Teacher Quality and the Implementation of Stem Curricular for Modern Society

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Abstract.
The effective implementation of Science, Technology, Engineering and Mathematics (STEM) curricular largely depends on the STEM teachers. In this paper, teacher quality is examined as it affects effective implementation of the STEM curricular. Features that enhance teacher quality are discussed under teacher qualification, teacher characteristics and teacher practices. The deficiencies observed in STEM teacher continuous professional development, access to new technologies, infrastructural development, poor quality of enrolment in teacher education, low numbers of graduates and poor education funding was discussed under major areas of concern. Finally the paper examines essential tips like increased education funding by government, improved quality of prospective teachers for admission and continuous professional development as steps that can improve teacher quality and help enhance STEM curricular implementation.
Key words: Teacher quality, STEM curricular, Modern society

Introduction

The demand for qualified and quality teachers has maintained a progressive increase the world over, more-so in our nation where education is seen as a right for every child as emphasized in the National Policy for Education (FGN 2014). Education involves the process where the society through its institutions of learning pass to the next generation the desirable knowledge and skills needed for survival and progress in their communities. In the formal school environment, the teacher is seen as the major player for ensuring the acquisition of the appropriate knowledge and skills that will ensure actualization of a nation's set goals for her learners.

The nation's expectations for her teachers are contained in the teacher education objectives which include:-

1. To produce highly motivated, conscientious and efficient classroom teachers for all levels of educational system.
2. To encourage further the spirit of enquiry and creativity in teaching.
3. To help teachers fit into the social life of the community and the society at large and enhance their commitment to national goals.

4. To provide the intellectual and professional background for their assignment and make them adaptable to changing situations.
5. To enhance teacher's commitment to the teaching profession, (FGN, National Policy on Education; 2014:43).

With the scrapping of the teacher training colleges, two levels of established pre-service teacher training now exist and they are colleges of education and faculties of education in the universities. The colleges of education offer post secondary teacher training program and awards the Nigeria Certificate in Education (NCE) which serves as the minimum qualification for teaching in the primary schools. Faculties of education at the university level offer post secondary /post NCE programmes leading to the award of bachelor degrees in education which is the minimum qualification required to teach in the secondary schools.

The importance placed on education by successive Nigerian governments have accounted for the steady growth of student enrolment. However this has not been marched with equivalent teacher capacity (quality and quantity) or infrastructural development. The situation is the same in both primary and secondary schools. Ajayi (2004) laments this condition of quality when he notes that more than one third (1/3) of the practicing primary and secondary school teachers in Nigeria are people who have never seen the inside of any teacher training institution or undergone any course in education in any higher institution of learning. The situation is not different in the secondary schools where we have a lot of out-of-subject teachers teaching various subjects like physics, mathematics, biology, chemistry, computer, etc. If the present and future needs of both the nation and her learners are to be realized, there must be adequate resources on ground (human and infrastructural), to ensure sustainability of not only the quantity but quality of teachers.

From the goals of teacher education, professional teachers must be intellectually, emotionally and socially equipped to tackle the task of building the nation's youth for present and future man power. The task of teaching is not only about passing knowledge but a social process of interaction between the teacher and the learner with the purpose of acquiring new skills and attitudes (Godwin & Nsima, 2014). A science and technologically literate and skilled population serves as bedrock on which any serious minded nation can develop and progress in the present age of science and technology. STEM education simply implies the teaching of science related subjects in our schools. The broad goals of science education as reflected in the National Policy of Education (FRN, 2014) include:

1. "Cultivate inquiring, knowing and rational mind for the conduct of good life and democracy.

2. Produce scientists for national development.
3. Service studies in technology and the cause of technological development; and
4. Provide knowledge and understanding of the complexity of the physical world and the conduct of life".

The stem curricular was designed to equip learners with science process skills which include the ability to observe, classify, measure, make inference, make prediction and be able to communicate findings and experiences (Ukwungwu & Oyedapo, 2014). These skills were meant to emphasis knowledge application rather than knowledge acquisition as we continue to have in our classrooms today. With these skills, the learner will be able to develop a scientific attitude, discover his environment, apply science in his everyday life and establish cause and effects in the phenomena he see around his environment. However, with all the myriads of challenges faced by science teachers, many just tend to continue with the age long method of feeding the learners with facts and information without initiating them into the science process skills. The reasons for this are not far-fetched.

