Microbiology Education in Light of COVID-19 Pandemic: Challenges and Opportunities in Nigeria: A Review

Oladunjoye, I. O.,[1*] Tajudeen, Y. A.,[1] Akinsuyi, O. S.[2], Alaka, H. O.[3] and Atta, H. I.[4]
[1]Department of Microbiology, Faculty of Life Sciences, University of Ilorin, Ilorin, Nigeria
[2]Department of Microbiology, Faculty of Life Sciences, University of Lagos, Akoka, Nigeria
[3]Department of Microbiology, Faculty of Science, Obafemi Awolowo University, Ile-Ife, Nigeria
[4]Department of Microbiology, Faculty of Sciences, Ahmadu Bello University, Zaria, Nigeria
Corresponding author: iyiolaoladunjoye@gmail.com

Abstract: Nigeria has a population of over 200 million people of which 1% of the population are enrolled in universities. Microbiology is a course with a high enrolment rate among undergraduates. The field is a vital discipline focusing on the study of microorganisms and their role in health, industry, environment, agriculture, climate change and other relevant sector and it has a potential of revolutionising medicine and the fate of a disease outbreak if the right research is conducted. However, microbiology education in Nigeria is faced with a lot of challenges which slow down the progress of the discipline and has negative impacts on the training of future microbiology leaders. The COVID-19 pandemic brought about closure of schools which put extra load on the already deficient education system and microbiology education is not left behind. The aim of this paper is to examine the challenges faced by microbiology education in Nigeria and explore the opportunities for improvement.
Keywords: Microbiology, Education, COVID-19, Pandemic, STEM, Nigeria

INTRODUCTION

Advancement in Microbiology education is evident in developed countries through their breakthroughs in vaccine development, drug discovery and application of gene-editing tools in the health sector. However, such technological progress related to Microbiology has been slow in developing countries like Nigeria. About one hundred and ten (110) tertiary institutions in Nigeria offer Microbiology as a course of study (Fatherprada, 2020) but there are still some vital research skills and technology lacking in these institutions thus posing a serious challenge in training future microbiologists. Even though Nigeria is a low- and middle-income economy, it is still lagging behind research in the field of Microbiology. Closure of tertiary institutions took effect on March 26th, 2020 as a response to the global pandemic and total resumption is still tentative at best because the disease is not yet contained. The Coronavirus pandemic is revolutionizing both digital and virtual learning worldwide and only private institutions in Nigeria have the minimum capacity to completely adopt this new method of learning (Obo *et al.*, 2020). The most disturbing fact is that most of the students enrolled in higher institutions in Nigeria attend federal universities, and most of these institutions lack the relevant ICT facilities required to adopt virtual learning completely. Thus, students of Microbiology in these institutions will continue to feel the effect of this gap long after the pandemic comes to an end. As Abdulwaheed (2019) opined, there is the need to incorporate virtual learning while teaching Microbiology in Nigeria to allow students to learn essential topics unavailable due to lack of the needed resources. Online science laboratory, short videos, online repositories and web games are some of the free assessment virtual tools recommended, and these can be very useful during this pandemic period. In particular, since students cannot physically perform experiments in the laboratory, online resources (training videos and ICT resources) are required to fill that gap.

Current Overview of Microbiology Education In Developing Countries

There are many challenges such as economic problems, political instability and educational problems (Chimombo, 2005). Economic problems include lack of funding for the following: infrastructure, training needs of personnel, professional development of academics, purchase of modern laboratory equipment and audio-visual equipment, maintenance of laboratory equipment, learning materials and lack of proper supervision which can act as a barrier towards the quality of Microbiology education thus making the teaching and learning of Microbiology difficult. External funding contributes to the development of education through its impact on research and improvement of postgraduate trainings in tertiary institutions. However, the Global Education Monitoring Report (2013/2014) reported that aid to education has stagnated over the past years which are further aggravated by the need to sustain the economic growth of underdeveloped countries (Al-Ansi, 2017; UNESCO, 2017). Even though there is the Tertiary Education Trust Fund (Sofola, 2014) set aside to fund research and postgraduate training in Nigeria, however, these funds are not dedicated to only Microbiology education alone but also to other fields of studies, thus accounting for its high level of competitiveness. Factors such as corruption and nepotism have been allegedly linked with the selection process at the institutions during the application process (Abdulwaheed, 2019) making Microbiology education difficult. Unlike the situation of education in developed countries, many developing countries most especially the sub-Saharan African countries are faced with the problem of infrastructural deficits which is severely affecting the resulting quality of education. Apart from the lack of available lecture halls due to the high number of students, there is the problem of unstable power supply making the use of electronic learning devices such as projectors, audio-visual equipment, electronic whiteboards, and ICT equipment, difficult to use (Chimbelu, 2011). Broadband internet connectivity is also a challenge in most Nigerian universities.

