

**CHEMISTRY EDUCATION AND NATIONAL COMMISSION FOR
COLLEGES OF EDUCATION MINIMUM STANDARDS:
AN ANALYSIS OF TRENDS, CHALLENGES
AND DEVELOPMENT OF CLOUD-BASED
APPLICATIONS**

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Abstract

Education plays an important role in maintaining the economic development of a country such as Nigeria. The colleges, polytechnics, and the universities are regarded as tertiary education where higher education is given to students. Higher education is instrumented in fostering growth, reducing poverty and boosting shared prosperity. The benefits not just the individuals but the entire educational system. The paper focuses on Nigeria Certificate in Education (NCE) Chemistry Education Programme that is supervised by an agency regarded as National Commission for Colleges of Education (NCCE). Although, Chemistry Education both Nigeria Certificate in Education (NCE) and Bachelor Degree programmes are offered in Nigeria by different Teacher Education Institutions and varying degrees of success recorded, various problems still confront the programme with far reaching consequences in the Nigerian educational system. Today, the system of education is changing and students attracted more towards technology. Therefore, in this changing environment, it's

important that we think about the latest technologies which will help the society with the better teaching and learning processes. One of such trending technology is cloud computing. The need for education (chemistry education inclusive) is increasing constantly and the development and improvement of e-learning solutions is important. More so, the e-learning systems need to keep the pace with the technology, so the new direction is to implement cloud computing into the NCCE minimum standards of secondary education science programme. The paper recommends that efforts should be made by government to provide NCE chemistry teachers skilled in ICT to each Colleges of Education to inculcate ICT skills to the chemistry students and also should stabilize electricity supply for meeting the challenges of e-learning for national development.

Keywords: National Commission for Colleges of Education, Chemistry Education, Challenges, Nigerian Certificate in Education, Cloud Based Applications and National Development.

Introduction

Education is the process of training and institution especially of children and young people in schools and colleges which is designed to give knowledge and develop skills. Education is commonly and formally divided into stages such as preschool or kindergarten, primary school, secondary school and then college, university apprenticeship.

Throughout the world, education is considered to be the very important tool for attaining national goals. Education provides learners with skills needed for survival. The National Policy for Education (NPE,2012) acknowledges in no unmistakable terms, that for education policy to be serviceable and visible must be geared to the special needs and aims of a nation. We must now evolve a policy, a system of education which produce men and women who will not be out of place in a technological age, a system which will ensure uniform standards, a system which will blend science and technology with culture and spiritual enrichment, a system which will feed our industries with personnel without starving our schools, colleges, the church and offices of such personnel, a system which will inculcate in our youths due respect for the land, in short a system which will produce useful, self-confident and competent citizens (N.P.E., 2012).

The above information can easily be seen to point clearly to the direction of today's educational objectives of the country. Accordingly, higher education, also known as the tertiary education in some countries, refers to all post-secondary education including both public and private universities, colleges, technical training institutes and vocational schools, (World Bank Group, 2020). The group also adds that a highly skilled workforce with a solid post-secondary education, is a prerequisite for innovation and growth. Well educated people earn

higher wages, and cope with economic shocks better. The Federal Ministry of Education (FME, 2014) went significantly further and specified the different sections of tertiary education, as: - (a) university education (b) teacher education and (c) technology education.

In addition to the statement of National Policy of Education, that no education system can rise above the quality of teachers, teacher education becomes the paramount part of this paper (FME, 2014). Teacher education refers to the policies and procedures designed to equip prospective teachers with the knowledge, attitudes, behaviours and the skill they require to perform their tasks effectively in the classroom, school and wider community (<https://definition.net/teacher-education/>, 2020). Nigeria, like, many other developing countries in the world, teaching is the most vital and strategic profession for national development. The central purpose of teacher education is to provide teachers with the intellectual and professional background for their assignment (Ogunyinka, Okeke and Adedoyin, 2015). The effectiveness of any educational system depends greatly on the educational attainment of teachers because no system of education can be quantitatively higher than the quality and commitment of its teachers, (NPE, 2012).

