

STRATEGIES FOR ACHIEVING QUALITY ASSURANCE MECHANISM IN SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) EDUCATION IN NIGERIA

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Abstract,

The widespread recognition of education as a major driver of economic competitiveness in an increasingly knowledge-driven global economy has made high quality education more important than ever before. This emphasize the importance of ensuring quality assurance in Science, Technology, Engineering and Mathematics (STEM) education for sustainable development through quality education. Thus, this paper delves into the meaning and importance of STEM education, achieving quality education through STEM Education, parameters for measuring quality assurance in STEM Education, challenges of quality assurance in STEM education as well as strategies for improving quality assurance mechanism in STEM education. The paper concludes that the importance of STEM education in providing quality education cannot be overemphasized and ensuring quality assurance in STEM education should be paramount to stakeholders in the field of education. Regular inspection of schools from the science section of the Ministries of Education, setting up of quality assurance implementation committees as well as encouraging STEM teachers to attend in-service trainings such as sandwich and part-time training through government sponsorship were recommended.

Keywords: Quality Assurance, STEM Education, Ministry of Education, Teaching and Learning

Introduction

Nigeria has earned the designation of the giant of Africa by good worth of its size, population and vast resources. However, the pitiable state of infrastructure, low standard of education, wearing away of value system, and many other tribulations prevalent in the society has caused the country to be fast losing its respect across the sphere. Nigeria is blessed amply with all the resources to be the best in all ramifications but yet the educational system is in shambles just because it is a product of Nigerian norm where in most cases, normal things are abnormal and abnormal things are normal (Usman, 2018). The world has realized that the economic success of the states is directly determined by the quality of their education systems (Pavel, 2012). It is worrying that while some countries have recognized the value of investing heavily in education as a vehicle for irremediable growth and brawny economy, Nigeria still prioritizes sustaining an excessively expensive system of governance ahead of instituting mechanisms that will guarantee quality education (Usman, 2018).

The widespread recognition that education is a major driver of economic competitiveness in an increasingly knowledge-driven global economy has made high quality education more important than ever before (Asiyai, 2015). Therefore, it is imperative for countries to strive towards raising candidates with higher level employment skills and sustain a globally competitive research and knowledge breeding base to the benefit of society (Ewuzie, 2020). Quality education equips people with the ability that will enable them explore the world and manipulate it for their survival and establishment (Njoku, 2016). It has been the backbone of development in most countries of the world, because it propels both economic and social

emancipation of a nation (Iniobong, 2013). Therefore, the means of providing education should be effective to promote quality sustenance so as to enable the educational system to be well developed and effective (Okoli, 2016). For quality education to be achieved in a nation, the principal actors of learning (teachers, learners and the environment) should be cooperatively organized. In other words, the teacher must be adequate in quality and quantity, the students must be well trained and required facilities must be provided as well (Adegbesan, 2011).

Reversible if there is a positive attitudinal change and conscious affirmative action by all stakeholders. Stakeholders in the education sector are advocating that Nigeria education institutions at all levels should be encouraged and supported to develop strong internal quality assurance mechanism to drive the sector process and progress. They observe that countries that thrive in all sectors of their economy did embrace education as their bed rock (Ewuzie, 2020). Achieving a robust quality education status in a nation does not happen by chance but achieved through implementation of well thought out strategies that can upgrade the education standard and improve quality of products churned out from the various citadels of learning. Amongst the strategies needed to guarantee the desired quality of education is to build quality assurance mechanism into the learning process (Thom-Otuya & Inko-Tariah, 2013). Quality and standards must be derived from a coherent policy framework, which provides clear directives and guidelines as well as principles, assumptions, structures, roles and responsibilities (Federal Ministry of Education; FME, 2014).

Achieving Quality Education through STEM Education

STEM education is defined as an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering and mathematics in contexts that make connections between school, community, work and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy (Tsupros, Kohler & Hallinen, 2009). It is commonly agreed in both theory and practice that STEM education refers to the integration of the four disciplines (science, technology, engineering and mathematics) in various ways and levels (National Academy of Engineering & National Research Council, 2014). STEM education emphasises the importance of making connections between academic knowledge and real-world problems as a foundation for integrating S-T-E-M subjects in teaching (Margot & Kettler, 2019). With the integration of S-T-E-M disciplines, STEM education can offer high-quality science and technology education and the relevant knowledge to understand scientific, technical and cultural interrelations (Bybee, 2013).

