Research Article

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COVID-19 Pandemic: A Catalyst to Technology Integration in Teaching for Sustainable Science, Technical and Vocational Education in Nigeria

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ABSTRACT

It is an undisputed fact that the existence of COVID-19 disease has posed many challenges to the different sectors of the Nigeria economy and the educational sector seems to be the most adversely affected. This is because of the total lockdown of schools for several months as part of the measures put in place by the federal government to curtail the spread of the disease. As a result, teaching and learning activities were shut down because of various technological development challenges. This paper focuses on the challenges posed by the COVID-19 disease to the education sector and the need to sustain the growth of science, technical and vocational education (STVE) in Nigeria in spite of the pandemic. Using the narrative literature review methodology, impact of the pandemic on teaching and learning STVE were discussed as well as different innovative and technology-driven approaches that could be integrated when similar crises occur in the future such as online teaching and learning, social media platforms, electronic learning, learning management systems, printed courseware, flipped classroom model, educational broadcasting, and synchronous communication tools were also explored in the paper. The recommendation elaborates on the need for stakeholders to be adequately prepared in terms of necessary trainings and provision of amenities that support continuous learning whenever civic and health crises necessitate emergency closure of schools in the country.

Keywords: COVID-19, science technical and vocational education (STVE), technology-driven education, technology integration, vocational education

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INTRODUCTION

In recent times, different health crises have been experienced in Nigeria. There was H5N1 virus (bird flu) outbreak in 2008, the ravaging ebola virus disease in 2014 that delayed schools' resumption and the lassa fever disease which continue posing health problems in different communities in Nigeria. In the midst of all these, a new corona virus infection disease (COVID) broke out in Wuhan province of China in December 2019. Since then, the disease continued to spread like a wild fire to nearly every country of the world with an anticipated threat to public health. World Health Organization (WHO) defined COVID-19 virus as a disease caused by a novel strain of coronavirus which links to the same family of severe acute respiratory syndrome (SARS) and some types of common cold (WHO, 2020a). Olowo (2021) reported that WHO declared the disease as an outbreak on January 30, 2020 and as a global pandemic on March 11 of the same year. It is a viral infection that causes respiratory illness and it is basically transmitted through contacts with droplets of an infected person. Some of the symptoms include sore throat, fatigue, running nose, coughing, sneezing, and difficulty in breathing (WHO, 2020b).

In February 2020, Nigeria Centre for Disease Control (NCDC) recorded and reported the first index case of COVID-19 in the country through an Italian businessman who visited the country from Europe (NCDC, 2020). Since then, thousands of infections and hundreds of deaths linked to the disease have been recorded in the country. In order to curtail the spread of the disease, the Federal Ministry of Education (FME) on March 19, 2020 ordered the indefinite closure of schools throughout the nation. The closure lasted for several months, thereby preventing teaching and learning activities from taking place within the premises of the school, a situation that calls for sober reflection and the need to re-tool the country's educational practices just like the developed countries of the world.

Research Problem

One of the major sectors of the economy badly struck by the pandemic is the education sector. UNESCO (2020b) estimated that 1.725 billion learners, representing 99.9% world students' population,

were globally affected as a result of school closure. While school closure in developed countries is attributed to physical closure of the schools' infrastructure with option for electronic supported learning, school closure in developing countries like Nigeria is total and complete absence of teaching and learning of any kind. This was buttressed by the statement credited to the FME that COVID-19 has deprived over 80 million Nigerian students access to quality education (FME, 2020). The act of depriving students access to education during the lockdown was facilitated by the infrastructural challenges inherent in the education system such as power supply, unavailability of devices and computers, and the internet or low internet bandwidth which would be used to connect teachers and students for continued learning.

Now that the danger of the pandemic is lessen, Cortez (2020) calls for urgent need to address instructional delivery system in developing countries, to which Nigeria is no exception.

