor by Aina (2010)<br>● Teaching method by Akpoghol (2016)<br>● Language factor by Atadoga (2001)<br>● Resource Utilization by Okonkwo (2009)<br>● Workload by Atadoga (2001) |
| RQ3 | Evidence to justify science Achievements from Secondary Data Analysis. | ● Enrolment and Performance in science subjects WAEC 2005-2009<br>● WAEC Results 2009-2013<br>● NECO Result 2009-2013 |
| RQ4 | Addressing problems of STEM Education with prospective delivery. | ● Science equipment center by SEDI-M<br>● Innovative practice in science education by (David, 2018)<br>● Unified syllabus by (Adeneye & Oludola, 2013)<br>● Using local language in teaching science by The Guardian Newspapers (2017). |

**Importance of STEM Education to National Development (RQ1)**

After framework analysis was done of the literature reviewed, three main factors were identified contributing to the importance of STEM education to national development as elaborated below.

**Digital Economy.** Digital economy is basically characterized by advanced digital computing technologies which permits free flow of information world over. It is new internet technology that is supporting web platforms and play a significant role in promoting globalization which has been brought by the current era of technology. Three main components of digital economy has been identified below (Tsupros & Hallinen, 2009).

- Supporting infrastructure (i.e. hardware, software, telecommunications, networks, etc.)
- E-business promotion (i.e. how business is conducted, any process that an organization conducts over computer-mediated networks),
- E-commerce innovation (i.e. transfer of goods, for example when a book is sold online). Every digital economy is powered by skills embedded in STEM developmental culture.

**Employment Potentials.** The growth of a country's economy is measured through increase in the per capita income of its people and the only way by which this can be enhanced is when graduates from both secondary schools and tertiary levels are equipped with knowledge and skills from STEM Education. Ben, John and Audrey (2011) opined that employment opportunities created by STEM occupations attract handsome pay than non-STEM employments. Globally, it has been recognized that national capacity building and economic prosperity are attained when there are increase in number of students studying STEM subjects in both secondary schools and postgraduate levels. According to Langdon, McKittrick, Beede, Khan, and Doms (2011), at different levels of educational attainment, STEM workers wage seems more attractive when compared with non-STEM workers.

**Employment Security.** Nigeria is blessed with human resources that are grossly characterized with potentials in STEM skills but not harnessed to the optimal level. Across the world, STEM occupations account significantly a greater percent of the employment opportunities. These types of opportunities are growing much faster than other jobs with high sense of job security. This however, show that the demand for workers with STEM knowledge are in short supply. Over the past decade, STEM jobs grew three times faster than non-STEM jobs particularly in Nigeria. Ross, et al. (2010) explained that a rich innovation pipeline plays a pivotal role in a nation's industrial development, commercialization, competitiveness, and ability to sustain long-term growth. Therefore, the STEM workforce is a powerful component of this innovation pipeline. Employment security is evidenced in STEM career fields as the workers contribute meaningfully to the economic development of any nation.

With advanced technologies like big data analytics, Internet of Things (IoT), Augmented Reality (AR) and other disruptive technologies, STEM workers will be in high demand in these areas.

**Issues and challenges associated with teaching and learning of STEM Education (RQ2)**

The analysis from systematic review revealed that there were many factors hindering effective teaching and learning of STEM education. These factors are summarized using framework analysis and are discussed under four main sub-section with the understanding that the same is applied to teaching and learning generally.

**Class Size factor.** The population of Nigeria has grown to over 200 million. This growth in population has brought increase in students' population and class size. Secondary

schools within Abuja Federal capital territory and in some state across the federation are having a teacher- student ratio between 1:100 and 1:30 per class against a teacher-student ratio of 1:35 as recommended by UNESCO (2009).

This condition results to poor classroom management and control. Individual students are also not enjoying group work, group discussion and prompt attention from the teacher. When students lack attention from their teacher, no effective learning could take place, they get bored and discouraged with no motivation to learn. All these factors contribute to low performance in Science, Technology, Engineering and Mathematics (STEM) subjects. In addition, it is quite common that when there are large class sizes, the weaker students receive little or no attention from the teachers. Only brilliants ones are recognized.