It also provides students with important digital competences (Barragán-Sánchez *et al.*, 2020) and soft skills, such as problem solving, creativeness and critical thinking that are essential for the workforce to sustain a country's economic growth (Wong, Dillon & King, 2016). There have been increasing demands for future citizens to be literate in STEM subjects and to have knowledge of socio-scientific-technical interrelations and their application in addressing real-world problems. Modern citizens must be able to employ the science and technology knowledge that they learn in school to deal with development challenges, including environmental pollution, unpredictable climate phenomena, the exhaustion of natural resources such as water and energy, and social and political conflict. As well as preparing students with STEM competencies, STEM education improves students' abilities to innovate – an increasingly important skill for openly embracing change and responsibly shaping the future. With these soft skills, modern citizens are able to follow sustainable lifestyles; promote human rights, gender equality and a culture of peace and non-violence; appreciate cultural diversity; and trigger culture's contribution to sustainable development.

Due to its interdisciplinary nature, STEM education is seen as both a curricular and a pedagogical approach (Margot & Kettler, 2019). In terms of curriculum, STEM education refers to the interdisciplinary framework, whereas pedagogical approaches centre around instructional practices such as enquiry through representations, problem solving and reasoning, challenge-based learning, design-based approaches and digital technologies. Many studies have shown that the following key principles are necessary for integrated STEM education in secondary schools to address sustainability: the integration of STEM content; enquiry based on the real world; and problem-centred, design-based, and cooperative learning approaches (Asghar *et al.*, 2012 and Thibaut, 2018). Hence, the interdisciplinary and real-world problem-based works are engaged in STEM pedagogical practices and curriculum and material designing (Jurdak, 2016).

Parameters for Measuring Quality Assurance in STEM Education

Measuring quality assurance in STEM education according to Thibaut (2018) involves evaluating various parameters across four main dimensions of input, output, process, and content. Effective quality assurance in STEM education requires a comprehensive evaluation of these parameters as discussed below which ensured that institutions identify strengths and areas for improvement and ultimately enhance the quality of STEM education and its impact on students and society.

1. Input Parameters: Input parameters refer to the resources and infrastructure necessary for delivering quality STEM education. Key aspects include:

- a. Curriculum Design: The relevance and rigor of the curriculum aligned with industry standards and educational goals.
- b. Faculty Qualifications: The expertise and experience of educators, including their ongoing professional development in STEM fields.
- c. Resources: Availability of laboratories, technology, equipment, and learning materials that facilitate hands-on learning.
- d. Student Demographics: Diversity in student backgrounds, which can influence learning experiences and outcomes.
- e. Institutional Support: Administrative backing for STEM programs, including funding, facilities, and mentorship opportunities.

2. Process Parameters: Process parameters focus on the methods and practices used in delivering education. Important elements include:

- a. Teaching Methods: The effectiveness of pedagogical approaches, such as inquiry-based learning, collaborative projects, and experiential learning.
- b. Assessment Strategies: The tools and methods used to evaluate student performance, including formative and summative assessments.
- c. Engagement: Levels of student engagement and participation in STEM activities, including extracurricular programs and competitions.
- d. Feedback Mechanisms: Processes for gathering and utilizing feedback from students and faculty to improve the educational experience.

3. Output Parameters: Output parameters assess the results of the education system, focusing on student outcomes. Key factors include:

- a. Academic Performance: Measurable achievements such as grades, test scores, and completion rates in STEM courses.
- b. Skill Development: The extent to which students acquire critical skills, such as problem-solving, analytical thinking, and technical proficiency.
- c. Career Readiness: The preparedness of graduates for STEM careers, including internships, job placements, and employer feedback.
- d. Continued Education: Rates of students pursuing further education in STEM fields, such as graduate studies or certifications.

4. Content Parameters: Content parameters evaluate the relevance and quality of the educational material itself. Key considerations include:

- a. Curricular Content: The depth and breadth of topics covered, ensuring they are up-to-date with current scientific and technological advancements.
- b. Interdisciplinary Integration: The extent to which STEM fields are integrated with other disciplines, fostering a holistic understanding of complex issues.
- c. Cultural and Ethical Context: Inclusion of discussions on the societal implications of STEM, ethics, and the impact of technology on society.

