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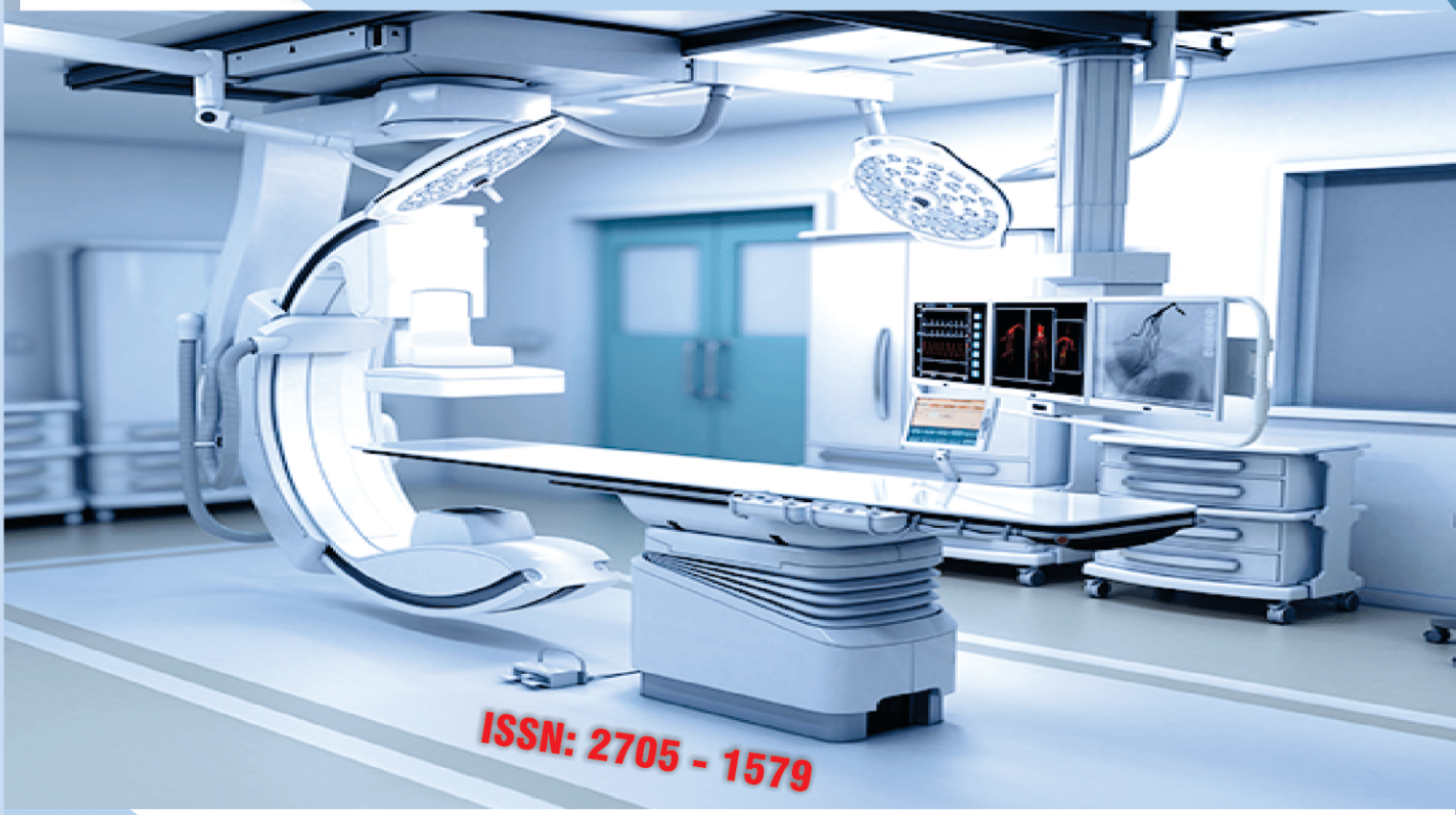

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EDITORIAL

The task of effectively applying Science, Technology, Engineering and Mathematics (STEM) education research of utmost importance to STEM educators and other stakeholders, even the survival of any nation depends on the sustainability of its STEM education programme.

Currently, we are facing the challenges of COVID-19 pandemic. Our country Nigeria did not anticipate such disease and as such caught up with the pandemic. Hence the un-preparedness of our nation led to the closure of public places including schools.