The fact remains that teaching and learning depend on teachers for there can be no meaningful socio-economic and political development in any country without teachers. These objectives can be achieved if teachers are made to attain education in its various forms, therefore the ultimate realization of any set of aims for education depends on the teachers. The NPE (2012) sets out the major goals of teacher education as to:

- i Produce highly motivated, conscientious and efficient classroom teachers for all levels of our educational system;
- ii Encourage further the spirit of enquiring and creativity in teachers;
- iii Help teachers to fit into social life of the community and the society at large and enhance their commitment to national goals; and
- iv Provide teachers with the intellectual and professional background adequate for background adequate for their assessment and make them adaptable to changing situations: and enhance teacher's commitment to the teaching profession.

Science Education is the field concerned with sharing science content and process with individuals not traditionally considered part of the scientific community, (Future of Education Summit, 2019). The disciplines that make-up science education include: physics education, chemistry education and biology education. The focus of this paper is on the role of Information and

Communication Technology (ICT) for developing higher -order thinking skills, such as inquiry, graphing and modelling in NCE Chemistry Education programme.

Chemistry education is a veritable instrument for national development. According to Okoro (2014), science is a way of seeking information (process) and also an accumulated knowledge resulting from research (products). Okoro sees Chemistry as a systematic investigation of nature with a view to understanding and harnessing them to serve human needs.

It addresses the needs of majority through its relevance and functionality in content, practice and application. What many nations like Nigeria need now is a functional chemistry education that will assist in national development. Chemistry education has been identified to be one of the major bedrock for the transformation of our national economy. Chemistry Education can be seen as the acquisition of knowledge or ideals relevant to chemistry. It is concerned with the impartment of knowledge on properties, components, transformations and interactions of matter.

Hence, the development of the nation is usually measured by the degree and extent of growth brought to it through the enterprise of science education and a gate way to it is chemistry education. Chemistry education is the vehicle through which chemical knowledge and skill reach the people who are in need of capacities and potentials for development. In addition, chemical education addresses the social objective of substance development, as education is now of the primary means for empowerment, participation, cultural preservation, social mobility and equity, (Ababio, 2013).

Conclusively, the ideas of chemistry are not getting the attention they desire in either formal or informal education provision. It is argued that an improvement in this position requires the further development of the nature and quality of chemical education to chemical industries through intensive inclusion of e- learning in tertiary institutions of higher learning .In fact, e-learning in Nigeria tertiary institutions has recently to grow at unprecedented speed but with a lot of challenges.

The Nigeria Certificate in Education Chemistry Education, like any other programmes run in the colleges of education is supervised by an agency regarded as National Commission for Colleges of Education (NCCE).This agency has the major function of supervising all aspects of non-degree teacher education and professionalism in Nigeria. National commission for Colleges of Education lays down the minimum standards for all teachers' education programmes.

The objectives of chemistry programmes at the NCE level as noted by NCCE, (2012) that students should have competencies in chemistry teaching including ability to:

- i) Develop functional knowledge of Chemistry concepts and principles;
- ii) Observe and explore the chemical environment;
- iii) Apply the skills and knowledge gained through the study of chemistry to solve day-to-day problems;
- iv) Explain simple natural phenomena;
- v) Develop scientific attitudes such as curiosity etc.
- vi) Manipulate simple apparatus for purposes of demonstration and use; and
- vii) Improvise simple equipment from available junk in the chemical environment

Virtually all aspects of the system were affected by the change generated by the establishment of National Commission for Colleges of Education (NCCE) scheme objectives, curriculum, enrollment, financing, staffing, facilities, management and control. Consideration of the current status of the system can hardly complete without working, in time perspective at trends in the changes that occurred in the aspects of the system being considered.