Political instability is another problem affecting Microbiology education in developing countries. Education policies and plans are developed at the national level based on the interests of government and contemporary political thoughts (Popkewitz, 2000). The federal government plays a key role in the funding of education, developing standard curricula across fields of study, managing and supervising lecturers and overseeing various aspects of the educational system and setting standards for evaluation of students' performance (WorldBank, 2004)

Another challenge is inadequate learning resources which include textbooks, laboratory manuals, journal subscriptions, and relevant software for certain applications and analyses of certain laboratory data. Also pertinent are e-learning materials in higher institution of learning (Ndume *et al.,* 2008). Lack of sufficient funds and poor policies are among the reasons for this dearth of educational resources. Hence, there is the need to develop books at the local level which will be of international standards through regular updates (Balogun *et al.,* 2017). E-Learning is another problem that falls under this category; this is an online educational system that requires the use of reliable internet connectivity.

However, some of the challenges associated with e-learning in most of the sub-Saharan African countries include poor internet connection, budget constraints, lack of e-learning policies consideration, lack of e-learning curriculum developers, lack of required technological infrastructures, insufficient virtual learning skills by both students and lecturers (Ndume *et al.,* 2008). The COVID-19 pandemic is revolutionizing the educational system in every country and this is the best time to advocate for e-learning to achieve a comprehensive learning experience on all occasions.

The response of developing countries to the COVID-19 pandemic made it all the more glaring that our current research capabilities need revamping and a total overhaul to make us better prepared in handling health crises relating to infectious diseases. Most of the studies worldwide relating to the SARS-CoV-2 virus are from developed countries and very few from developing countries in Africa. It is pertinent that Nigerians and Africans study the virus concerning our unique environment, as this is vital in understanding the epidemiology of any disease. Even though, many approaches have been successfully applied in managing diseases such as malaria and tuberculosis which are common in Africa, there is still a lot of work to be done in mitigating the spread of infectious diseases, especially with the occurrence of emerging and re-emerging diseases.

Challenges of Studying Microbiology In Nigeria

These challenges include but are not limited to:

A Decline in Teaching Experts

In Nigerian institutions, the teaching of Microbiology has always been affected by the unavailability of adequate resources. The high number of students being enrolled in Nigerian universities has resulted in a poor lecturer-student ratio, leading possibly to poor teaching and supervision of students during lectures and practical sessions which in turn leads to a decline in the quality of education passed on to the students. The decline in the teaching experts is a result of brain drain resulting from teaching experts leaving the country to further studies abroad and in most cases, they do not return (Abdulwaheed, 2019), or leaving academia for other sectors of employment, such as the commerce industry, private firms, agriculture, banking, manufacturing industry, et cetera.

Inadequate Funding

The study of Microbiology requires adequate funding to meet the demands of the course requirements. An explicit comparison between the stunted growth and rapid growth of schools built in the 1980s and the ones established in the preceding last two decades respectively shows the big gap in funding (Ugwuanyi 2016). Another big challenge facing Microbiology education in Nigeria is "funding". There is no adequate fund dedicated to Microbiology training (Abdulwaheed, 2019), although there is a Tertiary Education Trust Fund (TETFund) in Nigeria which is primarily used to fund research and postgraduate pieces of training for academics in tertiary institutions (Sofola 2014).

Poor Training Infrastructure and Facility

Basic laboratory equipment such as incubators, autoclaves, hot air ovens, microscopes, which are very crucial for the course is not adequate or unavailable in some cases (Abdulwaheed, 2019). They are often outdated and not in tune with the current technology, also due to the large number of students handling them, they tend to succumb to wear and tear faster,

thus requiring replacement which doesn't usually happen. In a scenario where insufficient laboratory equipment is used in practical sessions, it will always result in overcrowding of students and inevitably most of the students get distracted and end up not having "hands-on" practical experience. However, this challenge is not common in private owned universities since they have adequate funding. As a result of this, most graduates of Microbiology in Nigeria are not globally competitive (Abdulwaheed, 2019). Libraries have become archives of mostly obsolete materials, also some of the libraries do not have facilities for e-resources, thus subscriptions to e-journals and global scholarly publishers are non-existent. Consequently, shortage of learning resources also results in poor quality graduates (Ugwuanyi, 2016), which can contribute very little to innovative research in Microbiology.

