

Investigation into the Strategies for Improving Online Teaching of Chemistry in Pandemic Era in Universities.

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Abstract:

Introduction: During the era of covid-19, universities were closed down thereby affecting teaching and learning activities across subjects.

Objectives: Hence, this study investigated the strategies for improving the online teaching of chemistry in pandemic era in universities.

Methods: The study adopted descriptive survey research design. The population of the study was 1,080 respondents. The sample size consisted of 266 respondents. The study was guided by two research questions. The instrument used for data collection was Strategies for Improving Online Teaching of Chemistry Questionnaire (SIOTCQ, $r = 0.82$). Mean and standard deviation were used to answer the research questions.

Results: The results revealed that recruitment and retraining of lecturers, active participation of students during online learning, provision of online learning facilities among others can improve online teaching and learning of chemistry. The results equally revealed that high cost of chemistry online-instructional software and poor internet services among others are challenges hindering effective online teaching and learning of chemistry.

Conclusions: The study concluded that chemistry education lecturers should have positive attitudes, acquiring all the necessary digital skills and be proactive on effective and efficient online teaching so that universities should not be put on hold in the emergency situation such as covid-19 outbreak in 2020.

Keywords: Covid-19 pandemic, online teaching, strategies for improving, chemistry education lecturers.

1. Introduction

The development of science and technology in universities has received more focus because it is the primary driver of national development. This is due to the fact that a man's entire existence depends heavily on science and technology, which is possible thanks to a solid understanding of chemistry. One of the foundational sciences taught at the university level is chemistry. Achimugu and Ali (2018) defined chemistry as a branch of science subject that deals with composition, structure, properties, changes and uses of matter. It is crucial to the manufacturing of food, drugs, clothes, toiletries, medicine, and other industrial processes (Akpan & Assien, 2019). It is important for the growth of the nation, the economy, and society as well as for every part of our daily lives. The teaching and learning of chemistry in universities must therefore be given emphasis.

A professional teacher's job is to transfer knowledge both within and outside of the classroom. It comprises utilizing various techniques and approaches that can aid learners in comprehending and assimilating what their instructor is teaching in order to apply what they have learned to practical situations (Oketoobo & Uba, 2022). The primary goal of university education is to instill knowledge in young people's minds.

University education is the stage of education that offers courses leading to the award of degrees in various fields for the period of four years for post primary school graduates who have passed the prescribed examinations and admitted into the university, while on the other hand three years for direct entry students who have passed the advance level courses at tertiary institutions. According to the Federal Ministry of Education (2014) through the national policy of education, university education shall make optimum contribution to national development by: intensifying and diversifying its programmes for the development of high level manpower within the context of the needs of the nation; making professional courses to reflect our national requirements; and making all students as part of a general programme of all round improvement in university education. The policy document further stated that: university research shall be relevant to the nation's development goals; universities shall be encouraged to decimate their research results to both government and industries; university teaching shall seek to inculcate community spirit in students through projects and action research; a greater proportion of expenditure on university education shall be devoted to science and technology; and not less than 60% of places shall be allocated to sciences and science-oriented courses in the conventional universities. Based on this, the National University Commission (NUC) is guided in all its activities by this vision to produce Benchmark Minimum Academic Standard (BMAS), the application of which produce individuals that can confront diverse challenges. Teaching and learning, which are two separate processes, have changed in recent years from being teacher-centered to student-centered, as well as from being done face-to-face to incorporating and using ICT to teach students in the comfort of their homes. Because of the corona virus, mobile learning is becoming a more popular method of instruction.