**Teacher as a factor.** Qualified teachers are instrumental to effective teaching of science subjects. But there are evidence of paucity of science teachers in Nigerian schools. The so-called science teachers are not professionally qualified. The content knowledge of the subject matter is there but lack skills in the use of different classroom practices and pedagogies (Aina, 2010). The systematic review on the studies of challenges and prospects of primary science teaching affirmed that there are unqualified science teachers of the schools in Nigeria. Teachers' attitudes towards effective teaching are discouraging; they have been teaching for many years without using modern technology and advancing their knowledge via in-service training. This affects their output and it is a problem to the development of science education. Science teachers should use different strategies as there is no single universal approach for specific class. A lot of teachers teaching science subjects are still used to adopting methods of being stationed in one place with chalk and talk which is not appropriate for science teaching in this modern time. Poor application of modern strategies in the teaching of science slow student performance and in the long run influencing student's enrolment.

**Teaching method as a factor.** Students' achievement in the process of learning is largely affected by the method employed by the teacher. Researchers such as Akpoghol (2016) and Adzape (2015) observed that poor performance of students is attributed to teachers' inability to use necessary techniques in teaching science subjects. Their studies revealed that the teaching and learning of science is too teacher-centred and the teacher dominates in explanation of concepts, thereby making students passive. The studies also observed that the teachers mainly introduce topics to students on the chalkboard and allow them to copy. They also observed that there is inability of teachers to use new teaching strategies as well as students' ideas in planning their classroom experiments. Students rarely performed experiments on their own, and they also did not use the library or sources other than the textbooks. Therefore, the teaching and learning of science is mainly through the traditional approach rather than incorporating science process skills.

**Language factor**. Language is a key factor to effective instruction. It is used as a medium through which knowledge is passed onto the students. It is also an important tool for good communication both verbal and nonverbal. For effective teaching and learning to take place, there must be proper communication between the teacher and the students. STEM subjects are taught and learnt through the English language as a medium of instruction in Nigerian schools. For better teaching and learning both the teacher and the students must be able to express themselves in English language for better content delivery and improved performance. Mathematics is another language of physics and chemistry which is expressed in symbols and equations. Therefore those who are poor in mathematics may not be able to handle calculations in physics and chemistry which are mathematical in nature. Researchers observed that the problems of language in science subjects run across all levels of education (Atadoga, 2001). It is no longer surprising to find students even at tertiary level who are unable to express themselves in English language.

**Resource Utilization.** Resources are those facilities/materials that are used to enhance effective instructions in STEM subjects, Proper utilization of resources contributes significantly towards improving students' performance in STEM subjects. Educational training is only possible if directly or indirectly supported by facilities in order to enhance acquisition of knowledge, competence, skill and technical know-how (Okonkwo, 2009). However, most teachings in science subjects are done without instructional materials. Most secondary schools lack basic laboratory apparatus, such as magnetic boards, resonance kits, iron filling, bar magnetic, projectors and accumulators. The science laboratories across the country are inadequately furnished, where they exist (Okonkwo, 2009).

Hence, electricity as a topic for example, may not be adequately covered so external examination questions set in this area and other related areas might be difficult for the students to answer. Most secondary schools in Nigeria have no laboratory personnel to assist in the process of teaching and learning of science. Hence, when these personnels are not available, the work of the science teacher is doubled and highly demanding so the teaching and learning of any science subject may be hindered (Ezeudu, 2013).

**Workload factor.** Qualified STEM teachers in our schools at all levels of Nigeria's educational system are grossly inadequate. (Atadoga, 2001). As pointed out earlier, the ratio of STEM teachers to students across the country is 1:130 average. This is too big for effective classroom communication and learning to take place. Most teachers have between 12 to 15 teaching hours per week. Where the teachers have to run at least one practical class per week, this will be too much to handle, especially since they have to also mark the students' practical notes.

**Evidences to Justify Science Achievements from Secondary Data Analysis (RQ3)**

Despite the significant role Science subjects played towards economic growth, performance of students in the subjects have been very discouraging and this poor achievement of students in STEM subjects has continued to be a major source of concern to all science teachers and other stakeholders (Akpoghol, Samba & Asemave, 2013). This situation point to the fact that most students are not meeting the minimum entry requirement into Nigerian tertiary institutions especially those who wish to study science courses must have credit passes at Biology, Chemistry, Physics and Mathematics as core science subjects.