Out-dated Lecture materials

In many Nigerian institutions. Many lecturers do not update their notes and still use these out-dated notes that contradict current realities (Abdulwaheed, 2019). Even though the Nigerian Universities Commission (NUC) ensures the curricula in Nigerian universities are updated with recent course contents, some academics still rely on old materials which may contain outdated information not conforming to the current situation. Also, an explicit comparison between some of the institutions' Microbiology curriculum and the ASM Recommended Curriculum Guidelines for Undergraduate Microbiology Education showed that topics like emerging diseases, information flow and genetics, microbial systems and the impact of microorganisms are either not taught or need some improvement in its teachings. To make Nigerian Microbiology graduates more globally competitive, these topics need to be taught and incorporated into the curriculum.

COVID-19 has hampered the landscape of learning in Sub Saharan Africa by limiting the learning accessibility of students across the country (Aborode *et al.,* 2020). So far, non-pharmaceutical interventions such as masks, washing of hands, social distancing, have been the most effective way of minimizing the spread of COVID-19. The World Health Organization (2020) listed Nigeria amongst 13 other African countries identified as high risk for the spread of the virus, in response to this the government set up a body to mitigate the menace the virus would pose if it eventually emerges in the country. The government alongside with Federal Ministry of Education directed all educational institutions in Nigeria to close down schools on 26th March 2020 in an attempt to curtail the spread of the virus. The effect of COVID-19 on higher institution development in Nigeria including; reduction in international education, disruption of academic calendar of higher institutions, cancellation of local and international conferences, teaching and learning gaps, loss of workforce in the educational institution, cut in the budget of higher institution and finally, suspension of examinations (Jacob *et al.,* 2020).

In Nigerian institutions, basic Microbiology has traditionally been taught by the faculty of science while the medical or clinical Microbiology unit is usually part of Colleges of Medicine. Basic Microbiology is taught as part of graduate and undergraduate programs at many universities, especially science and technology–oriented universities, while medical Microbiology is taught during clinical postings (Abdulwaheed, 2019). The following paragraph attempts to provide some of the impacts of COVID-19 on Microbiology education in Nigeria.

The Microbiology community is saddled with the responsibility of conducting quality research (O'Malley, 2016). However, the COVID-19 pandemic leading to the closure of schools has slowed down Microbiology related research. Final year students of Microbiology in Nigeria universities are greatly affected as final year laboratory work were still in progress before the lockdown and thus cultures preserved could get contaminated or become non-viable during this period of school closure.

Secondly, the closure of schools has influenced the move to adopt online learning but due to lack of the required tools and internet coverage, the move has been stagnated. Digital Global Report 2020 reported that 60% of people from Nigeria are not connected to the internet and thus online learning has failed woefully especially with the COVID-19 pandemic (Digital Trend, 2020).

Also, the pandemic has revealed that there is an inadequate number of independent molecular microbiologists in Nigeria. This can be attributed to the fact that not all public Nigerian universities have the required human and capital resources to teach molecular techniques. These two topics can be integrated into Microbiology education in Nigeria using electronic tools such as short videos, massive online courses and web games (Abdulwaheed, 2019).

Finally, COVID-19 has greatly shown that research in the field of Microbiology needs to receive more funding, and government needs to increase the percentage of budgetary allocation to tertiary institutions. Thus, there is the need to invest in the field as it has a very important role to play in prevention and control of infectious disease outbreaks being experienced globally.

Proposed Solutions/ Recommendations

Telelearning and Massive Open Online Courses (MOOCs)

Telelearning is online instrumental tool, resource, and device widely used in MOOCs for providing teaching services in form of live and recorded lectures using platforms like Zoom, Skype, Google Meet, etc. (Rani and Surana, 2015). Telelearning can be effectively used in MOOCs platforms which when integrated with Microbiology taught courses can serve as a means of promoting the study of Microbiology as well as complimentary digital teaching tools in achieving educators' and students' goals. MOOCs are unrestricted models used for delivering Microbiology courses online where students can have access to reading materials, problem sets, and also participate in discussion boards (Passey 2012; Abdulwaheed, 2019). Most of these courses are openly accessible and teaching sessions are usually in modern video format using notable platforms like Coursera (https://www.coursera.org), edX (https://www.edx.org), Udemy (https://www.udemy.com), Udacity (https://www.udacity.com), FutureLearn (www.futurelearn.com) etc. MOOCs are made available to students to supplement their taught courses/topics as well as personalize their learning environment (Morris 2014).

