

Delivering High School Chemistry During COVID-19 Lockdown: Voices from Africa

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ABSTRACT: This paper provides glimpses of transactions in chemistry classrooms in five African countries (Burundi, Ghana, Morocco, Nigeria, and Senegal) during the COVID-19 lockdown. Members of the secondary school community in the countries including teachers, students, and school managers were unprepared for the unprecedented demand in shift from a face-to-face to an online delivery system. From a tepid, faltering start in the early days of the lockdown in Morocco, Nigeria, and Senegal, and recognizing that the end of the lockdown may not be in sight, some minuscule progress is being made in exploring virtual delivery of the chemistry curriculum. Four major challenges to online delivery of chemistry education emerged. These are a teacher capacity deficit for delivering online education, poor internet service, an erratic power supply, and severe inadequacies in infrastructure for open and distance education. Taken together along with poor teacher motivation induced by low and irregular wages, these challenges are depressants to quality chemistry teaching during the COVID-19 period. We foresee that these challenges will persist. The harsh effect of COVID-19 on the economy of all African countries is a sign that funds will be unavailable to address these challenges in the near future. A glimmer of hope can be the reprioritization of funding resources by African governments to online delivery of education, noting that blended learning will be the new normal in the coming decades.

KEYWORDS: *High School/Introductory Chemistry, Laboratory Management, Student-Centered Learning, Distance Learning/Self Instruction, Computer-Based Learning*

INTRODUCTION

In most of the 54 African countries, March is a month that sits two-thirds of the way to the end of the academic session. It is a month for concluding examinations for the term, followed by a short break and resumption into the last lap of the academic session which ends in June–July. For secondary school students in their final year, it is a crucial month for preparing for certificate examinations that will guarantee them a place in a university. Without forewarning, the new coronavirus struck the African continent as it did the rest of the world, and most African governments ordered the immediate closure of schools. Unsure of when the COVID-19 threat will be over, schools were encouraged to engage their students in some form of virtual delivery of the curriculum. This report summarizes how chemistry teachers and students are coping with the sudden change in delivery mode from face-to-face to virtual in five African countries representing three subregions of the continent: West (Nigeria, Ghana, and Senegal), East (Burundi), and North (Morocco). These countries were selected by the authors on the basis of accessibility of data directly from chemistry teachers and from science educators. The authors are “boots on the ground” in these countries as they currently live in or are nationals of the countries surveyed. We begin with a global context.

According to UNESCO, at least 165 countries have closed schools globally, and more than 516 million children and youth are affected.^{1,2} Following the closure of schools, many countries

immediately shifted from face-to-face teaching to remote teaching, yet a number of countries do not have the required resources to engage in remote teaching.^{3,4} In spite of limited resources, governments have encouraged universities and schools to continue to engage students on all courses using online modes and other available user-friendly online platforms agreeable to students. As noted by Holme,⁵ educators are now meeting the challenges of the moment as they strive to teach in new ways during the current COVID-19 pandemic.

CHEMISTRY TEACHING BEFORE COVID-19

In Burundi, Ghana, Nigeria, and Senegal, chemistry in secondary schools is taught mainly through face-to-face lecture and class discussion with occasional teacher demonstrations in the chemistry laboratory.¹⁰ The lack of well-resourced chemistry laboratories, especially in government-owned (public) schools, and large classes place limits on the extent to which students can be exposed to individual chemistry laboratory work. Group work is an occasional alternative to no practicals at all. A few individual laboratory experiments are carried out close to the end-of-course

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certificate examinations. A few (less than 1% of the total) top-rate private schools (owned by individuals or corporate organizations) engage in blended modes of lesson delivery where online presentation of some chemistry content and submission of assignments complement face-to-face interactions. In Morocco, schools are relatively better resourced, assuring more frequent exposure of secondary school students to chemistry laboratory work. In all countries surveyed, online delivery of the secondary chemistry curriculum is the exception rather than the rule.