Aims and Research Objective

The purpose of this study was to appraise teaching and learning of science, technical and vocational education (STVE) before the pandemic, impact of the pandemic on teaching and learning activities and review some innovative ways of teaching during and after COVID-19 especially in Nigeria and by extension in other developing countries of the world. In order to have a system that conform to global acceptable standard, experts in the field of educational system design must work towards the digitalization of school curriculum by developing courseware, multimedia systems and simulated graphics for teaching practical oriented courses particularly STVE. Additionally, the digitalization must be accompanied with provision of physical and digital laboratories, the raw materials, machines, tools and behavioral re-orientation to the trainees.

The researchers used the literature review method. This method involves gathering information through the narratives of relevant research reviews critique and summarizes a body of literature to form a position paper on a particular theme or topic.

Teaching and Learning of STVE before COVID-19 Pandemic

Prior to the pandemic, the typical academic year in Nigerian schools ran from September to July of the following year. During this period, most institutions of higher learning offering STVE courses in the country operated a two-semester-based program in which students spent between 12-15 weeks in a semester for registration, lectures and examination. This conventional mode of schooling was usually characterized by over-crowdedness in class, abnormal student-lecturer ratio, inadequate infrastructure, lack of qualified human resources and ultimately, less-quality education among others.

Since face-to-face interaction between the teacher and students is a requirement, a course lecturer would gather a group of students in a class for physical and direct interaction during teaching and learning. These classrooms are usually overcrowded due to the overpopulation of students against the resources available. A classroom that was originally meant to accommodate only 30 students would now accommodate about 100 students.

In addition, student-lecturer ratio was abnormally represented because of the understaffed nature of Nigerian institutions of higher learning. Lecturers are left with no option than to combine students in large classrooms especially during general courses. In such situations, 65% of the students would have no place to sit while those who managed to get a seat would manage to hear what the lecturer was

teaching. Classroom management and control by the lecturer therefore became a difficult task to achieve.

Furthermore, work overload in terms of laboratory/workshop practical, project and thesis supervision were an issue that could be linked to shortage of manpower in most Nigerian institutions offering STVE. Supervision overload is an issue arising from the abnormality in lecturer-student ratio. Students were not adequately and effectively supervised during practical and projects because the ratio of students assigned to a lecturer was always more than what he or she could productively handle viz-a-viz other administrative tasks. This directly affects lecturer's productivity in science, technical and vocational education practice.

The inadequacy of physical infrastructures as well as unavailability and insufficiency of teaching and learning resources were also contributory characteristics. In some institutions, the resources were not available, while in some others, it was either obsolete or not working because of shortage of funds to buy spare parts or for maintenance. Consequently, science courses which includes biology, chemistry, physics, general mathematics, further mathematics, agriculture, physical education, and health education were often taught in abstraction. The skills of science may be learned easily if the students are given opportunities to explore, exercise creativity, debate and argue in the process of learning science. Such experiences lead to a sustainable development through the provision of a well-skilled human capital capable of providing solutions to real-life problems (Opoko et al., 2018).

STVE courses that need more practical demonstration, observation and active learners' participation were poorly taught in Nigeria even before the COVID-19 pandemic due to the aforementioned points, one could only imagine the devastating impact of the disease on STVE in Nigerian institutions.

IMPACT OF COVID-19 PANDEMIC ON TEACHING AND LEARNING OF STVE

COVID-19 is a health challenge which requires drastic precautionary measures. Being a global health problem, there was lockdown and restrictions of movement in many countries of the world to curtail the spread of the pandemic and educational institutions were not exempted (Chukwuemeka et al., 2020; Falode, 2020). Although, the lockdown was put in place to curb the pandemic, it however, left teaching and learning STVE with some irreversible impacts which its implications call for the need to re-tool future educational practices. UNESCO (2020b) reported that over 100 countries that implemented school closure had many students experience disruptions of their academics. During this period, unlike developed countries, students in Nigerian schools felt the impact of physical separations from their teachers and schools in the following ways.

Interruption of Academic Activities

The Federal Government of Nigeria through the Federal Ministry of Education on March 19, 2020 ordered the closure of all schools nationwide in order to prevent the circulation of the deadly virus. The closure lasted more than the duration pronounced making the closure of schools' indefinite until a little window of reopening in December 2020. No school was able to flow in their normal routine as many activities such as students' learning; internal assessments were interrupted just to meet up with the examination. According to

Ogunode et al. (2020), public assessments were cancelled while some were replaced by inferior alternative.

