IMPROVING SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS(STEM) TEACHING PRACTICE (TP): CHALLENGES AND PROSPECTS

[1]Abdullahi Ibrahim Barau; [2]Mohammed Bala Kanko & [3]Mu'azu Nasir Kontagora
Corresponding E-mail: *ibrahimbarauabdul@gmail.com*

[1]Department of Physics, Niger state College of Education Minna
[2]Department of Biology, Shehu Shagari College of Education Sokoto
[3]Department of Integrated Science, Niger state College of Education Minna

Abstract

This study reviews the challenges of Science, Technology, Engineering and Mathematics (STEM) Teaching Practice (TP) at NCE level. The study was guided by the following researchquestion: what is the reason(s) responsible for lack of interest by students for teaching STEMrelated subjects during Teaching Practice (TP). The study employed a survey methodology; asample of which include students randomly drawn from Niger State College of Education Minna. The result shows that mindset rather than skills is the major impediment on the side ofstudents in teaching STEM related subject. The main conclusion is that, improving STEM education 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 i.e. lecturers, 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 Nigeriaas a whole in enhancing economic development.

Keywords: Economic development, Mindset, STEM TP, National development; Problems, Prospects

1.0 Introduction

1.1 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 technologyin today's world revolves around good STEM Education. The contribution of STEM to social, industrial and economic development human life. (Ikeobi, 2010). Its nations including Nigeria has imparted. The provision of good water supply, quality food and health care delivery, as well as various materials for construction in industries, roads, and automobiles arebyproducts of STEM Education.

Teaching today is an invaluable asset to the society. Teaching is a process through which a teacher applies his/her knowledge of the learners, subject matter and methodology to

help an individual learn. According to Aina (2010), teaching is the use of educational knowledge, methods and space to educate whoever desires to be educated. It is a complex variety of mutual activities undertaken by both of them (the teacher and the learner) in order to promote learning.

According to Chinwe (2018) the professional education of teachers cannot be validated without adequate preparation of prospective teachers for dynamic roles in today schools through practice. The practical phase of teacher preparation commonly referred to as teaching practice isa crucial aspect of teacher preparatory programme in teacher training institutions in general suchas school of education in colleges of education and faculties of education in Nigerian Universities.

During this period, the student teacher may be faced with some challenges which include classroom management, attitude of the supervisors towards the student teachers, curriculum development, instruction and environmental challenges.

Supervisor is described as college representative (trained teacher) who is responsible for coordinating the student teachers while teaching. He is also seen as somebody who guides andcoordinates the activities of teachers and other school personnel towards the realization of educational objectives. He mediates between people and school programmes in order to ensurethat the processes of teaching and learning are improved (David, 2018).

Statement of the Problem

The fallen standard of education in Nigeria has reached an alarming stage yet education is thebedrock of development. Akpoghol (2016) opined that the future of any nation depends on thequality of her teachers. The National Policy on Education (2004) stated that no educational system can rise above the level of its teaching staff. This shows the role of the teachers and theteacher education programmes in national development. With the introduction of the Universal Basic Education, (UBE) in 1976, only well trained teachers can successfully translate the objective of UBE to reality.

Doesn't STEM have aim? That the aim of STEM Education is enhance the proficiency of students in STEM and increase 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 Scienceand Technology. This ugly situation has surfaced due to the ineffective functioning of STEM education. Oriafo (2012) argued that STEM Education in Nigeria is grossly characterizedby content inadequacy, poor teaching methodology by teachers, paucity of facilities, equipmentand materials in our laboratories, as well as dominated socio-cultural lapses. These flaws have tobe properly addressed for our STEM education to produce graduates with sufficient skills for self-reliant life activities.

The inability to fully realize the objectives of teaching practice or the inability of student teachersto perform to expectation can be attributed to certain challenges or inadequacies of the STEM Education. The challenges that face student teachers during teaching practice is what necessitates the need for the study and hence the problem of the study.

Objectives of the Study

The paper is guided by the following objectives:

i. to discuss the importance of STEM Teaching practice
ii. to highlight the major challenges militating effective STEM teaching practice.
iii. to examine secondary data evidences on STEM students' achievement in Niger State College of Education Minna,
iv. to suggest solutions through which the problems of STEM Teaching Practice could beaddressed for sustainable development.

1.1 Research Questions

The following Research Questions (RQs) were set in line with the above-mentioned objectives:

1. to what extent is STEM Teaching Practice (TP) important for National development?
2. what are the major problems hindering effective STEM Teaching Practice delivery inColleges of Education?
3. what evidence can justify STEM achievements from secondary data analysis?
4. how could the problems of STEM Teaching Practice be addressed?