Strategies for Improving Quality Assurance Mechanism in STEM Education

The concept of quality in academics is the concept of quality of educational input and output in its entirety. Quality is considered as baseline standard in education, which can be measured on a scale of preference. Standards imply accepted principles, rules, guidelines or levels established by group of people, organizations or societies. Bisong (2000) is of the opinion that the educational enterprise has to do with establishing and maintaining standards, which form the basis of evaluation. Quality therefore is an expression of standard or it is the means by which a certain set standard in education can be achieved. This can be assessed in respect of many factors that exist within the academic system. It addresses the issue of accountability in educational practice in terms of the use put to materials and personnel. The material and personnel resources when broken down cover many areas of educational practice. Walklin (1992) defined quality assurance as the avoidance of non-performance by pre-empting failure through proper planning, execution, monitoring and evaluation. It is a way of managing an organization so that every job, every process, is implemented right first time and always. Ukeje, Akabogu & Ndu (1992) explain that quality assurance in a school setting is made possible through proper planning by the management which involve all the staff in the functions of planning, execution, monitoring and evaluation using set standards and objectives. The SEAMEO VOCTECH: Southeast Asian Minister of Education Organization Regional Centre for Vocational and Technical Education and Training (VTET) in its efforts to provide quality assurance in its product and services, has instituted the six (6) strategic goals reflected in its 3rd five year development plan (2004/5 - 2008/9), as follows:

- a. Developed and implemented relevant, innovative and quality capability building programmes geared towards sustainable development.
- b. Institutionalized research and development initiatives.
- c. Enhanced human resource development

- d. Instilled a dynamic organizational culture
- e. Intensified networks and partnership.
- f. Optimized resources and operation of information services.

The goals are being operationalized through the application of quality management to facilitate continuous upgrading/improving of the different programme areas to strengthen VTET institutions in the SEAMEO VOCTECH member countries, for example, training, research and development, ICT and information services thus achieving quality assurance in the process. It is recognized in the field of VTET that quality assurance can be measured through the quality inputs, process and output of the learning institutions in terms of producing skilled and competent work force (Mosbi, 2005). Quality assurance in STEM education can be improved upon through the following.

1. Provision for learning facilities and equipment. Onyemachi and Ekong (1999) described instructional materials as all the practical and skill development resources that facilitate the processes of teaching, learning and evaluation of vocational technical skills. It includes all electronic systems, tools, equipment and other resource materials that could be utilized for directing and controlling vocational technical operations thus reinforcing the teaching and learning of specific skills. It is no gainsaying that most of our institutions lack basic infrastructure and equipment to carry out effective teaching and learning which will guarantee quality assurance.
2. Adequate staffing which will definitely provide the framework within which teachers' workload can be reduced to enhance efficiency and quality. If teacher-student ratio does not improve, the consequence is a substantial decline in teachers' relative performance. Nwoke (1990) agreed that serious shortfalls have always existed in the number of professionally qualified science and technical teachers needed in the nation's schools and colleges. Teaching is a profession and no better education system can rise above the quality of its teachers. Bisong (2000) stated that the quality and standard of teacher education and teaching have declined. The author reemphasized that any person who intends to or is teaching must obtain a qualification in education (teaching) before practising at any educational level.
3. Provision of in-service training. Uche (1980) on in-service training programmes for teachers revealed that the programmes improved the teaching skills of the recipients as well as enhanced their job performance. In support, Ibadin (1991) revealed that the various, forms of in-service education with particular reference to regular, weekend and sandwich programmes improved the performance of the recipients, improved their academic and or professional attainment as well as prepared them for roles.
4. Quality assurance can be improved upon by regular attendance of science teachers at workshops, conferences and seminars (Onyemachi & Ekong, 1999).
5. There is need to improve teachers remuneration beyond what it is presently, as high wages will tend to produce commitment and efficiency. Bloomer (1980) observed that if quality and professionalism is to be encouraged it must be rewarded. According to author, salary has a potent influence upon the attitude of teachers as on other workers.

Challenges facing Quality Assurance in Nigeria

The most prominent amongst the impediments of quality assurance in the education sector in Nigeria is underfunding. The issue of funding of education has been a recurrent decimal in the history of Nigeria's educational sector despite the poor state of education system in the country (Amahua, 2010). An analysis by Abdusalam (2023) revealed that only 7.9%, 7.40%, 7.04%, 7.05%, 6.70%, 5.68%, 7.2% and 8.8% was allocated to the federal ministry of education by the government in 2016, 2017, 2018, 2019, 2020, 2021,

2022 and 2023 respectively. The obvious low allocation is definitely a hindrance to the sector in implementing policies that reassures quality education.

In Nigeria, policies transform recurrently with almost every change in country's leadership leading to inconsistencies in education policies (Igborgbor, 2012). These frequent change of policies signifies the absence a workable strategic plan for education sector development and constitute a serious challenge to the reforms in the education sector (Asiyai, 2015).