Therefore, Science Teachers' Association of Nigeria (STAN) Anambra State Chapter dedicated this 2nd Biennial State conference hold on decencies 8th-9th, 2021 at Federal Science and Technical College, Awka, Anambra State, Nigeria to COVID-19 and Emerging issues in STEM Education.

The editorial board had welcomed our members whose papers - articles were extracted from conference.

Happy Reading.

Prof. Rita N. Nnorom
Editor-In-Chief

COVID-19 AND EMERGING ISSUES IN STEM EDUCATION

NKECHI P.M. ESOMONU
DIRECTOR, AFFILIATE INSITUTIONS,
NNAMDI AZIKIWE UNIVERSITY, AWKA, ANAMBRA STATE, NIGERIA.

A KEYNOTE ADDRESS PRESENTED DURING THE SCIENCE TEACHERS' ASSOCIATION OF NIGERIA (STAN) ANAMBRA STATE BRANCH 2ND BIENNIAL STATE CONFERENCE – DECEMBER 8-9TH, 2021

VENUE: FEDERAL SCIENCE AND TECHNICAL COLLEGE, AWKA

Protocol

Preamble

It is my pleasure to use this opportunity to congratulate the Science Teachers' Association of Nigeria, Anambra State Chapter for all their successes and laurels in recent times. I particularly thank the leadership of the Association; they have done well especially in maintaining their biennial conference.

I wish to express my gratitude to the organizers of the conference for inviting me to deliver a Keynote. I am delighted to address the cream of Science Educators and others. I congratulate the STAN, Anambra State for the choice of the theme, **COVID -19 and Emerging Issues in STEM Education**. This theme is crucial judging from the place of STEM in the world order and the need to optimize STEM practice in pandemic era.

Introduction

Ordinarily and in contemporary sense STEM education concerns the teaching and learning of science, technology, engineering and mathematics. As innovations take center stage with emerging technologies, the concept tilts in meaning to accommodate more effective strategies. Hence, The Maryland State Board of Education (2012) defines STEM as an approach to teaching and learning in which the content is integrated with skills of science, technology, engineering and mathematics. The core goal of science, technology, engineering, and mathematics (STEM) education is to improve learners' critical and creative thinking skills to face the challenges of the 21st century (Nugroho, Permanasari, & Firman 2019). In STEM education, four disciplines - science, technology, engineering, and mathematics, are integrated (Gonzalez & Kuenzi, 2012). This was emphasized when The Maryland State Board of Education (2012) defines STEM as an approach to teaching and learning in which the content is integrated with skills of science, technology, engineering and mathematics. This integration according to Baharin, Kamarudin and Manaf (2018) makes STEM education a new discipline as it links the knowledge a student acquired in school with day-to-day realities of life. STEM education imbibe in the learners the skills that will drive new innovations across disciplines, making use of computational power to quicken discoveries. However, gaining access to STEM education and its resources has over time become a challenge to learners and teachers in the educational system. This

challenge of access to education was compounded by the coronavirus disease also known as Covid-19.

The Covid-19 pandemic affected the world in spheres of life. In the education sector, Covid-19 emergence has led to the closure of face-to-face activities of schools in over 190 countries. According to UNESCO (2020a), by mid-May 2020, over 1.2 billion of the world's school population at all levels of education worldwide had stopped having face-to-face classes. In Nigeria, the stop of face-to-face classes took effect on March 19, 2020, when the Federal Ministry of Education in Nigeria approved the closure of all educational institutions. This unexpected school closure caused significant interruptions in the Nigerian schooling structure; which includes learning methods and access to school related services (Nlebem, 2020; TEP-NESG, 2020). Students were at home for over four months of the school calendar. According to UNESCO (2020b), the closure of schools affected 36,400,000 primary and secondary school students across Nigeria. The situation was also detrimental to students in higher institutions. Students in higher education engaged in STEM education suddenly found their internships cancelled and their academic pursuits severely disrupted. Those studying STEM are now in a far more precarious position as they navigate the challenges of remote learning. Accordingly, AMNH (2020) posed these questions- how can one pursue STEM education if they cannot even go to class or the lab? And what kinds of resources and support can help counteract these disruptions? Although this abrupt closure of schools affected access to STEM education, in quality and quantity, it also boosted the restructuring of education delivery across the world. STEM education did not stop during the Covid-19 pandemic.