Cancellation of Academic Conferences and Exhibitions on Research Outputs

Academic programs were put on hold due to the seriousness of the pandemic. The education sector especially the science, technical and vocational education cancelled and in areas where cancellations were not possible, re-scheduled academic conferences and exhibitions on research outputs scheduled for the first quarter of the year 2020 and early 2021. Ogunode et al. (2020) reported that during the pandemic, institutions were mandated to suspend research activities involving large gatherings leading to a low turnout of academic research and exhibition work.

Loss of Workforce

The COVID-19 pandemic claimed a lot of lives while many staff quit their jobs for the fear of contacting the virus and for the safe keeping of their loved ones. According to Ogunode et al. (2020), tertiary institutions in Nigeria and others across the world recorded loss of many lecturers and great researchers to COVID-19 pandemic; a loss that is irreplaceable in a decade. These losses left laboratories deserted with no research activities going on, many reagents lost viability and laboratory animals died in the process. The loss of human workforce coupled with social distancing practices in laboratories affected the growth and development of science, technical and vocational education in Nigerian institutions of higher learning.

Social Distancing in Laboratories and Workshops

STVE by its demand is a practical oriented education which requires collaborative approach and methodologies, interactions and the conduct of experiments in teams among scientists, technologists and researchers. Thus, the mandatory social distancing of two meters, posed limitations to physical collaboration of researchers, students and lecturers during such practical activities in laboratories and workshops.

INNOVATIVE APPROACHES TO TEACHING STVE DURING AND AFTER PANDEMIC

There were identified problems associated with STVE before the COVID-19 outbreak. The pandemic in addition to the problems on ground, added more challenges, yet teaching of STVE should continue and be better improved upon. This therefore calls for innovative approaches that could take care of the present and the unforeseen future challenges.

The teacher training received in the 1980s and 1990s need to be updated to reflect the needs of present reality. This is because, the teacher training programmes of those years could not be applicable to the reality of this period as there was no COVID-19 pandemic, neither did the method of teaching require any form of technology. However, with COVID-19 and related health challenges, teachers need to make adjustment in planning and delivering teaching through different platforms such as Zoom, Skype, and other electronic learning (Cortez, 2020). The adjustment required is in skill development, paradigmatic shift toward incorporating technology for distant interactions, meetings, conferences. The need to integrate technology in teaching and learning is in line with the UNESCO 2030 education declaration and framework for action which emphasized the need for countries to provide alternative modes of learning that would ensure flexible learning in both formal and non-formal settings, as well as during emergency situations (UNESCO, 2020a).

COVID-19 is an emergency situation and the following are effective and flexible approaches that could be employed during and after the pandemic for teaching and learning while still maintaining standard.

Online Teaching and Learning

Online teaching/learning is an approach where online tools and resources are employed for the purpose of disseminating and acquiring knowledge. The key element to achieving this is the internet. Some of these platforms available online are www.openlearning.com, www.helphub.com, www.teachable.com, www.eliademy.com, and www.learnworlds.com among others, which allows the teacher to create contents, connect with students and experience online teaching and learning through these easy-to-use platforms. Apart from learning online, other interactions between the teacher and the students can be done online, assignment and examination at the end of the academic period can also be conducted using online facilities. The entrance examination into some tertiary institutions were conducted online during the pandemic with the candidates remaining in their homes while some institutions also successfully conducted semester examinations for students who were not at school. Online teaching and examination platforms were deployed for these exercises and would be much more needed in the future for the teaching, learning and evaluation of learning outcomes of students in science, technical and vocational education.

Social Media Platforms

Students in institutions of higher learning constitute the largest users of mobile devices (tablets and Android phones). Nearly all social media platforms for interactions can be installed on these devices which can enable the lecturer to make use of the chat feature capability on these platforms. The lecturer can create a group chat for students who are registered for a course at a particular period. Furthermore, planned educational contents in form of texts, audio, pictures or short video clips can gradually be released to the group in bits, discussions and interactions support can be ensured and the extent of participation by all students can also be monitored by the teacher. Platforms that allow those who may not be online at a scheduled time to have access to previous discussions and posts could be given preference in order to be of benefits to individuals who could be having problems related to internet connectivity. According to Chukwuemeka et al. (2020), the adoption of WhatsApp and Facebook as well as other social media platforms has increased significantly after the pandemic because of its ability to offer access to learning resources at any time and location in various formats.