A rapid respiratory disease outbreak of the corona virus, also known as corona virus diseases 2019, occurred in Wuhan City, China, in 2019. The first quarter of 2020 saw significant hurdles for the global economy, especially the educational sector, due to the emergence of this disease. Many nations have implemented steps to stop the spread of Covid-19, such as a prohibition on public gatherings, movement restrictions, maintaining social distance, the use of hand sanitizer, and the

wearing of face masks. Due to the forced closure of schools, the educational sector, like all other sectors, was severely hampered. The immediate effect of the COVID-19 pandemic era on universities was a temporary halt to university activity, including the suspension of lectures. The fact that neither the students nor the professors knew how long the crisis would endure made the situation especially unsettling (Ade, 2020). Because of the perceived threat posed by Covid-19 to university teaching and learning, educational scholars have developed a number of teaching and learning techniques to encourage the continuation of this practice by promoting the use of online teaching and learning options (Bao, 2020). In the wake of the COVID-19 pandemic, online education is expanding quickly. Even after the Covid-19 pandemics, which offered answers for distance learning, the search for online teaching and learning is likely to continue, but this time it will be a matter of choice rather than necessity.

Online learning and teaching can be thought of as a technology-based technique of instructing pupils without having them interact in person with the teacher. Online teaching and learning, according to King-Agboto et al. (2022), is the process of educating people over the internet. According to Madu et al. (2022), online teaching and learning refers to a range of initiatives that use the internet to deliver instruction both within and outside of the classroom and to promote student-teacher interaction. Hence, it is a digital method of teaching that transfers knowledge from the teacher to the students. Online instruction and learning are also known as e-learning, remote learning, open learning, and virtual classrooms. To justify the advocacy for the application of this approach to teaching and learning, there is the need to relate this to a potent theory that better explains this.

Hence, this study is anchored on social constructivism theory. Okarofor (2022) defined social Constructivism theory as that which learning takes place in interaction between learner and social world. According to the author, learner social world includes the teachers, peers and participants in all forms of activity. According to Ullah (2020) constructivism theory facilitate, support and guides students to cooperative learning. Social constructivism theory emphasis active participation of learners in classroom discussion with teachers and peers. The captivating attributes of social constructivism theory is that it fit into online teaching and learning as it gives the students the opportunity to construct their own meaning from the information they gather from computer, teachers and peers. In constructivism, the teacher acts as a guide and the students learn by doing and collaboratively working with their teacher and peer.

However, despite the importance of online teaching stakeholders in chemistry education does not adequately implement it. Many factors appear to be responsible for the poor implementation of online teaching. These factors notwithstanding, there is need for improved implementation of online teaching. This need inspired the researcher to find out the strategies that can improve online teaching and learning.

Strategy is planned actions that allow one reaches a well-defined destination. It is a long term plan of actions that focuses on achieving a given goal. It is also the development of well-articulated activities aimed at comfortably arriving at individual or group set goals. One from time to time, endeavor to improve on a given strategy. Science education experts have in past carried out students on problems and prospect of online teaching and learning but students on strategies on improving online teaching and learning of chemistry is scarce, hence the need of the study.

The main purpose of this study is to determine the strategies for improving online teaching in pandemic era in universities. To address the research progress the following research questions were raised to guide the study

1. What are the strategies for improving online teaching of chemistry in pandemic era in universities?
2. What are the challenges hindering effective online teaching of chemistry in pandemic era in universities?

2 Objectives

Empirically, Mahmood (2020) explored different instructional strategies to help in implementing online teaching in higher education and found the factors to include: getting feedback from the students, offering flexible teaching and assessment policies, recording online lectures and getting support from teaching assistants. The finding of this study is centered on teacher educator-related solutions and it is consistent with established best practices for efficient online teaching.

In a study on rural online learning in the context of the Covid-19 crisis in South Africa, Dube (2020) discovered that the problems faced by rural learners included poor internet connectivity, network unavailability, high internet data costs, a lack of online devices, and a lack of computer literacy. In order to make the cost of using online tools more reasonable for students, the study advised providing subsidies as well as appropriate online learning infrastructure. The essential point of this paper, is that government at various levels as stakeholders on online teaching should live upto their expectation by providing the essential amenities for online teaching.

Literature review by Mazlan et al (2021) highlighted some challenges and some strategies that educators could use to enhance online teaching and learning. The challenges highlighted were lack of facilities, poor internet connection, lack of required skills and lack of motivation. The paper than highlighted the strategies for improvement as: use of suitable platform, effective communication and motivating students. The literature review is emphasized on the roles of teacher educators as key stakeholders in quality online teaching and learning and that they should be committed to use of appropriate platform, effective communication and motivation of students.