In Nigeria, in response to this education emergency as a result of Covid-19, the federal and state governments and private sector implements various learning interventions using technological platforms, internet-based tools and traditional media to mitigate the impact of the closure of schools. The appropriate education stakeholders adapted quickly and developed solutions to minimize the potential learning slide resulting from the pandemic. Some of these solutions are: remote teaching and learning, printed packets, or online learning; deployment of distance learning modalities through a variety of formats and platforms (with or without the use of technology); the support and mobilization of education personnel and communities; and concern for the health and overall well-being of students.

These platforms and online systems faced various barriers to the teaching and learning of science during the Covid-19 pandemic but STEM educators were able to adapt. One-

way STEM educators were able to keep students carry out STEM activities was by providing STEM projects that students can work on in their own homes. The assignment can be delivered online and teachers' feedback can also be given online using the learning management system (Zulirfan, Yennita, & Rahmad, 2020). The need to make best use of the house as a learning environment for STEM students in carrying out scientific activities was emphasized by Zulirfan et.al, (2020).

Background to STEM Education in Nigeria

It is generally agreed that formal education was brought into Nigeria by the Christian missions at about 1842 (Ugo & Akpoghole, 2016). However, Science was first taught in Nigeria in 1859 in CMS Grammar School, Lagos. Science was taught inform of arithmetic, algebra, geometry and physiology. Between 1859 and 1929, teacher training institutions were established to cater for the training of teachers in other science subjects such as astronomy, chemistry, geology and botany. In the 1920s, the Phelps-Stokes Education Commission noted the backwardness of teaching and learning of science when the visited West Africa. The commission recommended and ensured that science subjects were included in the secondary school curriculum in Nigeria. Teaching of science was difficult due to lack of teachers; very few qualified science teachers were available in few schools. Besides that, unsatisfactory teaching methods affected the teaching of science in Nigeria (Ikeobi, 2010). There was a remarkable improvement in the teaching and learning of science by the time Nigeria got her political independence in 1960. Before independence in 1960, science at the secondary school level was predominantly General Science since majority of the schools did not have academically qualified science teachers or even skilled personnel.

In 1963, the first organized curriculum development effort took place at the Comprehensive High School, Ayetoro. The Science Curriculum Development Committees were formed in 1968 under a cooperative agreement between the Comparative Education Study and Adaptation Centre (CESAC) and the Science Teachers Association of Nigeria (STAN) (Okpala, 2012). The memberships of these committees were drawn from both bodies and the Universities and Ministries of Education. The Committees produced the first sets of indigenous curricula in Integrated Science, Biology, Chemistry and Physics. Following the production of these curricula, both CESAC and STAN developed science projects which proposed radical changes in content, context and sequence of teaching science in secondary schools. These included STAN Nigeria Integrated Science Project (NISP), CESAC Basic Science for

Nigeria Secondary Schools (BSNSS) and CESAC Nigeria Secondary Schools Science Project (NSSSP) for Biology, Chemistry and Physics. In September 1969, there was a National Curriculum Conference in Lagos which drew a lot of participants from diverse backgrounds who were eager to see Nigeria chart a new course in its educational system. At the primary school level, there were two pioneering projects developed between 1970 and 1977 by the Bendel State Ministry of Education and the Institute of Education, Ahmadu Bello University, Zaria. The projects had the support of UNESCO/UNICEF (Okpala, 2012). The apparent success of these projects led to the production of a number of primary school courses by the State Ministries of Education, the Nigeria Educational Research and Development Council (NERDC) and individuals. A national curriculum in primary science was also developed with clearly stated objectives and activities (FRN, 2013). All these efforts were aided by science activities in Africa.

The first major attempt at curriculum development in Africa which Nigeria participated was the African Primary Science Programme (APSP) which was in 1960. The programme brought together educators and scientists from eleven English speaking African countries. The APSP later metamorphosed into Science Education Programme for Africa (SEPA). This programme which was a research and development project was sponsored by the Educational Services Incorporated (ESI), which later became Education Development Centre (EDC), in Massachusetts, U.S.A in the 1960's (Ugo & Akpoghole, 2016).