2.0 Methodology

2.1 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 relate to thetopic under consideration. The idea behind the use of this method was to provide summary of the evidences relevant to the research questions formulated. The systematic review approach considered Google Scholar indexed journals and articles that were from 2020 backwards. Therefore, secondary data available from Niger State College of Education, Minna for STEMTeaching Practice (TP) achievements were analyzed in relation to the problem under consideration. Google scholar was used as a tool for searching and narrowing the topic based onquick access to it.

3.0 Review on STEM Education as Framework of Practice and Implementation

Science, Technology, Engineering and Mathematics (STEM) Teaching Practice (TP) is

one ofthe most important aspects of teacher training programme in Nigeria aimed at exposing thestudent teachers to the field of STEM to carry out the theoretical knowledge and experience into practice in real classroom situation under the supervision of a

qualified teacher. In some cases,the objective of teaching practice may not be fully realized, this is because, most student teachersstill lack the required and necessary skills for which they were sent on teaching practice. Thestate goal is to nurture the development of skills as well as competencies for career and lifelonglearning. 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 ofa discipline based on the integration of another disciplinary knowledge into a new whole. Thisinterdisciplinary knowledge bridging among discrete disciplines is now treated as an entityknown as STEM Education (Morrison, 2016). Thus, STEM education creates best opportunitiesfor students to make sense of the world holistically, rather than understanding it in pieces. It should be noted, however, that STEM Teaching Practice is an interdisciplinary approach tolearning (Aina, 2010)

3.1 Importance of STEM Education to National Development (RQ1)

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

1. Digital Economy: Digital economy is basically characterized by advanced digitalcomputing technologies which permit free flow of information world over. It is a new internet technology that is supporting web platforms and plays a significant role in promoting globalization three main components of digital economy have been identified below (Tsupros & Hallinen, 2019).

- Supporting infrastructure (i.e. hardware, software, telecommunications, networks, etc.)
- E-business promotion (i.e. how business is conducted, any process that an organizationconducts 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.

2. 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 of both secondary schools and tertiary institutions are equipped with knowledgeand 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 inboth 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.

3. **Employment Security:** Nigeria is blessed with human resources that are characterized byskills in STEM but not harnessed to the optimal level. Across the world, STEM occupations account for high percent of employment opportunities. This however, shows that the demand forworkers with STEM knowledge is in short supply. Over the past decade, STEM jobs grew three times faster than non-STEM jobs particularly in Nigeria (Sailus, 2019). Employment security isevident in STEM career fields as the workers contribute meaningfully to the economicdevelopment 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 (Atodoga, 2011).

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

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

1. **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 stated across the federation arehaving a teacher- student ratio between 1:100 and 1:30 per class against a teacher-studentratio of 1:35 as recommended by UNESCO (2019). This condition results in poor classroom management 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 withno motivation to learn. These factors contribute to low performance in Science, Technology, Engineering and Mathematics (STEM) in addition, it is quite common that when there are large class sizes, the weaker students receive little or no attention from theteachers. Only brilliants ones are recognized.

2. **Teacher as a factor:** There are evidences 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 classroompractices 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 in Nigeria (Ikeobi, 2010). This affects their output and it is a problem tothe development of science education. Science teachers should use different strategies asthere is no single universal approach for specific class. A lot of teachers teaching sciencesubjects are still used to adopting methods of being stationed in one place with chalk andtalk which is not appropriate for science teaching in this modern time. Poor applicationof modern strategies in the teaching of science slow student performance and in the long run influencing student's enrolment.

3. Teaching method as a factor: Students' achievement in the process of learning is largelyaffected 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 centered; the teacher dominates inexplanation of concepts, thereby making students passive. The studies also observed thatthe 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, or use the library. Therefore, the teachingand learning of science is mainly through the traditional approach rather than incorporating science process skills.

4. Language factor: Language is a key factor to effective instruction. It is used as a mediumthrough which knowledge is passed onto students. It is also an important tool for goodcommunication both verbal and nonverbal. For effective teaching and learning to takeplace, 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 teacher and students must be able to express themselves in English language for better content delivery and improvedperformance. 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, 2011). It is no longer surprising to find students even at tertiary who are unable to express themselves in English language.

5. 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. Educationaltraining is only possible if directly or indirectly supported by facilities in order toenhance acquisition of knowledge, competence, skill and technical (Okonkwo, 2019). However, most teachings in science subjects are done without instructional materials.

6. Most secondary schools lack basic laboratory apparatus, such as magnetic boards, resonance kits, iron filling, bar magnetic, projectors and accumulators. Science laboratories are inadequately furnished (Okonkwo, 2019). Hence, electricity as a topicfor example, may not be adequately covered so external examination questions set in thisarea 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 personnel's 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).