■ IMMEDIATE RESPONSE: COALITION OF THE UNWILLING, UNPREPARED

About 2 weeks into the lockdown in all the countries surveyed except Burundi, most schools were unenthusiastic in starting virtual interactions with their students, with the hope of early resumption. By the third week and with no end in sight for an easing of the pandemic, school authorities in Nigeria, Senegal, and Morocco ventured slowly and with faltering steps into virtual learning. Teachers were not trained to undertake such a quantum jump from face-to-face to online delivery. Deficiencies in internet connectivity and devices to use to teach and learn chemistry remotely also posed a major challenge. However, there were occasional incidents of good practices, especially in Nigeria and Morocco where radio and television programs on government-supported channels were strengthened. In addition, social media platforms, notably WhatsApp, YouTube, and Facebook, were explored for delivering chemistry content.

In Nigeria, a few chemistry teachers, especially in urban areas with fair internet connectivity and with prompting from government and school authorities, created WhatsApp groups for their students, many of whom have internet-enabled phones. This marked the beginning of an adventure into the unknown world of online delivery by chemistry teachers who have not been trained in the virtual mode of delivery and students who were used only to private, personal, and nonacademic communication with WhatsApp. Chemistry students in rural locations with the twin handicap of a lack of electricity and internet service were disadvantaged. These more rural programs were strengthened by the government through a richer content in local languages and delivered by teachers judged to be among the most experienced in chemistry.

In Morocco, chemistry teachers began experimenting with Zoom and gradually gained fluency in its use. They also began exploration of delivering some chemistry content by means of WhatsApp which is a common tool used by secondary school students in the country. During the first few weeks, some students were excited to see their classmates on videos; conversely, some did not take the course seriously because they tried to study while they were on the bed while others wanted to show (flaunt) the opulence in their homes.

In Senegal, with some appetite from students for the early opening of schools, no serious online academic work was started. In a few schools, however, deployment of online delivery through social media like Facebook and video conference platforms like Zoom has started to pick up steam. In Ghana, as directed by the Ministry of Education, there is no teaching going on although a few schools, especially schools that are privately owned and in urban areas where internet service is fair, are engaging their chemistry students in remote learning mainly using WhatsApp and Zoom.

■ ONGOING RESPONSE: STILL A STEEP LEARNING CURVE FOR CHEMISTRY STUDENTS AND TEACHERS

Three months into the COVID-19 lockdown, chemistry teachers in Nigeria, Morocco, and Senegal have improved their early response. This is not unexpected as it is becoming clear that the easing of the lockdown for schools may not be in sight and keeping students idle at home is counterproductive to their intellectual development, readiness for external examinations, and progression to the next class.

The Nigerian case of ongoing response will be described in greater detail using interview data from some chemistry teachers. The teachers were asked to share their experiences in teaching chemistry since the national lockdown was instituted by government. Specifically, they were asked to indicate school level and individual efforts at keeping their chemistry students engaged. We start with the experience of Tunde (not the real name), a senior secondary 3 (grade 12) chemistry teacher in an urban school. Most chemistry teachers outside Tunde's example are, by day, improving in their use of WhatsApp and Zoom for delivering the chemistry curriculum. Rural schools, though they are improving since the early days of the lockdown, are still not as well-served.

"I have been teaching chemistry to my students online using Zoom as virtual class, Google classroom (class code: wkoq3mr) with 249 registered students out of 327 students. The PowerPoint file of each lesson is converted to YouTube video through Ibukunolu A. Ademola YouTube channel and the links are sent to the students to watch before the next class in order to prepare the students ahead of the lesson (application of flip method of learning). The Zoom links are sent to the students through their emails, Google classroom platform and the WhatsApp group created for the students. The purpose of sending the link to the three platforms is to ensure that all the students receive the link. The note of lesson is sent to the students to enable them have prior knowledge of the lesson. All these are put in place in order to ensure that the students do not miss anything at all (school away from school). Correction to the assignment are sent to the students via Google classroom as attachment after marking." (Tunde)

Another chemistry teacher, Wole (not the real name), who teaches senior secondary class 2 (grade 12) chemistry in an urban public school described efforts at accessing and using online and other resources provided by government and private individuals and groups for teaching. According to Wole:

"As the reality of COVID-19 became clearer and national lockdown was activated, prepared or not, all schools were left with no option but to switch to an alternative mode. Chemistry lessons are delivered via different electronic and internet-based platforms. Teachers in federal and state government-owned schools reach out to their students through the organized TV-lessons by the ministry of education in addition to web-based recorded lessons and learning apps (examples of such platforms include: <http://www.ogundigiclass.ng>; <http://tribuneonline.ng.com>; <http://schoolgate.ng>; <http://mobileclassroom.com.ng>). While private school students receive chemistry lessons through various online platforms and chat apps such as Zoom, Google classroom, telegram and most widely adopted, WhatsApp messaging app."