According to the NCCE minimum standards (2012), the intrinsic values as well as the utility values of chemistry in all sphere of human activity has necessitates its inclusion in the school curriculum. The teaching and learning of chemistry at the Nigeria Certificate in Education (NCE) level should be such as to produce competent, effective and efficient teachers who having acquired the requisite skills should be able to impact same to their students. The college of education is thus, the vehicle for shaping attitude towards modernization: this is because it is the second institution of learning that exposes a youth to different aspects of science and technology through teaching and learning of chemistry. But the reverse is the case with the colleges of education in not fulfilling all their important task.

It can be deduced that ICTs are essential for contemporary educational development of any nation. E-learning is important as it allows the online delivery of training with real time tracking of training results, optimize time and reducing costs associated with traditional learning methods, (Moore, 2020).

Therefore the application of e-teaching and e-learning in Nigerian educational system cannot be far from the following especially in consideration of the onset proposal for redesigning the minimum standards for Nigerian tertiary

institutions. The internet facilities when judiciously and fully implemented would:

- i. Reduce and/or eliminate the costs for instructor fees and materials to certain level.
- ii. Increased retention and enhanced hands-on application unlike traditional methods.
- iii. Make easy use of multimedia in practice and assessment according to learners' abilities.
- iv. Make knowledge cumulative as lessons are built consecutively and more flexible.
- v. Assist e-learners create, have access, view, modify and print or send documents.
- vi. Enhance evaluation as it becomes self-paced because e-learning is a networked phenomenon.
- vii. E-learning supersedes training and instruction as it is a tool that improves behavior performance.

The benefits of e-learning are many. It may as well include cost-effectiveness, enhanced responsiveness to change, consistency, timely content, flexible accessibility, and providing customer value (Olomo, in Terrande, 2012).

There are three basic learning theories that influence the adaptation of e-learning in Nigerian institutions, (chemistry education inclusive), as outlined by Terrande(2012). These include:

- (i) Behaviorism: This treats learning as a set of changes to the learner as he/she reacts to environmental events. Memorization and imitation are critical in this learning process. The focus here is always on the teacher, or the computer providing the carefully arranged material but not the learner.
- (ii) Cognitive Science: It bases learning on attention, motivation, perception and other internal processes. It focuses on screen design and on human / computer interaction, where the teacher usually has the role of the facilitator or partner.
- (iii) Constructivism: It is a paradigm that postulates learners can construct their knowledge as they react with and interpret their environment. The most important thing here is that focus is centered on the learner.

The most common challenges of implementing e-learning with Nigerian higher institutions according to Tomoh, (2018) include the following: i) Management's attitude; ii) Erratic electricity supply in most part of the country,

and iii) Non-inclusion of ICT programmes in NCCE minimum standards curricula at the basic levels of education.

E-learning and virtual classrooms have become the order of the day in most learning institutions whereby academics, non –academics and support staff can access the education system, monitor and even provide guidance accordingly,(Almajalid,2010). Public cloud, private cloud and service as a cloud (cloud application) are the different forms of cloud computing(Saini, Jyoti&Kaur,2017).There are three components of the internet; e-mail, UseNet news groups, and the World Wide Web. Muoneke and Muoneke, (2018) revealed that internet services cannot provide all that is needed in e-learning and e-teaching in schools. They found that internet services lack basic infrastructures required in the application of e-learning in schools. This is because there is need for the major innovations to enter the world wide classrooms in this modern age.

Cloud computing is one of the major innovations (Saini, Jyoti&Kaur, 2017) when used with other forms of technology implementation that entered classrooms in recent years.A cloud application, or cloud app, is a software program where cloud-based and local components work together. This model relies on remote servers for processing logic that is accessed through a web browser with a continual internet connect(Rouse and Joel, 2017).

Hence, this paper addresses the need of improving ICT skills to students by incorporating cloud- based application into the teaching and learning of chemistry especially in Nigerian Colleges of Education.