Jessie (2021) did a study on student outline learning challenges during the pandemic and how they can handle the students in Philipines. The study pointed out the challenges confronting online learning as inadequate internet service, inadequate preparation of students on technology usage, lack of teachers' guidelines to effectively guide the students on online learning. Provision of quality internet service, adequate training of students on technology usage and provision of online learning resources among others were suggested solutions to problems of students online learning.

Yung (2021). Examined the effect and challenge encountered by teachers during COVID-19 pandemic on the online learning behaviors of university students in Taiwan Data was analysed using the spearman rank correlation test and the Wilcoxon signal-rank test: Findings of that study indicated that COVID-19 effected students' online learning behaviors and the researcher recommended asynchronous online learning approach as a method as a way of maintain university undergraduates' learning during the COVID-19 pandemic era.

Sahito et al (2022) investigated the challenges and coping strategies faced by university teachers during pandemic of covid-19 and revealed the challenges faced by teachers to include: issues of connectivity, online teaching methods and learning environment. They suggested that university management should arrange some workshops or training programme for teacher educators to improve their productivity during their online teaching. In-service training is very important as it will exposure teacher educators to modern digital skills for imparting online teaching; therefore there is the need for the university management to sponsor lecturers to national and international conferences/workshops/seminars on online teaching.

In a similar vein, King-Agboto (2022) investigated the difficulties of online teaching in the pandemic era and solutions to the issues in Nigeria and found that some difficulties with online learning include: login issues, poor internet services, and online work distractions, students' lack of preparation, lack of infrastructures, poor timing, lack of feedback, and lack of fundamental digital skills. They listed a number of actions that may be taken to lessen the difficulties, such as encouraging positive behavior from teachers and students, adequate digital literacy, reliable internet access, and suitable instruction for pupils. Teachers and students related-factors were identified as issues affecting effectiveness of online teaching and learning and paper recommended that development of positive attitudes by students and teachers will go a long way in addressing the issues. Teachers and students are therefore called upon to respond to this call.

Khalilah et al (2022). Carry out a research on gender perceptions of benefits and challenges of online learning in Malaysian during COVID-19. Descriptive survey research was used and data was analyzed using independent sample t-test. The finding of the study shoved that students failed some difficulties in learning online and that there is the need for lecturers to increase their capacities in utilizing and teaching online. The findings of the study also indicated that gender differences do not significantly impact students' opinions on the difficulties faced on the online teaching and learning.

Okyere et al (2023) investigated the challenges and improvement strategies for online teaching during covid-19 pandemic and found the teaching challenges to include: difficulties maintaining students' engagements, teaching practically oriented courses, assessing students, embracing changes, anxiety and stress inadequate teaching environment, increased work load and unstable internet. Recommendation for improvement ranged from modifying course outline, summarizing previous lessons, reducing course load, adequate assessment tools, incentives to regular training. This paper emphasizes on its improvement strategies, the roles teacher educators and Government at various levels. They need to be creative and committed to online teaching and learning.

Fikri et al (2023) investigated online learning models in the era and post-pandemic covid-19. The study adopted Literature research methods. This is done by collecting relevant literature such as books journals or scientific articles related to the topic. The findings indicated the four online learning processes; ICT -based learning models, problem-based learning models, blended learning models, and module-based learning models. Thus, these four learning models can support a distance learning system, increase student independence, improve digitalization skills and discipline, and increase student collaboration.

Firstly, from the literature review above, there is need to explore the roles of more stakeholders in enhancing online teaching, the present study examined more stakeholders such as teacher's educators, students, head of department, university management, federal government and parents in a single study. Secondly, according to the literature analysis above, numerous studies have been conducted on the difficulties associated with using ICT resources for effective teaching and learning chemistry; however it doesn't appear that these difficulties and the possible solutions have any mutually reinforcing effects. That is to say, there are scarce or few in-depth studies on methods for enhancing the use of ICT resources for efficient teaching and learning of chemistry online. This work seeks to close these gaps. What are the best strategies for enhancing online chemistry teaching in universities during the pandemic era by the key stakeholders is the study's problem.