Yemi (not the real name), a chemistry teacher, reported as follows:

“Using WhatsApp, chemistry teachers reached out to parents individually and some through the school to inform parents of lesson periods. A WhatsApp group was created on class basis, having the teacher and any member of the school management (for monitoring and supervision) as administrators. The teacher, prior to the lesson time would have posted content as text, PowerPoint slides and or short videos on the class page for students to access. These learning materials are posted as advance organizer and form the basis for discussion when lesson starts. Students signal the teacher for questions or comments using appropriate emoji. The teacher grants permission and then provides clarification where necessary using the audio recording facility available on the app. Where equations and/or mathematical expressions are required, the teacher caters for this through handwritten solutions and then a snapshot of it is sent to the platform as image.”

No practical work in chemistry is conducted as the physical laboratories are still out of reach. Virtual laboratories are not used either, but lessons showing teachers demonstrating chemistry experiments in laboratories as featured on television programs which state governments are sponsoring. In some cases, YouTube videos of chemistry experiments are watched by students and teachers to complement the theoretical treatment of topics. Online assessment is poor, and grading of assignments is a challenge in the face of huge student numbers. The delay in the payment of teachers' salaries and drastic reduction in salaries especially in private schools are dampening enthusiasm of chemistry teachers to go out of their way to innovate and improve their use of virtual delivery mechanisms. In sum, while the ongoing efforts at online delivery show a slow improvement, they are still severely short of the expected resources for a practical subject like chemistry.

While the data collection does not include specific interview responses, ongoing responses in other African countries can also be summarized. In Morocco, chemistry is being taught online by the Zoom platform where teachers explain to students the material that they had previously prepared in the form of PowerPoint presentations and direct interaction. Also, the teachers created WhatsApp groups, and they have given to students their email addresses to give an opportunity to ask questions to improve their learning for those who have not understood well during the online session.

In Senegal, a majority of schools have started to provide online courses including chemistry in secondary schools. However, only the theory part of the course is possible to be delivered, and no online test is considered for grading with video-conferencing apps like Zoom and GoToMeeting; social media like Facebook, WhatsApp, and Google classroom are being used.

■ CHALLENGES REMAIN AND MAY PERSIST

There are four major challenges to remote teaching of chemistry in secondary schools in our sampled countries. There are teacher capacity deficits for delivering online education, poor internet service, an erratic power supply, and severe inadequacies in infrastructure for open and distance education. Although national data is not available on the number of chemistry teachers who have skills in delivering online education in Burundi, Ghana, Morocco, Nigeria, and Senegal, we estimate from our vantage positions in these countries as “boots on the ground” that fewer than 1% of secondary chemistry teachers are

trained in using online platforms to teach chemistry. While internet penetration averages 39% in Africa,⁶ uninterrupted internet service is less than 10%.⁷ The cost of data is high. Seen in the context of a poverty level averaging 69% in the sampled countries,^{6,7} the affordability of data by poorly paid teachers and indigent students remains an issue.

The power supply is erratic in most African countries.⁸ Electricity is needed to power devices that teachers and students use for online education; hence, challenges in this area will adversely affect the quality of teaching chemistry in a virtual environment. There are other class management challenges. Tunde, the chemistry teacher from Nigeria, noted that

“Poor turnout on the part of chemistry students is another major challenge, about 35% of the population attend the Zoom classes that I teach while about 50% of them watch the lessons on YouTube. About 80% of the students respond to the assignment on Google Classroom out of which assignment of some students were unmarked because they were submitted as class comment. Secondly, at the beginning, class management was difficult because students kept on switching on their microphone which created a lot of disturbance to the class. Also, when the students write on their screen it affects the slides which I am using to teach. What they write on their screen at their end covers my slides and this cause a lot of confusion. Lastly, interruption from Zoom once we have spent 40 min on air. Zoom will log us out and we have to re-login again, at that point many of the students don't come back for the completion of the lesson.”

In Morocco, challenges confronting online delivery of secondary school chemistry include irregularity in the internet connection; nonpossession of computers by some students; nonfeasibility of practical work in a virtual environment; and, given the concentration of people at home, lack of a quiet monitoring space. In Senegal, challenges are weak network stability, cost related to data storage and accessibility for students, data reliability and security, and a low level of preparedness shifting from empirical teaching to online teaching on both sides (teacher and student).