Teacher quality is a term used to describe a collection of intrinsic qualities that makes a teacher stand out as great and efficient. Some of these qualities include but are not limited to passion for the profession, love for the learners, in-depth love and knowledge for the subject of specialization, a willingness to change or adapt to new technologies, love for self development and a constant desire to excel in the profession and with the pupils. Others include expert use of instructional materials, having pedagogical knowledge, a willingness to collaborate, good class management ability, a friendly and tolerant attitude. Teacher quality will be discussed under the following three broad headings:

1. Teacher qualification.
2. Teacher characteristics
3. Teacher practices.

Teacher qualification: This includes teacher subject qualification, professional certification, teaching experiences and in-service training. A teacher cannot give what he does not possess. Therefore a poorly trained STEM teacher will produce poorly trained students. Fafunwa (1972:66) summed this observation when he succinctly said "poorly trained teachers will produce poorly trained doctors, lawyers, engineers, architects and the like. Indeed teachers directly influence the quality of services provided by all the other trades and profession. Poor quality teachers tend to produce their kind". This means that STEM teachers should not just be any teacher teaching a science subject, but one who is trained and qualified in their specific subject area. A professionally

qualified teacher is one who has undergone the mandatory years of training in the Faculty of education and holds the degree of either B.Sc Ed, B.Ed, M.Sc Ed or M.Ed. The Colleges of Education award the Nigeria Certificate in Education (NCE). Academically qualified teachers with B.A, B.Sc, MA or M.Sc must obtain professional qualification with certificates like the Post Graduate Diploma in Education (PGDE) or Professional Diploma in Education (PDE). Teacher qualification is particularly important because research shows that it significantly affects students' performance. In the study of influence of teacher qualification on students' performance in mathematics Abe (2014) found significant differences existed in the performances of students taught by professional and non-professional teachers- between NCE and B.Sc Ed; between B.Sc and B.Sc Ed teachers in favour of the professionally trained. Also Owolabi and Adebayo (2012) studied effect of teacher qualification on performance of senior secondary school physics and the findings gave rise to the recommendation that professionally qualified teachers be assigned certificate classes to enhance students' performance.

Generally, teaching in ones area of specialization has been found to influence level of teachers competencies and thus affect students performance while absence of qualified teachers have adversely affected students academic performance (Adaramola & Obomanu, 2011; Ezendu & Orji, 2014; Masau & Abere, 2015). These results underscore the fact that the effective implementation of the science curricular at all levels of our educational system depend on well trained and professionally equipped STEM teachers.

Teacher characteristics: This encompasses variables such as teacher attitude and level of commitment, love for the profession and learners. Teacher characteristics are important indicators of level of teacher quality even as research has established this relationship (Olaleye, 2011). One can posit that teacher attitude is a strong determinant of students' performance because of their role in the learning process and the influence they exercise in the management of classroom practices and students' behaviour (Adu & Olatundun, 2007; Kosgei, Mise, Odera & Ayugi, 2013). This implies that teachers' characteristics or variables toward the learners will combine to enhance the fulfillment or frustration of the achievement of set curriculum goals in STEM education. All STEM teachers are not expected to be of the same disposition, commitment or talents, but as observed by Okonkwo, & Adigwe (2013), anyone in any profession who cannot exhibit an acceptable level of attitude, love, commitment and discipline expected of that profession becomes a mismatch and a hindrance to the progress of the system. It is therefore necessary to help STEM teachers cultivate and maintain a level of commitment of love for their profession and students. This is assuming that there was an initial love for the teaching

profession and students before one even enters into the teaching profession. There may be need as is done in other advanced countries, to evaluate the reasons for a prospective teacher's desires to be employed as a teacher. Many people see the teaching profession only as an immediate stop gap for a current unemployment state. They soon move to "greener pastures" at the slightest opportunity. Therefore, interest in teachers welfare, training and retraining, regular remunerations and promotion as at when due are some of the steps that can boost current serving STEM teachers' commitment. It will also ensure positive attitude that can aid the achievement of STEM curricular goals for a bright future. It is true that the teaching profession is generally viewed as one that promote service above material gains, but constant neglect of teachers, will eventually wear down their morale and cause attitudes that may impact negatively on teachers' duties and consequently on the students themselves. This is why Nenty (2002) warns that unsustainable educational practices are not always easily perceived by the relevant agencies and society because the results are not immediate and the consequences when they build up are dire. The response of the people and society after many years of ill practices in the educational sector is the rot we witness today.