Conceptual Clarification

E-learning explained

E-learning is defined as integrating learning with technology. It can also be defined as online delivery. It is instruction delivered through purely digital technologies such as CD Rom, the internet and private networks (Landon and Landon, in Tomoh 2018).

Chemistry Education explained

Chemistry Education, in its all-embracing and complex ramification can be seen as the acquisition of knowledge or ideals relevant to chemistry. It is concerned with the impartment of knowledge on properties, components, transformations and interactions of matter(Ababio, 2013).Chemistry Education is therefore the systematic process of acquiring the fundamental knowledge about the universe.

Challenges explained

According to Cambridge dictionary +Plus (2020), challenge is the situation of being faced with something that needs great mental or physical effort in order to be done successfully and therefore tests a person's ability. Some of the greatest challenges faced by science educators today on e-learning based-application are the issues of: Lack of ICT infrastructures; Incompetency of science teacher educators on the utilization of internet facilities, implementation, funding and management problem of the programme which boiled down to NCCE minimum standards of the secondary education science programme.

An Overview of National Commission for Colleges of Education Minimum Standards

The National Commission for Colleges of Education (NCCE) was established by Decree No.3 of April, 1989 as an agency to supervise all aspects of non-degree teacher education and professionalism in Nigeria. The enabling decree was later amended by Decree No.12 of 1st January, 1993. The decree establishing NCCE mandates it to carry out the functions, to;

- i) Makerecommendation on the National Policy necessary for the full development of teacher education and training of teachers.
- ii) Lay down minimum standards for all programmes of teacher education and accredit their certificates and other academic awards.
- iii) Approve guidelines setting out criteria for accreditation of all Colleges of Education in Nigeria.
- iv) Determine the qualified teacher needs of the country for the purpose of planning training facilities and in particular; prepare periodic master plans for the balanced coordinated development of Colleges of Education.
- v) Enquire into and advise the Federal Government on the financial needs of the Colleges and receive block grants from the government and allocate to the Colleges based on approved formula.
- vi) Undertake periodic reviews of terms and conditions of service of personnel in the Colleges of Education and make recommendations thereonto the government.(The Federal Ministry of Education, 2012).The agency is known as the regulator of Nigerian Colleges of Education

The National Commission for Colleges of Education (NCCE) lays down the minimum standards for all teachers' education programmes. The NCCE

minimum standards are of seven schools, as stipulated by Federal College of Education Zaria, (2018), these include:

- i. School of general education with departments.
- ii. School of secondary education, arts and social sciences with departments.
- iii. School of secondary education language programme.
- iv. School of vocational and technical education.
- v. School of childhood care and primary Education with department.
- vi. School of Special Adult and Non-formal Education with departments.
- vii. School of secondary education science programme with seven departments. These include; NCE biology, NCE chemistry, NCE computer science, NCE integrated science (single and double majors) NCE physics, NCE physical and health education (double major) and NCE mathematics.

The National Commission for Colleges of Education minimum standards Secondary Education Science Programmes (NCCE, 2012) spelt out the courses of the curriculum of secondary school science programme. It is intended that the lecturing of these courses will lead to the realization of the chemistry education objectives as listed by the policy, that is, all things being equal. Some of those things expected to be equal include:

1. The philosophy of NCE Chemistry.
2. The objectives of NCE Chemistry.
3. General admission requirement.
4. Facilities:
 - a. i) Laboratory (Dimension: 18x8 and 20x8 square meters), 50 students less in each year. ii) Staff offices. iii) Books in the departmental mini-library
5. Equipment:
 - a. Essential needs: constant supply of; (i) water ii) electricity, and iii) gas.
 - b. Supply of chemicals.
6. Personnel:
 - a. Academic Staff
 - b. Head of Department
7. Support Staff
8. Mode of teaching e.g. i) Computer Assisted Instruction (CAI)
9. Graduation requirement
10. Teaching practice
11. Project