3. Methods

The study adopted descriptive survey design. According to Nworgu (2015) descriptive survey research design is a systematic and unbiased investigation which is concerned with collection of data for the purpose of describing and interpreting existing practice, condition beliefs and attitude. This study adopted this design because the study collected data from the representative sample of lecturers and 400L chemistry education students in Federal Universities in Nigeria. The study was carried out in Federal Universities in North-Central, Nigeria which comprises of six states plus Federal Capital Territory, namely; Kogi, Benue, Nassarawa, Plateau, Kwara, Niger and FCT. The Federal Universities are Federal University Lokoja, University of Agriculture Makurdi, Federal University Lafia, University of Jos, University of Ilorin, Federal University of Technology Minna and University of Abuja. Each of the university has chemistry education as a programme. The population for this study was the entire 1,080 chemistry education lecturers and 400 Level 2022/2023 sessions of chemistry education students in the seven Federal Universities in North-Central Zone, Nigeria. The sample size of 266 which comprise of all 56 chemistry education lecturers in the seven Federal Universities and 210 final year chemistry education students (30 each) who were selected using proportionate random sampling technique. The instrument for data collection is questionnaire developed by the researcher titled, Strategies for Improving the Online Teaching and Learning of Chemistry Questionnaire (SIOTLCQ). The SIOTLCQ consist of 26 items and it is divided into two sections. Section A was used to obtain demographic data of the respondents while Section B elicited responses on strategies for improving online teaching and learning of chemistry as well as the challenges hindering effective online teaching and learning of chemistry. The instrument was structured using four-point likert-type of responses of Strongly Agree = 4, Agree = 3, Disagree = 2 and Strongly Disagree = 1. In taking decision a mean of 2.50 – 4.00 is agreed and 2.49 and below is disagreed. The instrument was validated by 3 experts, one from measurement and evaluation and two from chemistry education from University of Ilorin. Each expert was served with a copy of the instrument and was requested to read through each item for the purpose of identifying ambiguous statements and offer suggestions for improvement of the instrument. After critical scrutiny, their comments and suggestions helped in the development of the final instrument. To ensure the reliability of the instrument 5 and 50 copies of the questionnaire were administered to 5 lecturers and 50 final year chemistry education students of Kogi State University that were not part of the sample for trial testing. Data collected were analysed using Cronbach Alpha and the internal consistency estimate for the instrument was 0.82. The value was adjudged high enough to be used for this study.

The questionnaire were distributed and collected by three research assistants and the percentage return was 100%. Data collected for the study were analysed using mean to answer research questions.

4. Results

1. **Research Question One:** What are the strategies for improving the online teaching and learning of chemistry in Pandemic Era in universities?

Table I: Mean and Standard Deviation of Strategies for Improving Online Teaching and Learning of Chemistry in Pandemic Era in Universities.

S/N	Items	Lecturers			Students		
		\bar{x}	SD	Decision	\bar{x}	SD	Decision
1.	Recruitment of chemistry education lecturers that are knowledgeable on online teaching by the university management.	3.10	0.68	Agreed	3.25	0.76	Agreed
2.	Retraining of chemistry education lecturers through seminars/ workshops/conferences on online teaching.	3.28	0.75	Agreed	3.44	0.78	Agreed
3.	In-depth training of pre-service chemistry teachers in online teaching	3.00	0.59	Agreed	2.97	0.61	Agreed
4.	Possession of positive attitude towards online teaching by chemistry education lecturers	3.15	0.66	Agreed	3.35	0.58	Agreed
5.	Possession of positive attitude towards online learning by the students.	3.29	0.66	Agreed	3.36	0.68	Agreed
6.	Acquisition of adequate digital skills needed for online learning by the students	3.25	0.76	Agreed	3.43	0.69	Agreed
7.	Adequate monitoring of students' participation in online learning.	3.31	0.76	Agreed	3.45	0.67	Agreed
8.	Motivating students to participate actively in online learning by their lecturer.	3.05	0.78	Agreed	3.14	0.69	Agreed
9.	Regular assessment and feedback from the students on the online teaching and learning.	3.36	0.82	Agreed	3.18	0.72	Agreed
10.	Posting of ICT expert or technician to departments to support chemistry education lecturers.	3.41	0.67	Agreed	3.45	0.71	Agreed
11.	Provision of subsidy to ensure the	3.23	0.55	Agreed	3.21	0.60	Agreed

affordability of online gadgets/data.