The broad goal of the APSP with respect to the African child was to ensure the development of first hand familiarity with a variety of biological, physical and man-made phenomena in the world around them; interest in further exploration of the world around them on their own initiative and; ability to find out the problem for themselves and be involved in problem solving. The programme initially embarked on the production of science teaching materials which were mainly teachers' guide and to a lesser extent, pupils' books and a science library series for background reading. At a later stage, the programme embarked on formative evaluation of science teaching activities to ensure functional teaching of science at the primary school level (Okpala, 2012).

Contemporary Issues in STEM Teachers and Teaching

A pertinent question here is, how does one become a STEM teacher in our contemporary society? To be a STEM teacher, the candidate needs at least a bachelor's degree in science, technology, engineering or mathematic. To teach at the primary or secondary school levels, one needs training in education. One also needs to be certified and licensed by Teachers Registration Council of Nigeria. In order to teach at the college or university levels, there is need for one to have at least a master's degree in the STEM subjects. It is currently recommended the teachers at all levels must acquire pedagogical skills. That is, they should have teaching qualifications. The prospective STEM teacher needs excellent public speaking skills to inspire the students to learn the complex and challenging materials (Zip Recruiter Marketplace Research Team, nd).

As stated by Betterteam (nd), STEM teacher requirements Bachelor's degree in a STEM field, State teaching license in the relevant field, knowledge of STEM best practices, empathy and great interpersonal skills, excellent written and verbal communication, proficiency with basic computer software such as Word and Excel, experience working with children and adolescents. Previous experience as a STEM teacher will be advantageous, good classroom management skills and good teamwork abilities.

It is then certain that effective STEM teaching is a specific learned expertise that goes well beyond, STEM subject expertise. Developing such teaching expertise should be the focus of STEM teacher training and education Teachers must have a deep mastery of the content and have pedagogical content knowledge. That is the understanding of how students learn a particular content and the challenges as well as possess the skill to facilitate the learning of the specific topic. STEM teachers must participate in professional development and continuing education to make sure they remain current in their STEM subject area and be better prepared for STEM field that is continually evolving.

From the learning perspective, effective teaching is that which maximizes the learner's engagement in cognitive processes as well as motor skills and character formation. As such, an effective teacher designs good practice activities and hands-on that breaks down and collectively embodies all the essential component skills in three domains. Effective teacher should motivate the learners to work hard on content provided, evaluate students' progress and providing effective feedback. Thus, the effective STEM teacher according to Wieman, (2012) must:

1. understand expert thinking and design suitable practice tasks.
2. Target student thinking and learning needs. Such tasks must be appropriate to the level of the learner and be effective at building on learners' current thinking to move them to higher expertise.
3. Motivate the student to put in the extensive effort that is required for learning. This involves generating a sense of self-efficacy and ownership of the learning; making the subject interesting, relevant, and inspiring; developing a sense of identity in the learner as a STEM expert.
4. Provide effective feedback that is timely and directly addresses the student's thinking.
5. Understand how learning works, and use that to guide all of their activities.

The STEM Teachers have the responsibilities developing learning activities and hands-on materials, paying attention to individual students' needs, and communicating regularly with their parents. Betterteam (nd) summaries STEM teachers' responsibilities as follows:

1. Developing STEM curriculum.
2. Planning daily lesson.
3. Adopting a data-driven attitude towards measuring learns progress.
4. Developing STEM learning activities and hands-on material for classes.
5. Attending to individual student's needs.
6. Demonstrating an awareness of different students' backgrounds and culture.
7. Providing extra support to students who need it.
8. . Monitoring student growth to identify strengths and areas for improvement.
9. Using learner data to constantly refine your curriculum.
10. Providing regular feedback to student.

STEM Education and the New World Order

STEM education is pertinent to the world future because of its relevance to the economy and the need for a citizenry to be able to make wise decisions on issues faced by modern society (Wieman, 2012). These four disciplines are generally combined in the form of a student's STEM project. In science teaching, the STEM project is an application of science concepts that are always adapted to real contexts

in everyday life. According to Afriana, Permanasari and Fitriani (2012), the implementation of project-based learning in STEM education makes STEM learning interesting, motivating to the students and lead them to form creative attitudes.