12. Chemistry course codes, titles, credit units and status
13. The contents of the courses
14. Course credit requirements

E-Teaching and E-Learning Policy Framework in Nigeria

The successive governments in Nigeria have consistently formulated Policies which were directed towards ensuring that there are equal and adequate educational opportunities at all levels. As far back as 1977, Government began searching for alternative models to the traditional conventional system, which was rather restricted and limited in scope. In response to the need for a more elastic and accessible model of education, Government opted for a semblance of e-teaching and e-learning educational system. Thus, it can be said that the foundation of e-teaching and e-learning educational system in Nigeria was laid through the National Policy on Education of 1977, subsequently revised in 1981.

The current National Policy on Education (NPE) recognizes the place of e-learning educational system in achieving lifelong education and affirms that lifelong education shall be the basis of the nation's education policy. It went further to state that at any stage of the educational process after junior secondary education, an individual shall be able to choose between continuing full-time studies, combining work with study, or embarking on full time employment without excluding the prospect of resuming studies later. This envisaged the development of e-teaching and e-learning educational programs in the country. The NPE (2012) defined e-teaching and e-learning educational system as the mode of teaching in which learners are removed in time and space from the teacher. It uses a variety of media and technologies to provide and/or improve access to good quality education for large number of learners wherever they may be.

Components and benefits of cloud application in chemistry education

Cloud computing is termed as providing information technology resources when demanded through the internet (Almajalid,2010). The various forms of cloud computing include; public cloud, private cloud and cloud application also known as "cloud as a service", (Saini, Jyoti&Kaur,2017).

The components in a cloud refers to the flat forms, like the front end, back end, and cloud based delivery and the network used, as these together forms an architecture for cloud computing. (Ravichandran, 2020).The main components of the cloud computing are; Storage as a Service, (SaaS), Platform as a service(PAAS) and Integration as a service, (IAAS) .While the sub-components play a

Major vital role in the cloud computing technology, and these include: Database as a Service (DaaS), Information as a Service (IaaS), Process as a Service (PaaS), Application as a Service (AaaS), Security as a Service (SaaS), Management as a Service (MaaS), Testing as a Service (Taas), and Infrastructure as a Service(IaaS).

Cloud application servers typically are located in a remote data center operated by a third-party cloud services infrastructure provider. Cloud-based application tasks may encompass email, file storage and sharing, order entry, inventory management, word processing, customer relationship management (CRM), data collection, or financial accounting features (Rouse and Joel, 2017).According to them,cloud application servers typically are located in a remote data center operated by a third-partycloud services infrastructure provider. The benefits of cloud applicationsaccording to Rouse and Joel, (2017) can be explained as shown below:

- i) Easy Access/Fast response to business needs: Cloud applications can be updated, tested and deployed quickly, providing lesson plan, labs, grades, note, and Power Point slides – just about anything digital that you use in teaching is easily uploaded and accessed anytime.
- ii) Shareability/Simplified operation: Infrastructure management can be outsourced to third-party cloud providers. Chemistry teacher working on an instructional assignment with other teacher, he can share some or all of your files that you have stored in the cloud. No more obtaining an extra thumb drive or burning another CD or DVD. He just need to send a link to the files(s) destination.
- iii) Trackability/Instant scalability: As demand rises or falls, available capacity can be adjusted. The teacher makes changes to a lesson and want to change it back,no problem. Cloud computing will save multiple revisions and versions of a document so that you can chronologically trace back the evolution of items.
- iv) Security: The data, content, information, images anything you are store in the cloud usually requires authentication (ID and password, for example) – so it is not easily accessible by anyone. In addition, should something happen to the technology at school, your content will still be available to you and your students if it is stored elsewhere.Other uses of cloud application include: Application Programming Interface (API), Gradual adoption, reduced costs, and improved data sharing and security.



Fig. 1: Benefits of Cloud Application

Source: Adapted from Rouse and Joel (2017); Cloud application.