12.	Provision of adequate online facilities in the universities.	3.43	0.64	Agreed	3.38	0.70	Agreed
13.	Adequate purchase of online learning materials for the students by their parents.	3.39	0.67	Agreed	3.45	0.77	Agreed
14.	HOD/University Management adequate supervision of chemistry education lecturers' online teaching effectiveness.	3.18	0.76	Agreed	3.11	0.71	Agreed

The result in Table 1 shows that strategies for improving the online teaching and learning of chemistry in pandemic era is very high as majority of the lecturers and students had their mean score higher than the cut-off point of 2.50. This indicates that the respondents agreed in a very high level that these strategies can improve the online teaching and learning of chemistry in pandemic era in universities.

1 Research Question Two: What are the challenges hindering effective online teaching and learning of chemistry in Pandemic Era in universities?

Table 2: Mean and Standard Deviation of the Challenges Hindering Online Teaching and Learning of Chemistry in Pandemic Era in Universities.

S/N	Items	Lecturers			Students		
		\bar{x}	SD	Decision	\bar{x}	SD	Decision
1.	Chemistry education lecturers' incompetency in online instructional delivery.	3.50	0.80	Agreed	3.48	0.77	Agreed
2.	Poor sponsorship of chemistry education lecturers to conferences, workshops and seminars.	3.64	0.64	Agreed	3.52	0.56	Agreed
3.	Chemistry education lecturers' reluctance to adopt online teaching.	3.55	0.57	Agreed	3.42	0.64	Agreed
4.	Dearth of qualified chemistry education lecturers that are skilled in digital online teaching.	3.51	0.73	Agreed	3.53	0.82	Agreed
5.	Lack of motivation of chemistry education lecturers.	3.53	0.65	Agreed	3.20	0.74	Agreed
6.	Students' negative attitude toward online learning.	3.42	0.80	Agreed	3.50	0.66	Agreed

7.	Poor participation of students in online class discussion.	3.10	0.62	Agreed	3.00	0.57	Agreed
8.	Inability to adequately assess students during online teaching.	3.40	0.78	Agreed	3.62	0.82	Agreed
9.	High cost of chemistry online instructional softwares.	3.55	0.70	Agreed	3.60	0.69	Agreed
10.	Non-availability of experts or technical staff to support the online teaching in most universities.	3.20	0.65	Agreed	3.10	0.73	Agreed
11.	Inadequate online teaching and learning facilities.	3.32	0.85	Agreed	3.54	0.78	Agreed
12.	Fluctuation of internet services.	3.46	0.62	Agreed	3.20	0.66	Agreed

The result in Table 2 shows the mean and standard deviation responses of lecturers and students on the challenges hindering effective online teaching and learning of chemistry in pandemic era. The analysis showed that all the mean scores of lecturers and students were above cut-off point of 2.50 and were also very high. This indicates that the respondents have agreed that these are challenges hinder effective online teaching and learning of chemistry in pandemic era in universities.

5. Discussion

According to the study's findings (Table 1), strategies for enhancing online teaching and learning include hiring new chemistry lecturers, retraining existing chemistry lecturers, providing in-depth training for in-service chemistry teachers, chemistry lecturers' and students' positive attitudes toward online teaching, preparing students for online learning by teaching them digital skills, adequately monitoring students' participation in online learning, and inspiring students to take an active role in it. The analysis of research question one's findings also showed that regular students evaluation and feedback, the posting of ICT experts and technicians to departments, the provision of subsidies to make online learning facilities affordable, the provision of online learning facilities, adequate provision of online learning materials by parents, and strict control of lecturers can all improve the general teaching and learning process. These results are consistent with earlier research from King-Agboto (2022), who suggested that teachers' and students' attitudes should be positive, students should have sufficient digital skills, and participation from students should be monitored, and Okyere et al (2023), who suggested professional development for teachers and the hiring of qualified teachers as solutions. From the findings of this study, showed that stakeholders such as government, university management, head of departments, parents, lecturers and students have various roles to play to ensure effective and efficient online teaching and that this require them to be resourceful, creative committed and go extra mile in the implementation. In this way, universities will not be taken aware in future emergencies such as covid-19 outbreak.