Interestingly, in these courses that are significant, students' performance has not been encouraging and this worrisome situation called for investigation. The following Table 2 shows the students' enrolment and performance in WAEC in the three subjects that make up Science Education from 2005-2009.

Table 2

*Enrolment and Performance of Students in Science Subjects in WAEC from 2005-2009*

| Year | Biology | | Chemistry | | Physics | |
|---|---|---|---|---|---|---|
| | Total entry | % pass at grade $A_1$-$C_6$ | Total entry | % pass at grade $A_1$-$C_6$ | Total entry | % pass at grade $A_1$-$C_6$ |
| 2005 | 1,051,557 | 35.74 | 349,936 | 50.94 | 344,411 | 41.50 |
| 2006 | 1,082,556 | 35.61 | 352,452 | 50.95 | 345,225 | 43.84 |
| 2007 | 1,072,602 | 33.57 | 432,230 | 45.96 | 427,398 | 58.05 |
| 2008 | 1,285,048 | 33.94 | 428,513 | 44.44 | 424,893 | 48,26 |
| 2009 | 1,903552 | 33.87 | 442,091 | 45,97 | 429,174 | 43.56 |

Source: WAEC Office Yaba Lagos, Nigeria (WAEC, 2010)

The above table revealed that the percentage pass in Biology from the period under consideration was not encouraging compared to chemistry and physics despite increase in

enrolment. The trend show slight decrease in performance in biology. The decrease in performance in all the three subjects was attributed to class size, language factor and to some extent poor teaching methods.

In some states indices from examinations organised by WAEC and NECO showed both low enrolment and poor achievement in Chemistry. The analysis of Chemistry results of the May/June West African Senior School Certificate Examination (WASSCE) and June/July National Examinations Council Senior School Certificate Examination (NECO/SSCE) from 2009 to 2013 reveals a low percentage pass at credit level (Refer Table 3 below).

Table 3
*WASSC Results of Students in STEM Subjects in Public Schools from a Sampled State from 2009 to 2013*

| Year | Subject | Number of students sat for the exam | No. with credit pass | % with credit pass | No. with ordinary pass | % with ordinary pass | No. failed | % failed |
|---|---|---|---|---|---|---|---|---|
| 2009 | Math | 1260 | 3183 | 25.3 | 7923 | 63.1 | 1454 | 11.6 |
| | Chemistry | 2588 | 1133 | 43.8 | 1066 | 41.2 | 389 | 15.0 |
| | Physics | 2753 | 1116 | 40.5 | 1180 | 42.9 | 457 | 16.6 |
| | Biology | 1221 | 7088 | 58.5 | 3389 | 28.0 | 1644 | 13.6 |
| 2010 | Math | 17518 | 4331 | 24.7 | 11209 | 64.0 | 1978 | 11.3 |
| | Chemistry | 4040 | 1790 | 44.3 | 1789 | 44.3 | 461 | 11.4 |
| | Physics | 4104 | 1708 | 41.6 | 1964 | 47.9 | 432 | 10.5 |
| | Biology | 17450 | 9686 | 55.5 | 5516 | 31.6 | 2248 | 12.9 |
| 2011 | Math | 15793 | 5200 | 32.9 | 9780 | 61.9 | 813 | 5.1 |
| | Chemistry | 3966 | 1384 | 34.9 | 2422 | 61.1 | 160 | 4.0 |
| | Physics | 3909 | 1231 | 31.5 | 2557 | 65.4 | 121 | 3.1 |
| | Biology | 15580 | 6315 | 40.5 | 8635 | 55.4 | 630 | 4.0 |
| 2012 | Math | 15728 | 8321 | 52.9 | 6646 | 42.3 | 761 | 4.8 |
| | Chemistry | 4009 | 2152 | 53.7 | 1755 | 43.8 | 102 | 2.5 |
| | Physics | 3943 | 2122 | 53.8 | 1723 | 43.7 | 98 | 2.5 |
| | Biology | 15430 | 8777 | 56.9 | 5766 | 37.4 | 887 | 5.7 |
| 2013 | Math | 16565 | 9168 | 55.3 | 6636 | 40.1 | 761 | 4.6 |
| | Chemistry | 4518 | 2281 | 50.5 | 2135 | 47.3 | 102 | 2.3 |
| | Physics | 3709 | 1819 | 49.0 | 1792 | 48.3 | 98 | 2.6 |
| | Biology | 16242 | 9334 | 57.5 | 6021 | 37.1 | 887 | 5.5 |