Challenges of e-learning in Nigerian Colleges of Education (Chemistry Education in particular)

Nigerian higher education system has 90 colleges of education; 21 federal colleges of education, 49 state colleges of education, and 20 private own colleges of education; (Muoneke, 2013) and about 80 other tertiary institutions, Polytechnic and Monotechnics and Universities, (Oye, Salleh&Iahad, 2011).

Further reviews on these are; Nigerian contributed only approximately 2% among the internet users worldwide, (Oye, Salleh&Iahad, 2011). The developed countries ranked high among the world internet users. Oye, Salleh&Iahad, (2012) reviewed or surveyed four developed countries: United State, South Africa, Japan and Singapore on e-learning based on how they are successful. These include:

- (a) The vision and their programme action plans for e-learning.
- (b) The government policies programmes and financial support by substantial funding.
- (c) The earmarked action programme for each year.
- (d) The investment on the internet ICT infrastructure and power (electricity).
- (e) To embark on training and awareness as an essential component of an e-learning strategy.

Regrettably, chemistry and its education is yet to make any noticeable impact in the nation due to lack of commitment on the part of the government and all stake holders. Several factors have been identified to have be-devilled the development of science and chemistry in Nigeria. Among the various factors are:

- i. Non-inclusion of ICT programmes in NCCE minimum standards curricula at the basic levels of education: School curriculum in the pre-independent Nigeria was not for all-round development of the child as the aspects of science and technology which would have created entrepreneurial skills for self-reliance were ignored (Sabina, 2009). The worst is recorded at the Colleges of Education where all the practical requirements are virtually out of place. Here, the students are left to fend for themselves not minding the cost and risk implications. This is certainly a crude way of teaching and learning and can never bring about the most needed self-reliance and national development that can be attained through using e-learning in cloud- based application in chemistry education programme. There is an obvious relationship between development and the type of educational structures available in any country.
- ii. Poor technical infrastructures: The rudiment of chemistry can only be actualized with functional internet facilities. The absence of basic internet infrastructures has made chemistry education objectives not to be attained. The resultant effect of this is lack of loss of interest by both the parents and students. Ababio (2013) added that the lack of these formidable and essential facilities discourages teaching and learning of science and chemistry education and thus slows the pace of national development such as phone lines and internet connections are reliable or slow due to narrow bandwidth. Bandwidth refers to the amount of information that can be sent or received at a point on a computer network, the greater the bandwidth, the greater the carrying capacity and speed of transmission. (Oye, Salleh&Iahad, 2011).
- iii. Limited expertise means that there is lack of or inadequate trained personnel to use or Mann the ICT in higher institutions: A study carried out by Edomwonyi and Avaa, (2011) revealed that some lecturers are teaching chemistry but they are ICT illiterates. Some of the chemistry lecturers in colleges of education lack competent skills to teach ICT in colleges of education. The demand for ICT learning has been tremendous and the number of teachers who are trained to teach ICT cannot meet the demand. There are more students willing to be taught computing skills than there are teaches to transfer the skills.