Teacher practices: These include teacher classroom practices, alignment of practices with curriculum goals, pedagogical skills, skillful utilization of instructional materials and technological skill. The STEM Curricular typically specifies content, goals, detailed teacher and student activities designed to achieve those goals. A teacher of quality is expected to align his or her classroom practices to enhance the achievement of such stated goals. Thus, adopting a particular teaching method, utilization of appropriate instructional materials or a particular technology where necessary must be appropriately considered. Teachers particularly fall short in this area in relation to pedagogic skills, ability to use varied teaching methods or the use of technology; a practice which if properly exploited can unravel complex or abstract concepts in a science classroom and help enlighten its relevance and applicability. (Mbagua, Kibet, Muthaa & Nkonke, 2012) attributed students' poor performance in physics to inadequate instructional materials and retrogressive practices by teachers. Their research also revealed that 64.2% of the teachers used discussion method in teaching mathematics. Though many countries have shifted focus from this mode of instruction, STEM teachers in Nigeria are yet to grasp this change because the lecture model of lesson presentation demands less discipline and pedagogical expertise from the teachers (Okoye, 2012; Ibe, 2015). It must be noted that even though the discussion method is very effective in covering large contents, its major disadvantage is that for most of the time the participants are passive listeners in the learning process; a situation that kills the spirit of inquiry

needed in a STEM education classroom. Apart from this many STEM teachers are not aware of and so do not avail themselves of the many free resources available on the internet (Inyang, 2016).

Igbokwe (2009) rightly summarised the situation by stating that no matter how laudable a curriculum plan is, its success depends primarily on the characteristics of teachers as they determine what happens during teaching and learning. This makes the issue of STEM teacher quality a thing of grave concern. In an age when "change" is a constant, the effectiveness and efficiency of any STEM teacher in delivering curricular goals is dependent on their willingness to constantly update themselves in the spirit of "dynamic science"; because STEM is never a static area of learning. However it must be stated that updates can only be effective if the foundations were laid right from the beginning. This means that STEM teachers must have relevant subject and professional qualifications demanded of their calling. Many teachers currently teaching some STEM subjects are grossly unqualified by the standards of the "qualified teacher". This is no faults of theirs as there is a dearth of qualified STEM teacher and so the government is forced to employ the people available. However since they are already in the system, their update can be actualized by setting in motion a time table. Even for the already qualified teachers in the system, regular updates are necessary. These updates can take the form of seminars, in-service training and re-training programmes, workshops, conferences and short term courses and acquisition of higher degrees. There must be ways of ensuring and enforcing the trainings.

Teacher quality and efficiency in any nation ultimately determines the quality and efficiency of that educational system whether at primary, secondary or tertiary levels. Just as nations continually review their curricular to address new challenges and meet the demand for new skills, so also the need to periodically review infrastructure, skills and knowledge demands required to equip , strengthen and keep STEM teachers up to date.

Teacher quality in stem education: areas of concern

The challenges faced by STEM teacher educators raise pertinent questions for both the school systems and the governments. While, the school system has to grapple with the problems of teacher quality and the increasing societal expectations, the government is not providing the institutions and environment that fosters innovation to match the requirements of the school sector. Identified and listed below are some knotty areas of concern:

a. Poor continuous professional development plans: These include in-service programmes for continuing self growth of serving teachers. These provisions in most cases are very irregular. Research results have shown that many STEM teachers do not belong to any professional association

and neither do they attend professional conferences like STAN (Ihejiamaizu, Inyang & Adah, 2016) and with the poor funding, teachers are not sponsored to workshops and seminars (Abuh & Onimisi, 2015). Apart from this, government organized trainings are very irregular. This ought not so to be. Just as other professionals meet regularly to address issues concerning quality of output; STEM teachers must organize sessions where they can address their challenges and shortcomings also.

