THE VIRTUAL CHEMISTRY LABORATORY: A TOOL IN SCIENCE EDUCATION

ODOJE Oluwatoyin Funke
Department of Chemistry, Emmanuel Alayande College of Education, Oyo

Abstract
Laboratory and its application are of great importance in chemistry education, laboratories have a central and distinctive role in science education because it enhances a meaningful learning of science concepts and theories. However, laboratory applications have generally been neglected in recent times due to high laboratory operational cost time and some other reasons. This study is aimed at revealing the need to apply virtual learning environment in teaching and learning of science. The components of the virtual laboratory, the advantages as well as the constraints were also examined in this study. It was concluded that the virtual laboratories can serve as alternatives or supplements to the traditional physical laboratories in teaching and learning of science.

Introduction

Education is considered to be a very important tool for attaining national goals and development. It is a life-long process which transforms the life of an individual from that of a helpless and dependent creature to a self-reliant, rational and skilful person who can contribute to the development of his society (Akinbote, 1988). In other words, education provides learners with skills needed for survival. For any nation to attain sustainable development there is need to recognise science education as priority area for her citizen (Ogunmade, Okedeyi&Bajulaiye, 2006). Science and technical education is the 'factory' for the production of the needed technologists, technicians and craftsmen as well as skilled artisans who are required to form the nations' economy around and usher in the desired technological advancement which is very much required for the elevations of Nigeria from a consumer nation to a producer nation' from a 'developing nation' to a developed nation (Avaa, 2007). Science is a way of seeking knowledge, information (process) and also an accumulated knowledge resulting from research (products). It is a systematic investigation of nature with a view to understudy and harnesses them to serve human needs (Okoro, 2013).

The field of science, in its broadest contemporary sense, make some of the most valuable contributions to the general welfare of humanity. The level of scientific activity in a country or region can be directly correlated to the level of development and quality of life in that region or country (Pearson &Kudzai, 2015). Science education which has a distinct place in the educational system with its content consist of three main disciplines namely Physics, Chemistry and Biology (Babateen, 2011). Within the context of science education, chemistry has been identified as a very important science subject and its importance in scientific and technological development

of any nation has been widely reported (Avaa, 2007). Chemistry as the queen of science plays important role in achieving self-reliance and intellectual development. Chemistry has contributed greatly towards providing basic needs and improving the quality of life. It is a central science hence it plays a crucial role in most aspects of modern science and technology from biotechnology to the creation of new materials.It also plays major role in food (fertilizers and insecticides) clothing (textiles and fibres) housing (cement, concrete, steel, bricks) Medicines, transportation (fuel, alloy materials). Chemistry education is the vehicle through which chemical knowledge and skills reach the people who are in need of capacities and potentials for development.

Chemistry is perceived by students as a challenging subject because most of the content of science lessons especially chemistry is abstract. It is difficult to construct the abstract concepts frequently encountered in the subject area (Ayas&Dermirbas, 1997). It is also difficult to attach it to real world experience. Many students have difficulties in embodying abstract concepts. In order to overcome these difficulties, it is recommended that students configure the concepts of chemistry lessons by themselves and this can be achieved through the use of chemistry laboratories. Laboratories are important components of science teachingsince learning activities are not limited to the delivery of theory content and evaluation alone but also to experimental activities which are integral component of chemistry lesson enable students to build up their own experiences with concrete materials (Tasdelen, 2004).Science practical in schools is aimed at giving the students the opportunity to gain meaningful learning; acquire appropriate skills and attitudes that enable them live and contribute to the development of the society (Avaa, 2007)

The science laboratory is a setting in which students can supportively in small groups investigate scientific occurrence (Aina, 2012). The laboratory has been given a central and distinctive role in science education and science educators have suggested there are rich benefits in learning using laboratories activities (Tasdelen, 2004). Laboratories have been found to be scientist's workshop where practical activities are conducted to enhance a meaningful learning of science concepts and theories (Seweje, 2000). They have also been found to be a primary vehicle for promoting formal reasoning skills and student's understanding, thereby enhancing desired learning outcomes in students (Tasdelen, 2004). Laboratories play vital roles in the teaching and learning of science because students tend to understand and recall what they see more than what they hear as a result of using laboratories (Farounbi, 1998). The availability of operational chemistry laboratory equipments will go a long way in achieving the desired objective of effective teaching of science in schools. Effective teaching and learning of science involves; seeing, handling and manipulating real objects and materials.

Despite the importance of chemistry and science education to national development, many schools lack the instruments or equipment to conduct laboratory experiments due to high laboratory operational cost and this leads to very few students developing thinking ability. As a result of lack of essential resources for imparting the knowledge of science concepts to students, many students

learn little science; learning tends to be by rote and many students find science not interesting and boring (Ogunmade etal, 2006). The situation in many science classrooms in Nigeria is nothing to write home about. In many schools, merely empty rooms are labelled laboratories. Therefore, the teachers will have no facilities to demonstrate phenomena let alone allow the students to have opportunities for finding out things for themselves (Omoifo, 2012). There is therefore the need for the virtual laboratories which is becoming one of the most significant educational technologies due to the financial challenge which often require construction of physical laboratories particularly in education institutions in developing countries.