In relation to the implementation of STEM education, Bybee (2013) states that in STEM learning, at a higher level of education, students need to be challenged to perform authentic engineering tasks as a complement to science learning through project activities that integrate science, engineering, technology, and mathematics. As observed by Yennita et al (2019), applying STEM education particularly in schools is very low. Thus, science teachers need to be more active in applying the STEM approach in their teaching. Though STEM has not been maximally implemented by teachers in teaching, especially science teaching, all science educators agree that STEM is an all-inclusive method that is required. In his study, Bozkurt and Ercan (2016) observed that science teachers have a positive perception of the application of STEM in learning.

In teaching STEM, the aim is to maximize the extent to which the students develop expertise in the relevant STEM subject. That is, for the STEM education to be effective to stimulate the STEM learners to think as an expert in solving problems and in making decisions. The learners will also have the skill to monitor their own thinking when solving problems, testing their understanding and the suitability of different solution approaches, and making corrections as appropriate.

According to Marmon (2019), STEM has become an ubiquitous term that is used to describe the necessary skills that are essential for workers in a 21st century globalized economy. The term has thus been used to equate the 21st century skills with success in both the private and public sectors. There is therefore the assumption that students educated in STEM subjects would possess and exhibit 21st century skills.

The 21st century skills which is expected to drive STEM has been classified differently by different authors. The classification by Crockett (2016) is listed as problem-solving, creativity, critical thinking, collaboration, communication, ethics and action and accountability skills.

Problem-Solving

It is the act of determining the cause of the problem, identifying, prioritizing, and selecting alternatives for a solution. Problem-solving is about making choices. Effective problem-solving skills result in confident and independent individuals.

People with good problem-solving skills tend to look at challenges from fresh perspectives.

Creativity

It is the ability to think about a task or a problem in a new or different way. It is the ability to use imagination to generate new ideas. If one is creative the person looks at things from a unique perspective. The creative process involves four stages: (1) Preparation – this refers to the period of intense conscious attention to the task that continues until our thinking processes reach an impasse and we are baffled, and recognize that we need to take a break to give working memory an opportunity to refresh; (2) Incubation – this is a period of relaxation away from the task such that the brain may look at the problem with new perspectives or simply daydream; (3) Illumination – the *eureka* moment is here – that moment when the solution or insight suddenly becomes clear; and (4) Verification: Here we check thoroughly to see if the solution actually works.

Critical Thinking

Embedded in critical thinking are skills of analysis, interpretation, inference, explanation, self -regulatory and open-mindedness. It is ability to engage in reflective and independent thinking. It is the ability to think clearly and rationally. These skills are crucial in education and the workplace, as they enable the gathering and articulation of information towards the provision of solutions to complex problems. Such effort requires great insight and the ability to make reliable predictions following available evidence.

Collaboration

Collaboration skills enable one to successfully work towards a common goal with others. The skill encompasses communicating clearly, actively listening to others, and taking responsibility for mistake. This skill is widely demanded now more than ever in education, technology and the workplace.

Communication

People communicate by articulating their thoughts and ideas effectively using oral, written or, sometimes, non-verbal means. Communication also involves the use of multimedia formats including video and imagery. An aspect of effective

communication is the ability for one to listen carefully in order to appreciate meanings, values, attitudes, and intentions of others communicating with you.

Ethics and Action

Ethics and action involve global awareness, tolerance, environmental awareness and adaptability. According to Crockett (2016), these are among some of the essential features expected of a global digital citizen. A modern individual is expected to practice personal, global and online responsibilities that focus on how to make the world a better place for everyone. We need to deliberately create humane, selfless and caring persons who respect other cultures and their belief systems. Such people are diligent in their daily chores and seek to live above reproach in their interactions with other people, whether online or offline. Teaching in schools, colleges and universities should therefore deliberately emphasize internet safety and the habit of having empathy for others. With respect to ethics, it is noteworthy that ethics provides a set of standards for behaviour that makes it easy to take a decision on how we should act in different situations (Akpan, 2021). Ethics involves making choices, as well as providing reasons for such choices.

Accountability skills

The key to being accountable is to take ownership of your mistakes and shortcomings. Own up the errors and then make a plan to fix them. Ensure that the mistake does not occur again. There are personal accountability, fiscal responsibility and administrative accountability among others.