■ NAVIGATING THE MAZE OF CHALLENGES

After the technology weakness in online education became evident during the COVID-19 lockdown, many African countries have started to promote ICT use and access in education. In order to overcome the challenge with electrical power, schools are being encouraged to diversify their source of energy by using solar power.

In Nigeria, training sessions are being planned for teachers to address the lack of knowledge on how to use available technologies for teaching and learning. A few schools have started providing teachers with a data procurement allowance on a weekly or fortnightly basis. Students who do not have direct access to the needed facilities like Android phones, tablets, or computer systems are advised to make use of their parents' devices. Some television advertisements are currently running for parents to be guided on how to set parental control on gadgets and verify the activities of their children during their absence. In a rising number of cases, students are given instructions and a quick training on the necessary steps for using Zoom. Literate parents are asked open email accounts for themselves and for their children for easy communication and for submission of assignments.

In Morocco, teachers have started taking steps to explain the rules for online lessons to their students and parents. In Ghana,

in order to promote internet access, Vodafone Ghana has started pilot distribution of internet to universities. It is hoped that they will replicate this in secondary schools. Senegal is investing in ICT promotion among the youth and as well as combating ICT phobia.

■ ON THE MATTER OF CHEMISTRY LABORATORY WORK, ASSIGNMENTS, AND ACADEMIC INTEGRITY

As stated earlier for the five countries considered here, there have not been any practical activities during lockdown, so far. Practical activities could have been done by the teacher and converted to YouTube for students to watch, but there is no access to the laboratory due to the lockdown. All chemistry practical classes are suspended because the chemistry laboratory facilities are inaccessible to both the teacher and the students.

In Nigeria, in schools where chemistry lessons are delivered remotely, chemistry students receive and submit their assignments through the same platforms where teaching and learning is taking place, mostly on WhatsApp and less on Google classroom. Diagnostic and formative assessments are carried out in the course of the lesson. Assignments are marked, and feedback is sent to the students. In some schools, students receive and submit their assignments via email with extended response timeline. Such assignments facilitate teachers' engagement of students to improve learning of chemistry as well as to provide feedback to teachers on aspects of the lesson that students find difficult to learn.

In Morocco, no students assessments were permitted during this period of lockdown as all exams will be done in September in case schools reopen. In Ghana, as no online course is permitted as directed by the Minister of Education, there is no possibility of student assessment in general. In Senegal, all student assessments are suspended. However, the possibility of online assessment is contemplated.

On the matter of plagiarism and academic integrity, in Morocco, Ghana, and Senegal this is not an issue since no assessment is being done at this time. In Nigeria, cases of students copying materials from their more brilliant colleagues and Wikipedia for their assignments is not rare. The chemistry teacher commonly applies a punishment to such acts by canceling the marks for the assignment for the erring student. The student earns a zero and is warned. To further deter students, some chemistry teachers reported announcing to their students almost at every class session that their submissions are and will always be subjected to plagiarism checks.

■ CONCLUDING REMARKS

This paper provides glimpses of transactions in chemistry classrooms in five African countries during the COVID-19 lockdown. Most members of the secondary school community in the countries including teachers, students, and school managers were unprepared for the unprecedented demand in shifting from face-to-face to online delivery systems. Surely, migrating from traditional through blended learning to a fully virtual and online delivery strategy is not expected to happen overnight.

In the coming days and months, while efforts are directed at adjusting to what is now labeled as the "new normal" in terms of blended learning, African countries should take advantage of emerging trends in the global environment. Specifically for chemistry teaching, use of such software as Doceri,¹¹ web-based

video-conferencing,¹² use of a screen capture method,¹³ and creative use of an online video library¹⁴ should be explored.

Taken together along with poor teacher motivation induced by low and irregular wages, the several challenges highlighted are depressants to quality chemistry teaching during the COVID-19 period. We foresee that these challenges will persist.⁹ The harsh effect of COVID-19 on the economy of all African countries is a sign that funds will be unavailable to address these challenges in the near future. A glimmer of hope can be the reprioritization of funding resources by African governments to online delivery of education, noting that blended learning will be the new normal in the coming decades.

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Notes

The authors declare no competing financial interest.

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