b. Poor availability and access to relevant technologies. Many STEM teachers do not posses high computer or internet literacy skills which are expected of a 21st century STEM teacher and some of the few that do posses these skills do not use them for academic purposes (Akubuiro, Inyang & Ekpa, 2014; Ado, 2017). Out there is a world of varied technologies providing interactive games, tutorial, simulations and virtual laboratories that can be deployed in the STEM classroom, but they remain inaccessible to majority of the teachers because of poor skills and or the unavailability of these technologies in our schools. With all the technological developments making great impact on the teaching and learning process, teacher deficiency in this area is a big concern.
c. Poor teaching methods: Inappropriate and ineffective teaching methods have persistently been a key obstacle to quality STEM education particularly in the area of chemistry and physics. Despite the fact that the National Policy on Education (FGN 2014) clearly emphasizes the constructivist approach which demands science educators practice hands-on, guided inquiry, demonstrations and student-guided practical sessions, teachers continue to use the age-long theoretical and didactic methods they were brought up with thus making the class dull and uninspiring.
d. Poor Infrastructural development, equipment, utilities and furniture/ maintenance culture: Most schools and science resource centres are poorly equipped, such that laboratory equipments, instructional materials, utilities like water and light are most of the time unavailable or at best inadequate. This situation is not limited to the classroom teachers' experiences alone. Prospective teachers face the same experience as they are schooled and trained in these poor environments also. The laboratory is the lifeline of STEM education but the poor state of many school laboratories is a fact well known (Kalu, 2017). How does this make for teacher quality as they are trained without the necessary facilities? Omoifo in Nja (2017) laments the absence of "hands-on, minds-on" laboratory practical experiences of our science graduates; so how can they function effectively and efficiently as STEM teachers? Indeed you cannot give what you do not have.

e. Poor policy liaising: Educators are usually not carried along in policy changes and implementation. For example, Basic Education curriculum began to be implemented without proper orientation/preparation of teachers to carter for the newly introduced subjects. Thus teachers are ill prepared and ill equipped both in content and other necessary competencies to efficiently teach, mentor and guide the pupils in the new areas to achieve the expected goals of the new policies. This should not be so. The STEM teacher is the final implementer of the STEM curriculum with the aim of achieving the stated goals. Such people should be duly sensitized, trained and equipped to perform their tasks.
f. Quality of enrolment in teacher education/attrition: The low numbers of graduates going into the teaching profession are of grave concern such that most students applying for training are most times the last dregs refused admission in their departments of first choice. Very few apply as a result of love for the profession, which is why most of them do not usually end up in the classrooms as expected. If STEM quality teacher is to be assured, standards must be set concerning entry requirements of prospective teachers and these standards must be upheld. This must also be preceded by improved conditions of service for teachers as an incentive to attract more qualified candidates into the teaching profession.
g. Insufficient exposure to adequate teaching practice and the result is insufficient exposure to various forms of methodology and unpreparedness for the realities and challenges of the real life work outside. There have been calls by education experts to increase student teachers teaching practice period for up to a full school year. (Mezieobi & Mezieobi, 2017; Obanya, 2004). This will enable them gain much more experience that will be of use later.
h. Funding: Fund allocations are most often so terribly inadequate to maintain and expand services to acceptable standards. Since the year 2000, funding of education by the federal government has been consistently below the 15%-20% minimum recommended by the UNESCO for developing counties. In fact in the last three years (2016-2019) government allocation to fund education has been below 8% of the total Federal budget (John Ameh & Olaleye Aluko, https://punchng.com/2019-budget-education-gets-n620-5bn-against-unescos-advice/). The evidence of this poor funding according to Joshua and Essen (2017:342) has "resulted in lack of adequate classrooms, workshops, lecture halls, laboratories and libraries. It is estimated that only 30% of Nigerian student population have adequate access to these essential facilities" and this affects prospective teachers under training. It certainly cannot contribute to teacher quality. Olaaniyan and Adedeji in

Joshua (2017) assert that government's financing of education is a demonstration of the value they place on education. If this assertion is true, then government has to do more to show that it truly values the education of her citizens and sincerely desires quality teachers and quality education.