Source: Ministry of Education (2014)

The table above shows the percentage of students with credit pass across four science subjects. The percentage pass varies across the years under consideration. The rate of failure between 2009 through 2010 was very high compared to 2011 through 2013 (Table 4). These low performances always create vacuum in our tertiary institutions for science related courses. Most institutions are not getting the required number of students' intake due to the low performances in science related subjects. These problems are to a greater extent brought by poor teaching facilities, poor instructional process and mostly language factor.

Table 4
*NECO Results of Students in STEM Subjects in Public Schools from a Sampled State 2009 to 2013*

| Year | Subject | Number of Students sat for exam | No. with credit pass | % with credit pass | No. with ordinary pass | % with ordinary pass | No. failed | % failed |
|---|---|---|---|---|---|---|---|---|
| 2009 | Math | 18872 | 8612 | 45.6 | 7369 | 39.2 | 2864 | 15.2 |
| | Chemistry | 4257 | 1867 | 43.9 | 1555 | 36.5 | 835 | 19.6 |
| | Physics | 3934 | 2070 | 52.6 | 1145 | 29.1 | 719 | 18.3 |
| | Biology | 18080 | 5963 | 33.0 | 6956 | 38.5 | 5161 | 28.5 |
| 2010 | Math | 17799 | 7829 | 44.0 | 7497 | 42.1 | 2473 | 13.9 |
| | Chemistry | 3813 | 2441 | 64.0 | 1364 | 35.8 | 8 | 0.2 |
| | Physics | 3637 | 2004 | 55.1 | 1688 | 46.4 | 5 | 0.1 |
| | Biology | 14882 | 9151 | 61.5 | 5650 | 38.0 | 81 | 0.5 |
| 2011 | Math | 19765 | 8911 | 45.1 | 8711 | 44.1 | 2143 | 10.8 |
| | Chemistry | 4900 | 2507 | 51.2 | 1733 | 35.4 | 660 | 13.5 |
| | Physics | 4662 | 2785 | 59.7 | 1383 | 29.7 | 494 | 10.6 |
| | Biology | 18018 | 6960 | 38.6 | 7383 | 41.0 | 3675 | 20.4 |
| 2012 | Math | 21285 | 10532 | 49.5 | 8526 | 40.1 | 2227 | 10.5 |
| | Chemistry | 5268 | 2203 | 41.8 | 2261 | 42.9 | 804 | 15.3 |
| | Physics | 5223 | 3583 | 68.6 | 1360 | 26.0 | 280 | 5.4 |
| | Biology | 19537 | 8293 | 42.4 | 7293 | 37.3 | 3951 | 20.2 |
| 2013 | Math | 22278 | 11216 | 50.3 | 8835 | 39.7 | 2227 | 10.0 |
| | Chemistry | 5389 | 2379 | 44.1 | 2206 | 40.9 | 804 | 14.9 |
| | Physics | 5396 | 3676 | 68.1 | 1440 | 26.7 | 280 | 5.2 |
| | Biology | 19527 | 8247 | 42.2 | 7329 | 37.5 | 3951 | 20.2 |

Source: Ministry of Education (2014)

The above table shows the percentage of credit pass and percentage of failures across the four science subjects. The percentage of failures varied across years with no significant changes in mathematics. In biology also the percentage failed across the years signifies the fact that there was a problem with the methods of teaching, facilities and other related factors.

The analysis of studies by WASSCE and NECO/SSCE covering these periods 2009-2013 revealed low achievement in STEM subjects. This was probably due to the factors that either the teachers were not teaching the subject properly or the students did not understand the subjects. It is pertinent to know that underachievement in sciences is the reason why there is greater number of student seeking admission in non-science courses. STEM study is a principal change agent in the 21st century, it is therefore an issue of concern which must be addressed in order to improve learning and performance.

**Addressing Problems of STEM Education with Prospective Delivery (RQ4)**

Although the problems enumerated seem enormous, there is still hope for the future as regards to adequate STEM education delivery in Nigeria. The curriculum guidelines are adequate and the policy on education is clear on what is expected for national development through STEM education (Chinwe, 2008).