The twenty-first century education is faced with the challenges of providing high learning experiences and cost-effectiveness to suit the needs of the ever-increasing students' population in institutions of learning to meet the outstanding digital demands and knowledge-driven society required in today's educational system (Torrisi-Steele and Drew, 2013). These challenges which are also peculiar to Microbiology education in Nigeria can be addressed with MOOCs.

The digital revolution brought by the coronavirus pandemic has emphasized the crucial position of MOOCs in the teaching of Microbiology courses in Nigeria's tertiary institutions, the benefits of integrating MOOCs in Microbiology taught courses include: re-watching of lecture videos, strengthening key skills, filling spaces in expertise, and availing students with the needed skills and styles on virtual teachings (Griffiths *et al.,* 2015). Three courses integrated with Udacity contents in San José State University (SJSU) showed a high rate of students' success (Bruff *et al.,* 2013). It is important to note that adapting to new technology and computer literacy can serve as challenges to the integration of MOOCs (Bralic and Divjak, 2018). However, the higher institutions in Nigeria can learn from the achievement of SJSU by incorporating MOOCs in the teaching of Microbiology courses.

Virtual Science Laboratories (VSLs)

These are web-based platforms that use virtual technology to design makeover science laboratories that can be used for online teaching of Microbiology practicals (Vandermolen, 2016).

These laboratories allow the simulation of real laboratory equipment and operational procedures by Microbiology students in learning complex laboratory procedures such as PCR and other molecular methods (for instance, cloning), in modules like Microbial Physiology and Genetics; as well as basic Virology practical sessions not taught at undergraduate level due to lack or inadequate equipment/funding, and the risks associated—this can be made easy with free accessible VSLs and help students simulate the actual laboratory experiments anytime and anywhere (Abdulwaheed 2019). VSLs are good alternatives for institutions with limited laboratory resources such as the case of most government-owned institutions that offer Microbiology as a course in Nigeria.

The study of Microbiology in Nigeria is faced with challenges that negatively affect the students; these challenges include limited laboratory resources for large numbers of students. This could lead to the lack of essential laboratory skills among Microbiology graduates, thus making them seek careers not related to Microbiology. The Faculty of Engineering in a large research institute in the United States of America has successfully integrated MyDNA VSL in the teaching of DNA fragments separation and processes involved—with my MyDNA VSL, students can successfully repeat experiments and learn of their own volition (Toth 2016). The University of Glasgow in the United Kingdom also adopted VSL in the teaching of Molecular Biology topics like PCR and Gene Sequencing to improve students' knowledge in the aspect of Molecular Biology. Some of these VSLs include: DNA from the Beginning (www.dnaftb.org/##), General Microbiology Labs (www.uwyo.edu/molb2021), Learn Genetics (https://learn.genetics.utah.edu) etc. Integrating these VSLs in the Microbiology curricula in this country may be one of the best approaches in providing Microbiology students in Nigeria with basic laboratory skills that would help bridge the gap between them and their peers in developed countries (Abdulwaheed, 2019).

CONCLUSION

The study of Microbiology in Nigeria during this COVID-19 pandemic is faced with challenges that can be addressed by the government and the relevant policymakers. Even though, there is a need to incorporate online teaching tools like MOOCs, Telelearning and VSLs in the Microbiology curricula, it is worthwhile to note that issues such as poor internet band width and unsteady power supply have to be tackled

for a smooth transition to a virtual learning platform. Also, it is recommended that the relevant ministries and the National Universities Commission (NUC) devise training programs for the educators in the tertiary institutions on the necessary skills for using these MOOC tools for teaching. The government-owned institutions can also partner with private organisations to sponsor the provision of alternative power supply as well as internet facilities on university campuses to facilitate teaching and learning. Microbiology plays a very important role in the research of infectious diseases and as such it should be accorded utmost priority by the relevant stakeholders and the Nigerian government, as a substantial part of the annual budget being allocated for developing the online curricula to ensure there are no interruptions in all forms of academic activities relating to Microbiology. Other sources of funding from multinational companies and international bodies should be sought by the management of the universities, to ease dependency on the government. If anything, the COVID-19 pandemic has elucidated the significance of online learning and its status in education, Nigeria as a country with over 50% of its population as youths stands to gain a lot in incorporating virtual tools in its curricula. The age of the digital revolution is here to stay, and in the Nigerian university system, Microbiology being a major player in the Life Sciences cannot afford to be left out. The professionalization of microbiology in Nigeria would further help in funding of research in microbial sciences to aid the incorporation of digital education in enhancing knowledge outcomes for students, most especially during cases where lockdown of schools and social distancing are required.

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