Electronic Learning

Electronic learning entails the use of information and computer technologies, systems for developing and transmitting educational knowledge through the use of various electronic devices (Coman et al., 2020). CDs, mobile phones, radio, television, and computers are useful devices that support electronic learning. Even with the advent of world wide web, the use of offline resources such as CD ROMS and pre-recorded class sessions are still useful. A teacher could record his teaching and such could be packaged on CD and watched individually by students at different locations. Video camera used to be the major

known tool for such recordings, but with improved computer technologies, there are several simple-to-use software that can be used by a teacher to record, edit, score and share presentations to students. Students could download, copy and watch such recordings on computer, mobile devices or through digital video disc players at home or locations of their convenience. Further clarifications and discussions on watched session can thereafter be forwarded to the teachers by the students using different available means which is not limited to e-mail, phone conversion, WhatsApp platforms and so on. One major benefit of this is that recordings can be played back and watched over and over again until a learner is satisfied.

Learning Management Systems

Through the emergence and use of learning management systems (LMSs), many institutions have now made their teaching and learning internet-based. LMSs are web-based platforms for delivering quality online teaching which allows students to interact with educational contents, instructional providers as well as other learners (Angelova et al., 2015; Chukwuemeka et al., 2015; Falode et al., 2018). Popular LMSs include, Canvas, Moodle, Blackboard, WizIQ, D2L, eCollege, Sakai, Amazon Web Services Talent, HotChalk, and WizIQ (Dobre, 2015; Shakeel & Ijaz, 2011).

Through a dedicated LMS, the entire academic activities meant for a specified class of learners can be completed online. Students can complete their course registration, receive instructional contents, interact with instructors and colleagues, attend to assignments and test, manage their schedules, monitor and track their academic progress (Chukwuemeka et al., 2015). The COVID-19 pandemic leading to closure of many schools spurred several educational institutions to accept and adapt suitable LMS to their students' needs, of which has encouraged teaching, learning, and also having exams taken without any hindered.

Printed Courseware

Courseware refers to computerized learning material or other material designed on a specific discipline for use in an educational course or training. It is usually written and presented in a structured and sequential format in such a way that the end-user (learner) will feel that the writer directly teaches him or her (Falode, 2019). It is mostly used in distance learning programmes where the education provider and the learners are not in the same physical location. The material is then studied by students at their own pace, location and time of choice to acquire knowledge in a subject instead of attending regular classes. Although, in most cases, courseware is computer-decoded, traditionally, it can also be printed for learners who do not have access to required hardware for the courseware. When printed as text, it is affordable, easily accessible and offers experiences almost similar to those obtained in the classroom where learners rely on teachers' lesson notes and explanations.

If properly developed through team approach of instructional designers, subject-matter experts, graphic artists and language experts, all subjects and courses to be taken by learners in an academic term or semester can be printed, given to learners to study at home and learning will take place. If clarifications and additional points are needed from students, this could take place in classroom whenever schools resume.

Flipped Classroom Model

Flipped classroom is a classroom-inverted strategy in which students study instructional contents at home through online, electronic or digital means and complete assignments, exercises or practical in classroom with their peers and teachers (Abah et al., 2017). Lecturers are expected to create practical video contents of lectures and practical demonstrations that would be used throughout the session using a camcorder and editing software. These contents are stored in portable devices so as to enable students to safely transport media for learning at home (Chukwuemeka et al., 2020).

Based on the flipped classroom model, learning is shifted from classroom to the home while classroom contacts are only for assessments. At the commencement of schools' closure, the academic contents to be studied at school could be packaged and given to students to study at home while discussions and activities on them could later take place in the classroom whenever schools are opened.