Emerging Issues and Technology in STEM Education

Technology is the practical application of scientific knowledge. It is a sum of techniques, skills, methods, and processes used in the production of goods or services. It is accomplishment of objectives in scientific investigation. Technology is used to support both teaching and learning. Technology infuses classrooms with digital learning tools, such as computers and hand held devices; expands course offerings, experiences, and learning materials. It builds 21st century skills in learners and increases students' engagement. When technology is integrated into lessons, students are expected to be more interested in the subjects they are studying .It improves knowledge retention, encourages individual learning, encourages collaboration,

students can learn useful life skills through technology and teachers benefit in the technologies while teaching. (Esomonu, 2020). Some of the techniques, devices and systems that are in use include Classroom Response Systems (clickers), Mobile Learning(M-learning), Tablet Computing, Massive Open Online Course (MOOCs), Learning Analytics, Mixed Reality(MR), Virtual Reality (VR), Augmented Reality(AR), Video-Based Computer-Assisted Test (VBCAT) and so on.

Clickers

Classroom response systems or clickers are instructional technologies that enable teachers to rapidly collect and analyze students' responses to multiple-choice and free-response questions during testing or classroom activities.

Mobile Learning

M-learning or mobile learning is learning across multiple contexts, through social and content interactions using personal electronic devices. A form of distance education, m-learners use mobile device educational technology at their convenient time. M-learning technologies include handheld computers, MP3 players, notebooks, mobile phones and tablets.

Tablet Computing

This is a form of using fingers and swipe action, or by use of a special purpose pen to write on a type of notebook computer that has an LCD screen. The touch screen display is operated by gestures executed by finger or digital pen instead of the mouse, keyboard, etc.

Massive Open Online Course (MOOC)

This is an online course aimed at unlimited participation and open access via the web. It offers free education in an online environment, with no limit on class size. MOOCs are relatively new development in education, representing a trend towards affordable education, which is available to the masses, in a collaborative, connected space, with traditional educational materials, like lecture slides and videos, supplemented with interactive elements

Learning Analytics

Learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and its environment. Some of the techniques include machine learning, data mining, visualization, social network, gamification (Nistor & Hernandez, 2018; Sclater, 2017)

Mixed Reality (MR)

This is the merging of real and virtual worlds to produce new environments and visualizations, where physical and digital objects co-exist and interact in real time.

Virtual Reality (VR)

This is a simulated experience that can be similar to or completely different from the real world. Application of virtual reality can include entertainment (i.e. video games) and educational purposes (i.e. medical or military training.

Augmented Reality (AR)

This is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities.

A Video-Based Computer-Assisted Test (VBCAT)

This is also known as video computerized-assessment, and video computer-administered testing, is a method of administering tests in which the responses are electronically recorded, assessed, or both. As the name implies, it makes use of a video computer or an equivalent electronic device such as a cell phone or PDA. VBCAT systems enable educators and trainers to schedule, deliver, and report on surveys, quizzes, tests and exams with the aid of a video.

The question is how is Nigeria harnessing these technology advances in education system and particularly in STEM Education? As the result of great innovations and advancements in ICT across the globe, African countries including Nigeria like others are geared towards supporting their educational system to harness full advancements in technology. There are growing numbers of evidence of technology development success in the region. It was reported that 16% of the African population has internet access, and this number will increase to almost 50% by 2025 (ITU 2013). The

information and communication technology sector grew at an annual average rate of at least 20% over the period 2000–2009 (UN ECA in Esomonu 2020). Nigeria is one of the African countries where people gain access to information regardless of their location and obtain a technological tool that transforms their daily lives. There are good efforts to integrate these into our classroom and reduce the gap. The good efforts in these directions have not yielded significant results. However, the students are becoming ever more aware and comfortable with technology. Students expect technology integration into their learning.

STEM Education During the COVID-19 Pandemic

During COVID-19 there were online, screen or mobile-based learning, but radio has more potential in low- income countries **(**TEP-NESG, 2020). In terms of technology, radio has the widest reach, lowest cost and quickest start-up period (Bangay 2020; Hallgarten 2020).