7. Workload Factor. Qualified STEM teachers in our schools at all levels of Nigeria's educational system are grossly inadequate. (Atadoga, 2011). As pointed out earlier, theratio of STEM teachers to students across the country is 1:130 average. This is too big foreffective 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 onepractical 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 poorachievement of students in STEM subjects has continued to be a major source of concernto all science teachers and other stakeholders (Akpoghol, Samba & Asemave, 2013).This situation points to the fact that most students are not meeting the minimum entryrequirement into Nigerian tertiary institutions especially those who wish to studyscience 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.

Table 1 below shows the students' enrolment and passes in Four (4) departments/combinations inNiger State College of Education Minna.

Table1: Enrolment and Performance of Students in STEM Courses 2005-2019

Year	Maths/Comp Total	%	Bio/Chem Total	%	Bio/IntPhy/Chem Total	% Pass	Total	%
	Entry	Pass	Entry	Pass	Entry		Entry	Pass
2016	34	52.9%	287	46.3%	187	55.1%	39	53.8%
2017	37	45.9%	244	45.1%	141	59.6%	37	64.9%
2018	31	64.5%	189	53.4%	165	39.4%	22	45.5%
2019	36	50.0%	205	47.8%	150	54.0%	28	35.7%

Source: *Niger State College of Education Minna, 2021*

The above table revealed that the percentage pass from the period under consideration was notencouraging in comparison to departments/combinations despite increase in enrolment. The decrease in performance in all the department/combinations was attributed to teachers' motivation, class size, and language factor and to some extent poor teaching methods. Addressing Problems of STEM Teaching Practice with Prospective Delivery (RQ4)

Although the problems enumerated seem enormous, there is still hope for the future as regards toadequate STEM Teaching Practice (TP) 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, 2018).

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 forminimum academic standards would solve the problem of both professional teachers supply and quality of instruction. With enough teachers, large class size would probablybe 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 enoughschool science laboratories apparatus for physics, Chemistry and Biology for effectivedelivery 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 rolesin 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 SecondarySchool level and a national guideline at the primary level (Adeneye and 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 createa serious challenge, especially when they had become familiar with the indigenous languages while living with their parents (The Guardian Newspaper, 2021).

4.0 Conclusion

Research findings have revealed that there are few 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 TeachingPractice (TP) that include large class size, resource utilization, language factor, workload, teaching method and poor teacher quality among others, with consideration of the prospects ofSTEM education, it becomes necessary for stakeholders to rise to the challenges faced in termsof STEM education delivery. STEM teachers must be ready to create or provide situations wherestudents can learn effectively. In order to boast economic activities, revive industries, reduce menace of unemployment economic stability and national development, STEM education needsto be given priority and required attention it deserves.

5.0 Recommendations for the Way Forward

In order to make further progress in STEM Teaching Practice (TP) in Nigeria, the following recommendations were proffered:

- **Co-operating School**

1. School-heads should be given proper orientation on the need to fully integrate the student-teachers during the internship exercise.
2. Co-operating school which comprised the school and co-operating teachers should co-operate with the student-teacher in order to ensure effective teaching and to make student-teachers feel at ease to teach.
3. Also co-operating teachers should stop harassing the student-teacher in teaching and give them helping hand where necessary so as to ensure conducive teaching environment and make the programme more interesting.

- **College of Education Minna Authorities**

1. There should be proper orientation for student-teachers before going on teaching practice exercise.
2. During this orientation exercise, micro-teaching could be organized for the student-teachers. This will make them gain enough confidence during the real exercise.
3. Workshops and seminars should be periodically organised for science teachers so as toupdate them with new modalities of teaching to cope with the challenges of 21st century.
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.

6.0 References

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

Akpoghol, T. V. (2016). *Effects of lecture method supplemented and computer animations onsenior 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 onstudents' Achievement and retention in secondary school chemistry in Makurdi metropolis. *Research Journal in Curriculum & Teaching,* I(1), 529-537.

Atadoga, M. M. (2011). *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. (2018). Science, Technology and Mathematics (STM) Curriculum Development: David, A. (2018). Innovative practice in science education: A panacea for improvingsecondary 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: theCIBN Press Limited.

Morrison, J. (2016). *Ties STM education monograph series: Attributes of science, technologyand mathematics education.* U.K.: Wadsworth Publishing Company Belmont.

Okonkwo, I. G. A. (2019). *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. (2012). 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 December, 2021). *Teaching Sciences in local languages. Lagos-Nigeria. Guardian Newspapers limited.*

Tsupros, N. R., & Hallinen, J. (2019). STM education: *A project to identify the missing icon.*

Kmensuo Educational Publishers. UNESCO. (2019). UNESCO Institute of Statistics. Paris: UNESCO Press.