Educational Broadcasting

Broadcasting is the transmission of signals to many receivers or viewers simultaneously via powerful electromagnetic waves. Through educational broadcasting, well-planned contents relating to school subjects can be relayed to students in different locations through public or dedicated radio and television stations. Falode et al. (2019) reported that each of the 36 states in Nigeria have at least one state-owned government television station, and a branch of the Nigeria Television Authority station established by the Federal Government. Also, considering the relatively inexpensive of radio and television gadgets, with well-planned school subjects and broadcast scheduled, students can be at home, or even at school and tune in the broadcast station at the scheduled time and connect to teachers, lecturers or instructors as the case may be. Broadcasting of school contents to learners during school closure would be highly effective if implemented as Omiko (2018) already found and reported that Nigerian children are more familiar with radio and television programmes. One major advantage of this is that a teacher can reach out to a large number of students in the same academic level in different locations while still minimizing physical contacts.

The Synchronous Communication Tools

The synchronous teaching takes place virtually in a real time and all participants receive instructional contents from the teacher simultaneously and there could be mutual reactions from both the learners' end as well (Cortez, 2020). Interactive real-time tools such as Zoom, Skype, Google Meeting, and Google Classroom could be deployed for instructional delivery and teacher-students' interactions during a pandemic such as COVID-19, necessitating schools' closure. The main advantage of this is that, since communication is possible from both ends, instant feedback can be provided.

Internship Schedules

Whenever the school is closed, to curtail a public crisis or health challenge like COVID-19 pandemic, the period should be diverted and spent by learners to acquire practical skills in science, technical and vocational skills at relevant workshops or laboratories of their choice outside the school premises while aligning and maintaining all health precautionary measures such as social distancing as in the case of COVID-19. During this time, students could work as interns or apprentices and acquire real life practical experiences that would

complement and simplify abstract contents already learnt or meant to be learnt in the classroom.

CONCLUSIONS AND RECOMMENDATIONS

Effective science, technical and vocational education is pivot to the growth of any nation. In Nigeria just like many other countries of the world, the COVID-19 pandemic is a terror that hinders physical presence in classrooms, laboratories and workshops, hence, preventing effective teaching and learning of STVE. Notwithstanding, education practitioners should regard the pandemic as a catalyst that has made us realize the need and urgency to integrate technology into teaching and learning for the sustainability of science, technical and vocational education in Nigeria.

The teaching and learning of STVE therefore requires innovative approaches that are technology-driven particularly now that COVID-19 has taught us so many lessons and also in responding to post COVID 19 challenges. Thus, some of these relevant approaches that could be deployed and adopted for the dissemination of knowledge to students during and after a pandemic or any other crisis that leads to school closure were discussed in this paper. Their effective adoption and utilization in teaching and learning of STVE could be achieved if the following recommendations are attended to.

1. Trainings and workshops on utilization of technology-driven instructional platforms should be conducted for science, technical and vocational education teachers and students. This is because their acceptance to use these platforms rely on their ability to use them.

2. Usage of technology-driven instructional platforms depends on availability of those facilities and their accessories. Schools' administrators should ensure that necessary facilities, in adequate quality and quantity are available for teachers and students' usage.

3. Since students and teachers usually stay at home whenever schools are closed, it is suggested that efforts should be made by them to acquire distance learning trainings. This will equip them with adequate knowledge of distance learning procedures.

4. The teacher training curriculum should be updated to accommodate innovative techno-pedagogical approaches. This will help to equip pre-service teachers with adequate knowledge to practice on the field both in conventional and distance learning settings.

5. In-service teachers should be willing to update their knowledge. They should endeavor to move with innovations. They should strive to be 21st century teachers, digitally inclined to disseminate knowledge even from the least possible places.

6. Science, technical and vocational education curriculum should be re-designed to create more avenues for students' practical acquisition outside the premises of the school during holidays or school closure. This could be through apprenticeship and internship in relevant places.

7. Finally, quality in terms of teaching STVE should not be compromised. Low quality teaching leads to quality learning which produces low quality graduates, who in turn will produce bad products or handle sub-standard projects which could cause

physical, mental and health challenges as deadly as the COVID-19 pandemic.

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