According to Vegas (2020), while about 90% of high-income countries are providing remote learning opportunities, less than 25% of low-income countries are offering any type of remote learning at all. Consequently, the high-income countries engaged learners via online platforms, while the low-income countries mostly used television and radio to reach learners. In fact, only about 23% of countries in sub-Saharan Africa combine online and broadcast media platforms, and only 11% rely exclusively on online platforms. A paper-based self-study material was also introduced in some countries especially for students who might not have literate parents/ guardians. These materials catered for students at different attainment levels in those counties. However, there was a problem of hygiene logistics, as COVID-19 can live for long hours on paper (Bangay, 2020).

Most education technology service providers adapted their platforms to support remote learning on large scale. Websites for learning during this period expanded their content. Generally, education technology tools were remodeled during the pandemic to include features that would facilitate the participation of parents or guardians in their children or wards' remote learning (Adegboye & Henshaw, 2020; TEP-NESG, 2020). The question is to what extent did Nigeria fair in these experiences.

As emerging issues during pandemic, COVID-19 public health messages and training were included in STEM education. Although, the remote learning interventions

adopted was an immediate response strategy to STEM education on health issues. Information was also provided on how STEM educators can actively support public health campaigns. STEM education in emergencies generally included information on the prevention of, preparedness for, response to, and recovery from health challenges. With the transition to online learning, all lecture-based interactions occurred using the chat with students during lecture and utilizing smaller break-out rooms for small group interactions.

Impacts of Covid-19 on STEM Education in Nigeria

Prior to COVID-19, Nigeria accounts for one in every five of the world's out-of-school children. About 10.5 million children aged 5-14 years in Nigeria were out of school, and only about 61 % of 6 to 11-year-old children receive primary school education on a regular basis (UNESCO, 2020a). Hence, while Nigeria is battling with underlying educational challenges that have kept the country behind in getting young people ready for the dynamic workplace (Obiako & Adeniran, 2020), COVID-19 impacts further aggravated this problem.

Following the COVID-19 pandemic, all schools in Nigeria were closed from March 27, 2020, as one of the Federal Government measures to limit the spread of the disease. This translated to state-wide school closure across the 36 states in the country. In response, different states' Ministries of Education released modalities for radio and TV schooling and internet-based learning for students in public primary and secondary schools. Though these efforts could be effective in developed countries, but that was not the case with the education system in developing low-income countries like Nigeria (Obiako & Adeniran, 2020).

The remote learning devices and online learning apps for primary and secondary learners are practically not feasible in most Nigerian communities. Poorly resourced institutions and socially disadvantaged learners have limited access to technology and the internet. Even in communities children have to assemble in village squares and town halls to even have access to radio and television not minding that they are supposed to avoid physical contact.

University students who may have the skills to undertake internet-based learning faced poor internet infrastructure and a lack of reliable electricity supplies. Some universities that use online medium to teach their students could not conduct examinations. During or after each online lesson, students and teachers found it difficult to interact by asking and answering questions.

Online users faced many technical difficulties that hinder or slow-down the teaching–learning process. Teachers in the form of facilitators faced a lot of troubles while working or preparing for online lesson because some of them lack adequate technical training.

Epileptic power supply being experienced across the country is one of the challenges that rendered online teaching programmes useless in Nigeria. Many Nigerians who live in the urban centers where we are expected to have steady power supply cannot boost of having uninterrupted power for more few hours.

Not all the teachers and students have access to all digital devices, internet and Wi-Fi. Most of the schools that partake in online teaching during the lockdown find it difficult to assess their students. This was because children in rural and underserved communities in Nigeria were not equipped to adapt or transition to new methods of learning.

It should be noted that all the learning activities of students during COVID-19 were done from home. Most of these homes are located in noisy environments which are not conducive for learning.

Challenges of Continuing Education Amid Covid-19

Total eradication of COVID-19 may not happen very soon. So the world and particularly developing countries like Nigeria will have to coop with the challenges of continuing education in the pandemic era. Some of the challenges are as stated.

Adjustment of Calendar and the Effect on Curriculum

During COVID-19 education institutions were forced to adjust the school calendar. Such adjustment in turn affected the curriculum and curriculum implementation. The pandemic impacted on the curricula implementation considering the use of technological platforms in teaching and learning, and the need to integrate the goals for which the curriculum was originally designed.