The efforts on ground for improvement are encouraging. The following are identified from systematic review of literature as suggestions to improve as potential efforts for a better tomorrow:

1. The establishment of more universities and colleges of education with specifications for minimum academic standards would solve the problem of both professional teachers supply

and quality of instruction. With enough teachers, large class size would probably be more effectively handled.

2. The science equipment centres that were already established in some parts of the country e.g. Scientific Equipment Development center (SEDI-M), Minna would provide enough school science laboratories apparatus for physics, Chemistry and Biology for effective delivery of instructions.
3. Research result on the effects of innovative practices in science education and better ways of improving our curricula delivery would equip teachers to better fulfill their roles in their lessons so as to enhance students' active participation for improved academic performance (David, 2018).
4. There is a movement towards a unified syllabus in each STEM subject at the Secondary School level and a national guideline at the primary level (Adeneye, & Oludoala, 2013).
5. The federal government of Nigeria has announced plans to teach science subjects in local languages. This is because teaching our children in foreign languages would create a serious challenge, especially when they had become familiar with the indigenous languages while living with their parents (The Guardian Newspaper, 2017).

## Conclusion

### Summary and Implications

This paper examined STEM education as an instrument for national development and some problems that hinders its effective delivery in Nigeria. These factors militating against proper implementation of STEM education in Nigeria are quite enormous. But that does not in any way mask its laudable objectives. Research findings have revealed that a few number of areas of improvement for the attainment of our STEM objectives. These include innovative teaching style, establishment of more universities and technical colleges, as well as science equipment centres, uniformity of syllabus, among others. Having reviewed some of the common challenges in vague on STEM Education that include large class size, resource utilization, language factor, workload, teaching method and poor teacher quality among others, with consideration of the prospects of STEM education, it becomes necessary for stakeholders to rise up to the challenges faced in the 21st century in terms of STEM education delivery. STEM teachers must be ready to create or provide situations where students can learn effectively and by themselves. In short, in order to boast economic activities, revive industries and reduce menace of unemployment which will translate to economic stability and national development, STEM education should be given priority and required attention it deserves.

### Recommendations for the Way Forward

In order to make further progress in STEM Education in Nigeria, the following recommendations were proffered:

1. Parents, teachers, students and other stakeholders should work as partners and join hands to address the challenges of STEM Education in terms of equipment's, facilities and teaching pedagogy.
2. Workshops and seminars should be periodically organised for science teachers so as to update them with new modalities of teaching to cope with the challenges of 21st century.

3. Science teachers should be sponsored to both local and international conferences in order to share ideas with their counterparts in some parts of the world. This can be achieved by providing funds available to teachers.
4. Modern teaching facilities and equipment should be made readily available and Science laboratories, workshops and libraries should be upgraded to modern standard.
5. Science teachers should imbibe the skills of improvisation so as to locally source teaching materials in situations where the authorities fail to provide.
6. Science subjects should be taught only by teachers who are professional in our secondary schools and discourage those who are not qualified to teach.
7. Government should see the need to employ qualified laboratory/technologist to support STEM teachers to cope with the enormous demand for effective laboratory activities involving large class size.
8. There is a need to ensure that proper utilization of materials should be put in place

## References

Adeneye O, A., & Oludola S, S. (2013). Recent curriculum reforms in primary and secondary Schools in Nigeria in the new millennium. *Journal of Education and practice*, *4*(5), 98-107.

Adzape, J. N. (2015). *Effect of chemistry-Based puzzles on senior secondary school chemistry students' achievement, retention and interest in chemical periodicity* (Unpublished PhD Dissertation). Department of Science Education University of Nigeria, Nsukka.

Aina, J. K. (2010). Challenges and prospects of primary science teaching in Nigeria. *Continental J. Education Research, 5*(2), 32-37

Ajewale, G. A. (1997). Innovation in Biology: Adopting Innovations Strategies for improving the teaching/learning of Biology. 4tii Anniversary of Science Teachers Association of Nigeria. *Proceedings of A. J. JUMOGOBIA STAN Conference* (pp. 135-136).

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), 60-64.