- iv. **Inadequate Manpower:** First and foremost is the lack of adequate and qualified lecturers which is affecting the quality of our educational system; the quality of any educational program depends on the quality of those who teach it (Bugaje, 2013). This underscores the importance that is attached to the production of high quality ICT competent lecturers in chemistry education programme in colleges of education, (Pemida, 2005). The teaching profession is not regarded as much in high esteems as other profession, this coupled with low salaries, only low achieving students are often seeking admission into our colleges of educations (Abubakar, 2013). Abubakar further added that the findings of the study conducted by World Bank on teacher's competency in ICT skills (chemistry lecturers inclusive) in Nigeria indicated that only 75 out of 19,000 lecturers tested were ICT competent. Manpower shortage is a challenging problem facing chemical education in Nigeria (Nnamdi, 2014). However, the demand for the qualified chemistry lecturers especially at the secondary school level is very high but few are seen in the class because majority of them prepare to go to industries and oil companies (Nnamdi, 2014). Lecturers are the main determinants of quality in education, if they are apathetic, uncommitted, uninspired, lazy, unmotivated, anti-social, the whole nation is doomed (Bugaje, 2013). It is apparent in Nigeria now to find third class and pass graduate teaching in many of our higher learning institutions especially those owned by the states (Abdulwasiu, Jelani, Nayaya, 2013). But qualified and sufficient numbers of dedicated lecturers are needed to teach chemistry content or direct the chemistry curriculum (Bugaje 2013). Unfortunately many of Nigerian schools lack adequate qualified and dedicated chemistry lecturers to teach the content using e-learning on many schools and institutions.
- v. **Poor Funding and Mismanagement:** Financial restrictions involve two parts: (a) The cost of ICT equipment can be a limiting factor with regards to everyone affording this service. (b) The misappropriation of funds has added to the ongoing problem. Chemistry which is at the Centre stage in the field of science and have in no small way in Nigeria schools been faced with inadequate funding. The funding of schools in Nigeria especially the Colleges of Education has traditionally been from grants, by the government and international agencies which are usually tied to specific projects. High level of mismanagement and corruption in the utilization of the supposedly poor fund provided by the government and

other stake holders are also basic issues. This has largely hindered functional laboratories, workshops, internet facilities, equipment, and chemicals from being put in place. For this, there can be no meaningful national development through chemistry education.

- vi. Energy related problems: It involves irregular and frequent interrupted power supply in Nigeria. The energy related problem is a perennial problem affecting almost every aspect of the economy, including education. These are the critical factors affecting the acceptability of e-learning by distant students and chemistry lecturers of Nigerian colleges of education. The place of adequate power and workable infrastructure in chemistry education cannot be glossed over. Most Colleges of Education lack the basic infrastructure of internet to study chemistry. The absence of regular and stable power supply has made the use of e-learning impossible in the learning institutions.

Cloud-Based Applications on Chemistry Education Programme

Governments all over the world, such as Nigerian government play a key role in developing, funding and regulating ICT infrastructures as well as promoting internet connectivity. This new technologies allow for more flexibility in learning and a wider reach for education in many countries worldwide (Salawudeen, 2010). Therefore, integrating cloud-based application into the Chemistry Education Programme is a way of meeting the needs of e-learning and it encompasses the following stages:

- i. Building the system to create the cloud and upload the documents, files, images and videos on the cloud. In the institution of higher learning, chemistry teachers and students can access it from anywhere and they can as well prepare their own documents and share it with the others.
- ii. Chemistry teachers who have acquired the skills and knowledge from information and communication technology (ICT) training, can in their presentations show animations or perform experiments such as; volumetric analysis or quantitative analysis using inquiry, and modelling etc. on the documents.
- iii. Chemistry teachers in colleges of education prepare the class and upload the power points and videos for the next class in home using the account created by the administration through the ICT unit in the college. In response to cloud-based application, Vitz, Moore, Shorb, Prat-Resina,

Wendorff and Hann(2020) introduce the use of ChemPRIME(Chemical Principle through Integrated Multiple Exemplars). It is a collaborative project designed so that chemistry concepts can be presented in an order that reflects the conceptual structure of the discipline and students are able to learn within a broad range of contexts that relate chemistry to other disciplines and every day.

- iv. Chemistry teachers upload the lecture materials which can be accessed by the chemistry students in hostels or homes as well as in the laboratory.
- v. Chemistry teachers can give them online presentation or change the content of any image dynamically during lecturing, chemistry students can submit their assignments online etc.
- vi. Chemistry students login based on the authentication given to them and access power points lecture materials, results and assignment assigned to them, and video lectures. This cloud-based application will be helpful to colleges of education, polytechnics and universities students who have not been attending lectures due to the spread of corona virus pandemic in the world now will benefit from the service. This service will improve the chemistry students' skills and knowledge as it will improve interactive learning (Saini, Jyoti&Kaur, 2017).