Effect of School Closures on Student's Health and Wellbeing

UNESCO (2020b) points out that many countries are concerned about the effect of school closures on student's health and wellbeing. Thus, education interventions in health-related crises are encouraged to prioritize mental health wellbeing (Decosimo et al., 2019).

Availability and Optimization of Intervention/Learning Need

There have been efforts by governments, private sector and key education stakeholders to continued education amid COVID-19. These efforts range from large-scale, low-tech solutions that do not require internet-enabled devices like radio and television, to high tech alternatives like virtual classrooms, video conferencing, animated lessons and online resources that require internet-enabled devices. These learning services/interventions need to be available and optimized.

Unequal Access to Resources for Online Teaching

The interventions are more beneficial to those students in the urban areas who have the resources to participate in the interventions compared to their counterparts in rural areas. The resources that were identified as unequally accessible by the students include digital tools, internet access and electricity. Few of these learners - mostly from financially privileged households - have access to quality learning opportunities from the comfort of their homes. Major causes of this inequity include limited or non-availability of smartphones or computers and internet services in most homes, and the large number of schools that lack the financial and technical capacity to transition from in-school to remote learning facilitation (TEP-NESG, 2020).

Training of Teachers to Teach Online

Nigeria requires massive training of teachers participate on online teaching and in the use of e-learning. Teaching online is much more difficult than teaching face-to-face (Lawal, 2020). For schools that may be better resourced, it has been challenging facilitating practical-oriented subjects and courses that typically engage students through laboratory experiments. With the closure of schools, there are very few schools that can afford to set up and maintain virtual science laboratories where students and the teachers or lecturers can work together to simulate experiments (Abbey & Hoxley, 2020). These students will have to make do with learning the theoretical aspects of science subjects alone, until schools re-open.

Implementing Inclusive Education

The COVID-19 pandemic has also threatened the education of children or youths with special needs and disabilities. This has been a problem before pandemic but was aggravated in the emergency period of pandemic.

Monitoring of the Home-Schooling

The shutting down of schools has necessitated deeper and more technical levels of involvement of parents in their children's education. This has been challenging for most parents, as school teachers were mostly directly responsible for driving the learning outcomes of school children. A number of parents have had to balance working or managing their families with actively facilitating or monitoring the home-schooling of children (Babatunde, 2020). Children whose parents cannot afford remote learning facilities may have to wait for schools to re-open to continue learning, so the level of preparedness it is uncertain of children to return to school when the pandemic is over is not the same (Obiakor & Adeniran, 2020).

The Leadership Style of Government Agencies

The education crisis during the pandemic has also challenged the leadership style of government agencies working in education. These agencies have had to deploy crisis management skills in ensuring that the number of Nigeria's out-of-school children does not increase by working with stakeholders to provide distance learning opportunities many children. They however have not provided an enabling environment for public tertiary institutions to transition from traditional schooling to remote schooling.

Conclusion

COVID-19 has made intensive use of technological advancement in STEM Education inevitable. STEM educators will use more e-learning video services and online learning even after the pandemic is over. They will incorporate social media into their classrooms and will use more of artificial Intelligence (AI) in classroom. STEM Educators must harness the technological advancement in teaching STEM subjects. The will enable the inculcation of 21st century skills to STEM students to make them global competitive.

Recommendations

The students, the teachers and the environment should be made compliant to both remote and face-to-face modes of teaching and leaching of STEM subjects in the world new normal situation. To achieve these, the understated things should be done.

1. Revisions of the teaching, learning and assessment methods should be done to sooth the increasing technological advancements for STEM education.
2. Providers and stakeholders in education must be serious about equipping our classroom and learning environment for STEM education.
3. Students and teachers must have sufficient access to digital technologies and internet in their classrooms, laboratories and workshops to facilitate both distance and face-to face handling of STEM subjects.
4. Schools and institutions of higher learning should have standard and functional health providing systems/clinics
5. The curriculum should be reviewed to contain adequate digital content.
6. Nigeria needs to address the logistics and funding issues that hinder procurement, implementation, maintenance, and modifications of schools' technological equipment for STEM education.
7. Educational technology should be made available and accessible to the teachers and students. Workshops on application of various educational technology and awareness on its importance/impact should be done regularly to make the STEM teachers and students acquire the digital skills. (Esomonu, Eleje & Metu,2021)

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