Another factor hindering quality assurance in Nigeria as observed by Odo (2015) is the politicization of appointments in the education sector. In some instances persons without requisite experience or academic background in education are appointed into leadership of education and related institutions (Odo, 2015). Such misfit appointments can lead to absence of total quality management work culture in education system (Garba, 2015).

Outbreak of diseases of public health concern like ebola and corona virus disease (COVID-19) is also hindrance to quality assurance. There is no arguing the fact that education is one of the major casualties of COVID-19 pandemic (Onunaiju, 2021). The pandemic has affected educational systems worldwide, leading to the near- total closures of schools thereby disrupting academic activities (UNESCO, 2020). More worrisome is that, in Nigeria the presidential task force (PTF) formed since the outbreak of COVID-19 is perceived to have done more to orchestrate fear than articulate a better understanding of the nature of the disease (Onunaiju, 2021). School closures in response to the pandemics like COVID-19 have shaded more light on numerous issues affecting access and quality of education in Nigeria.

According to Chidobi and Eze-Thecla (2016) supervision has been a great challenge in education as it lacks the needed commitment and coordination to survive. The internal and external organs of quality assurance in education in this regard have failed and any system or project that is not properly supervised is bound to derail from its expectations and intended objectives (Amoor, 2010). In another dimension, persistent insecurity and conflicts remains a menace that resulted from the weak institutions and social organization in the country (Abdullah, 2019).

Over the years, educational institutions have become targets of bandits in carrying out their nefarious activities ranging from kidnappings and killings etc (Usman, 2020). Prominent amongst the cases which has disrupted school activities were recorded in Chibok in Borno state 2014, Dapchi in Yobe state 2018, Kankara in Katsina state 2020, Kagara in Niger state, 2021 and Afaka in Kaduna state, 2021.

uld be a monitoring team from the State and Federal Ministries of Education to check on-going STEM education programmes for flaws or breakdowns, provision of info Okebukola (2013) observed that poor management and governance of institutions by administrators is also having a consequential effect on quality assurance in the education sector. This problem characterizes every other sectors of Nigerian society. In this regard, Anioke (2013) posits that the problem in Nigeria is that the institutions for managing education whether at the local or national level are weak and inefficient because of the democracy deficit in our polity. It is certain that as long as management continues to play nonchalant role, quality assurance will continue to be jeopardized in the nation's institutions (Uzorka, Uzorka & Okobia, 2011).

Learning environment in modern day Nigeria has not been friendly with both learners and teachers. This has created a lot of quality vacuum in the learning process (Folami, Riaz & Musolihu, 2021).

Conclusion

The importance of STEM education to sustainable national development cannot be overemphasized and thus ensuring quality assurance in STEM education should be paramount to stakeholders in the field of

education and can be achieved through a comprehensive evaluation of input, output, process, and content parameters. Quality assurance in STEM education is a guaranty to national scientific and technological independence, however, underfunding and insecurity are the major challenges in actualizing the desired quality.

Recommendations

Notwithstanding the road block and challenges of quality assurance in STEM education, the following recommendations will help in improving and maintaining quality assurance in STEM education in Nigeria:

1. Seminars, workshops and conferences should be organized regularly for STEM teachers to acquaint them with the use of STEM equipment.
2. An implementation committee on science education should be set up and this committee should always be made up of people who are science experts.
3. A built-in evaluation instrument should be constructed as an appendage of implementation committee document for the purpose of periodical evaluation of both the implementation processes and the success or failure of science education programmes.
4. There should be regular inspection of schools from the science section of the Ministries of Education (Federal and State) in Nigeria. This inspection should focus on school accountability process, maintenance of equipment, improving performance and quality of teaching and developing an annual report covering school performance, students' achievement and financial performance.
5. More STEM teachers should be trained and employed in Nigeria to be able to cope with the increase in the population of students.
6. Efforts should be geared towards the provision of science equipment necessary for enhancing science education programme in Nigeria by the Federal and State government, philanthropist, communities, private sectors and organizations.
7. Special allowances should be paid to science teachers to boost their morale for high productivity.
8. There shormation to regulate activities and undertake corrective actions.
9. STEM teachers should be encouraged to attend in-service trainings such as sandwich and part-time training through government sponsorship in Nigeria.
10. Adequate budgetary allocation should be given to ministry of education in order to cater for the necessary educational programmes and activities.

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