Akpoghol, T. V. (2016). *Effects of lecture method supplemented and computer animations on senior secondary school chemistry students' academic achievement and retention* (Unpublished Ph.D. Dissertation). Department of Science Education, University of Nigeria, Nsukka.

Akpoghol, T., Samba, R. M. O., & Asemave, K. (2013). Effect of problems solving strategy on students' Achievement and retention in secondary school chemistry in Makurdi metropolis. *Research Journal in Curriculum & Teaching, I*(1), 529-537.

Atadoga, M. M. (2001). *A study of the strategies used by senior secondary school students to solve physics and their effects in academic achievement.* (Unpublished PhD Dissertation). Department of Education, Ahmadu Bello University, Zaria.

Ben, C., John, I. J., & Audrey, W. (2011). Science, technology, engineering, and mathematics (STEM) occupations: A visual essay. *Monthly Labour Review*. U.S Department of Labour. Retrieved December 24th, 2018, from http://www.bls.gov/opub/mlr/2011/05/art1full.pdf.

Chinwe, N. (2008). Science, Technology and Mathematics (STM) Curriculum Development:

David, A. (2018). Innovative practice in science education: A panacea for improving secondary school students' academic performance in science subjects in Nigeria. *Global Journal of Educational Research, 14*(19) 23-30.

Ezeudu, F. O. (2013). Influence of concept maps on students' achievement and retention of senior secondary school students in Organic Chemistry. *Journal of Education and Practice, IISTE, 4*(19), 35-43.

Focus on Problems and Prospects of Biology Curriculum Delivery. *Proceedings of the 49th Annual Conference of STAN* (pp. 77-81).

Ikeobi, I. O. (2010). *Beyond the stereotype: Thoughts and reflections on education*. Yaba: the CIBN Press Limited.

Langdon, D, McKittrick, G., Beede, D., Khan, B., & Doms, M. (2011). STEM: Good jobs now and for the future. U.S. Department of Commerce, Economics and Statistics Administration. Retrieved on March 19, 2013, from www.esa.doc.gov/sites/default/files/reports/documents/stemfinalyjuly14_1.pdf

Ministry of Education. (2014). *Summary of science subjects result in waec/neco* (2009-2013). Benue, Nigeria: MOE.

Morrison, J. (2006). *Ties STM education monograph series: Attributes of science, technology and mathematics education*. U.K.: Wadsworth Publishing Company Belmont.

Offorma, G. C. (2005). *Curriculum for wealth Creation*. Paper Presented at the Seminar of the World Council for Curriculum and instruction held at Kano, Oct, 25.

Okonkwo, I. G. A. (2009). *Effects of concept mapping and simulation game on students' achievement and interest in environmental concepts in chemistry* (Unpublished doctoral dissertation). University of Nigeria, Nsukka.

Oriafo, S. O. (2002). Refocusing science, technology and mathematics (STM) education in Nigeria: A book of Readings. Agbor: Kmensuo Educational Publishers.

Ross C. D., Armen, B., Kevin K., & Candice, F. (October, 2010). Best-performing cities 2010: where America's jobs are created and sustained. The Milken Institute. Retrieved November 10th, 2018, from http://www.milkeninstitute.org/pdf/bpc2010.pdf.

Sailus, C. (2019). *Meta-disciplines: Traditionalists, revisionism, and post-revisionists*. Retrieved November 10, 2019, from https://study.com/academy/lesson/meta-disciplines-traditionalists-revisionism-and-post-revisionists.html

The Guardian Newspaper. (23rd February, 2017). Teaching Sciences in local languages. Lagos-Nigeria. *Guardian Newspapers limited*.

Tsupros, N. R., & Hallinen, J. (2009). *STM education*: A project to identify the missing icon. Kmensuo Educational Publishers.

Umoh, S. W., Akpan, A. E., & Udongwo, A. M. (2013). Human resource development for effective STEM education: A pre-requisite for sustainable development in Africa. *Academic Discourse: An International Journal, 5(1),* 195-200.

UNESCO. (2009). *UNESCO Institute of Statistics*. Paris: UNESCO Press.

WAEC. (2015). Result May/June. Retrieved December 24th, 2018 from http://nigerianuniversityscholarships.com/full-statistics-of-performance-in-waecresult-may/june-2015-share-this/

WAEC. (2010) *Chief Examiners' Report.* Lagos Office, Nigeria.