Teacher quality in stem education: what next?

Since the turn of the century, or what we call the 'modern society' the rate of knowledge explosion and technological advancement has been enormous. It has impacted every sphere of life including education. As noted by Joshua (2017:14) "the three Rs (Reading, Writing and Arithmetic) were probably right for the then society, but certainly are not enough for the present". He opined that the 21st century education addresses the whole person and arms them with skills for survival in an ever changing and unpredictable world. These skills are tagged 21st century skills and they include critical thinking and problem solving, communication, collaboration and creativity and innovations. If STEM teachers must fit into the new global system, and efficiently turn out students who have (a) developed life skills, (b) are able to adapt to the changing globalised world, and (c) are creative, innovative and confident, then it means the teachers must acquire these skills first before impacting the lives of their learners. There is a paradigm shift that suggests that learners now expect more creativity and resourcefulness from their teachers during classroom interaction. This is because today's learners are "digital native" and have access to information like never before. Therefore STEM teachers with better trainings and greater interactions with ICTs can respond to these deficiencies by creating rich teaching environments (Etiubon, 2017). However also, these changing needs and priorities must first be reflected in the teacher training institutions for prospective teachers. Then they must be reflected in in-service training workshops, conferences and seminars for practicing teachers, thus providing a forum for sharing and discussing relevant observations, experiences and challenges. STEM educators of the 21st century must be well adapted to function effectively in an ever changing environment. Effective STEM teacher development is a process that can only thrive in settings that permit it. Therefore, an environment which allows analysis of situations, brainstorming and proffering suggestions and solutions must be established and sustained. The following are suggested to enhance STEM teacher quality:

1. Continuous teacher professional development must be encouraged using every means available. There must be a deliberate plan on the part of government and their agencies to ensure that there are opportunities for constant interchange of ideas.

2. There must be increased funding of education by the government and possible private/government partnerships. More money must be invested in quality education to receive good dividends in the form of enhanced teacher quality and efficiency.
3. There is the need to improve quality of prospective student teachers' admitted into teacher training programmes. Standards must be set concerning entry requirements of prospective teachers and these standards must be upheld.
4. Teaching practice process must be reviewed to enable would be teachers spend more time on the field before they graduate. The one semester teaching practice as practiced now is definitely not sufficient for prospective teachers to adequately socialize and gain enough experience for the classroom real life interactions.
5. Some level of ICT literacy or expertise should be demanded of STEM teachers. With the availability of various technological innovations to stimulate the teaching and learning of science, sound computer knowledge should be a fundamental requirement for STEM teachers.
6. The Teachers' Registration Council of Nigeria (TRCN) must also live up to its mandate in ensuring that the numbers of professionally unqualified teachers are systematically reduced by organizing certification training programmes for them. Moreover, STEM teachers should be required to obtain re-certification after a certain number of years, especially if new skills are required.
7. It must be added that the STEM teachers must be motivated. In other words all necessary strategies that would encourage serving teachers put in their best must be looked into. Such strategies include prompt and regular payment of salaries, promotions as at when due, in-service trainings, availability of training/instructional materials, and an enabling environment for qualitative teaching and learning.

Summary and conclusion

This paper examined teacher quality and STEM curricular implementation for modern society. The rationale for STEM education, the importance of teacher qualification, teacher characteristics and teacher practices were discussed. Also discussed were the major areas of concern in STEM curricular implementation, the expectations from the STEM teacher in the modern society, and the way forward. From the foregoing this paper concludes by emphasizing that quality STEM education is the bedrock of the nation's technological advancement. When the nation invests in STEM education to produce quality teachers, it is also investing in the future of the youths and in effect ensuring the continuity of the society and improvement of its own

technological advancement. Therefore more money should be invested to provide improved facilities that will advance the quality of education provided both at the classroom and teacher training levels. This will ensure good dividends in the form of enhanced teacher quality and efficiency for effective STEM curricular implementation.

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