They also attested to the fact that more than 90% of organizations currently using some kind of cloud based application, as are being recognized in almost all kinds of institutions across the board.

Barriers of cloud-based application in education system according to (Saini,Jyoti&Kaur, 2017) include: i) Cloud-based application depends on the availability of high speed internet access and reliability of the cloud,as the chemistry students cannot access their files or applications. ii) It requires proper availability of authentication to avoid having access to files anywhere, this is the security concern which must be handled. The challenges of cloud application according to Davatz, Inzinger, Joel and Leitner,(2017), can be seen in the users of infrastructure-as-a-service (IaaS) since the clouds is selecting cloud providers regions, and instance types cost-optimally for a given desired service level. They added that such issues as hardware heterogeneity contention, and virtual machine (VM) can result in considerably differing performance across supposedly equivalent cloud resources. Conclusively, overcoming these minor barriers of cloud based applications involves the integration of cloud management as established by (Turner and Mahowald, 2011): Identifying a plan, accessing the existing costs, identifying different opportunities, integrating and

monitoring the performance of application, and security priorities and strategies using its agenda cloud infrastructure, as well as Saas agenda.

Conclusion

Meeting the needs and challenges of e- learning in tertiary educational institutions in the 21st century will increasingly rely on various forms of electronic delivery system and communication facilities available in markets that are required to make education to be more flexible. Despite the roles ICTs can play in education, schools in Nigeria have yet to extensively adopt them for teaching and learning. Efforts geared towards integration of ICTs into the school system, have not had much impact. Challenges such as: poor policy, poor project implementation strategies and poor information infrastructure militate against these efforts. For e-learning to succeed in Nigeria, there is the need to build on another important pillar i.e. the existence of befitting infrastructure and some degree of viable connectivity, cloud based technology is the new direction.

Also, the ideas of cutting Information Technology (IT) costs and at the same time create a modern collaborative environment, tertiary institutions of higher learning can see some important benefits from moving to the cloud. Encourage learning processes and introducing new technologies in classrooms move students to develop skills and knowledge necessary for achieving their academic and professional goals. Modernizing and introducing new technologies will bring about meeting the needs and challenges of e-learning which invariably threads to attainment of national development.

Recommendations

- i. The Federal government should make internet connectivity a priority for higher education to be able to leverage on the promises and opportunities Information and Communication Technology present.
- ii. Both Federal, state and private Colleges of Education should be able to implement e-learning to an adequate level which is commendable with the Nigerian education management.
- iii. The government should provide adequate power supply to enable higher institutions such as college of education (chemistry education in particular) so as to enable them have their instruction delivered through purely digital technologies.
- iv) The NCCE agency through the effort of the Federal Government should make provisions on the NCCE Minimum Standards of Secondary Education Science Programme (Chemistry Education in particular) to the following groups: ICT management unit; chemistry students; chemistry

teaching staff – chemistry lecturers, laboratory technologists and support staff; software developers and research staff. This can be done by providing them with the necessary hardware and software equipment to conduct experiments requiring high levels of computation and processing, to host and visit web applications, to use the required and relevant software (e.g. operating email accounts, malware detectors) and hardware (e.g. servers and PCs), to use services from service providers of IaaS and SaaS clouds which will ideally be accessed through clients.

v) The professional chemistry teachers who are ICT literates should be posted to colleges of education, especially now that there is corona virus pandemic in globally .Cloud application is the best solution to covid -19, the lock -down period for students, teachers and parents,e.t.c.

v

Vi) There is need to deliver e-learning to the grass-root groups. Internet connectivity can be used to bring e-learning to the door of the students in their various villages.

Vii) The Nigerian government should provide masks that can be drawing internet services to the students' places of abode.

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