The analysis of research question 2 findings showed that ineffective lecturers, inadequate support for lecturers' training, resistance on the part of lecturers to adopt online teaching, a shortage of qualified

lecturers, a lack of motivation on the part of lecturers, and students' negative attitudes toward online learning are the main obstacles to effective online teaching and learning of chemistry in universities. On the other hand, it was also found that challenges impeding effective online teaching and learning of chemistry in universities include students' poor participation in online class discussions, inability to adequately assess the students, high cost of chemistry online instructional software, lack of online experts and technicians to support chemistry lecturers, inadequate online facilities, and poor internet services. These results are consistent with those of King-Agboto, et al. (2022), who discovered that the difficulties of online teaching include inadequate teacher preparation, a lack of digital literacy among both teachers and students, students' unpreparedness, and distractions during online learning; and Sahito et al (2022), who discovered that obstacles to the use of lack of online facilities, poor internet connectivity, inconsistent network, and inconsistencies. The ugly situation hindering efficient online teaching and learning can be arrested, if stakeholders in chemistry education are prepared to take the challenges by playing their expected roles in online education.

6. Conclusion

The world's lockdown due to the COVID-19 pandemic was a major difficulty, and it particularly had a significant impact on university academic programme. Education stakeholders pushed for online teaching and learning in universities to mitigate the effects of COVID-19, which caused the suspension of courses and the closing of universities. In conclusion, the study has identified approaches that may enhance the epidemic age online chemistry teaching at institutions. Also, the study has identified barriers to efficient online chemistry teaching at institutions during the pandemic age. In spite of the challenges, if all the stakeholders implement the strategies for improving online teaching, effective online teaching will be achieved in a very short time. This in turn will ensure that the academic programmes of universities can run smoothly during emergencies such as covid-19 outbreak.

It is necessary to point out that the study focused on Nigeria as developing nation. Therefore, further research should be conducted in developed nations to ensure the generability of these findings to both developing and developed nations.

Based on the conclusion of this study, the following recommendations were made:

Lecturers should have positive attitude towards online teaching, avail themselves for rigorous online training, monitor and assess students' online learning to get the required feedback on the strengths and weaknesses of the students. Where weaknesses are noticed, lecturers should provide the necessary remedial training. Students should develop positive attitude towards online learning, be prepared to acquire the required digital knowledge and committed to online learning.

Parents should make adequate provision for online learning facilities of their children by purchasing learning gadgets such as laptops, tablets, smartphones, etc for them. This is necessary as most of the online learning takes place at the student's homes and the gadgets in turn facilitate their online learning. Parents should also make their homes internet friendly by subscribing to data regularly and pay their electricity bills to ensure constant supply of electricity and internet services.

University management should encourage and sponsor lecturers to conferences, workshops and seminars to update their knowledge in computer education. The university management should also

ensure that the recruitment of lectures among other thing should be based on their in-depth knowledge of computer education. The management should ensure that expert or technicians are posted to departments to assist lecturer's conduct online teaching.

Head of departments should ensure strict supervision of lecturers in online teaching. This can be carried out by the quality assurance unit of the department, whose duty is to carryout regular supervision of lecturers. Head of departments should adequately monitor the lecturers to ensure that pre-service chemistry teachers are given in-depth training in online education. Equally, Federal government should ensure adequate provision of online learning facilities. It is also necessary that government subsidies the cost of online gadgets to ensure affordability.

Conflict of Interest

The authors declare no conflict of interest regarding this publication.

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