Laboratories are important components of science education needed to make students gain experience. Due to the fact that chemistry is totally an applied branch of science, the importance of laboratory application in instruction is clearly understood. In chemistry laboratory, students become active in their learning and seeing, observing and doing. Such kind of applications causes not only a better but also a permanent learning. Hence laboratories studies increase students interest and abilities for science subjects (Bagci&Simsek, 1999) The capital requirements of setting up a fully equipped chemistry or science laboratory have been and continue to be a deterrent for effective science teaching and learning (Pearson &Kudzai, 2015). Therefore this study is interested in evaluating the potential use of virtual laboratories to augment or replace traditional science laboratories.

The Virtual Science Laboratory

A virtual laboratory is defined as an interactive environment to create and conduct simulation (Woodfield,2004). It is also a laboratory without real walls and doors. It enables the learners to look between the theoretical aspect and the practical one without paper and pen. The virtual laboratory is a virtual studying and learning environment that stimulates the real laboratory (Babateen, 2011)

It is electronically programmed in computer in order to simulate the real experiments inside the real laboratories (Harry&Edward, 2005). The virtual laboratory is also a learning environment in which students convert their theoretical into practical knowledge conducting experiments (Woodfield, 2005). The virtual laboratories simulate a virtual operating system, the computer screen, science laboratories, exploiting the potential offered for modern media technology. Virtual laboratories provide students with meaningful experiences and present important concepts, principles and processes. By means of virtual laboratories, students have the opportunity of repeating any incorrect experience to deepen the intended experience (Jeschike,Ritcher& Zorn, 2010).

It also helps to facilitate studying many scientific phenomena that cannot be studied experimentally due to its danger, high cost or lack of time to complete the experiment. One of the unique capabilities of the technologies of the virtual laboratory is successful translation of abstract concept into visualised events with the possibility of users' interaction. (Horkenwarter&Lavisa, 2010). According to Gejdos and Leader (2016) and Doukeli, (2012), the virtual laboratory environment can be classified into different categories; which are simulations which is an imitation of operating systems through time via computers. These represent a process on the basis of a model that is cheaper, faster, less risky and more affordable than the real

process. In addition, the applets are experimental devices in small virtual laboratories and are quite popular in science subjects. They are small in size and easily transported and they can be used regardless of the operating system types.

The Components of Virtual Laboratory

According to Al-Baiati, (2006) and Dillion(2007), the main components of the virtual laboratory include the lab sets and equipment which is considered integrals to the traditional lab. Also, computer devices represented in personnel computers which are linked to the international net so that the students can work directly in the lab or at a distant anywhere and anytime. The communication network and the related hardware allow experiments to be performed electronically, all the sets linked to the computer because the link between the users with labs will be through digital communication.

The programme of the virtual laboratory are represented in simulation programs which are designed by professionals in an interesting and attractive form so as to attract students' attention and urge them to complete the experiment which is maintained by the animation techniques, video and the three dimension pictures. Co-operation programs and management are concerned with the method of managing the lab and the ones who perform the experiment including students and researchers. These special programmes register students and determine the kind of access that should be provided to each user in the different experiments. The technical team are constituted to support educators in preparing and assessing scientific material in addition to evaluating the program to determine its efficacy.

The Need for Virtual Science Laboratory in Effective Teaching and Learning of Science

Researchers have found shortages in the number of laboratories in Nigeria schools. Many schools do not have required laboratory facilities. Hence, students often fail to acquire science laboratory skills because their teacher were unable to conduct practical as they would like to and this always had inevitable consequences for students learning (Carnival,2003). The advantages of using the virtual science laboratory cannot be overemphasised and these advantages have been confirmed (Harry& Edward, 2005; Carnival, 2003). Virtual science laboratories help in knowledge building. It also help in performing experiment that are difficult to perform in the traditional laboratory due to its danger, that is if it involves health risk and high cost. It also helps in reducing the learning time spent in the traditional laboratory.

Also, virtual science laboratory can be very useful especially in cases where experimental activities need to be done quickly and observation and safe measurement are not easy. It is also applicable where there is danger of chemical reactions, time constraints, lack of laboratory equipment or insufficient lab conditions. Virtual laboratory encourages collaboration and communication between teachers and students. With the use of the virtual laboratory, students acquire tool with which they can experiment without limitation of time or space. Another advantage of virtual laboratory is that they are available all year round as opposed to the school laboratories which are limited to a specific place and for a limited time (Doukeli, 2012).The use of virtual environments makes students acquire better

computer skills which can be useful for lifelong learning (Majherova*etal*, 2014). It also makes resources sharing to become a reality thereby improving the utilization of costly equipment. Virtual laboratories also provide access to educational and research materials for both students and professionals.

Constraints of Virtual Science Laboratory

According to Zaitun(2005) and Carnival (2003), the following are the shortcomings of the virtual science laboratory:

- In the use of virtual science laboratory, there is lack of real interaction between hardware, tools, instructors and colleagues.
- The need for computers and tools with specific standards.
- The lack of laboratory social skills gained in virtual laboratory compared to the real laboratory.
- The need for specialised working staff, instructors and curriculum experts for designing and production.

Conclusion

The virtual laboratories have been found to be a viable alternative to traditional chemistry of science laboratories in the teaching of natural sciences. Many researchers established the fact that virtual laboratories have many advantages on increasing students' achievement (Ozdener&Erdogan, 2001). Also, some experiments that can usually only be performed using a demonstration method for reasons such as insufficient material and crowded classrooms. For these experiments it is clear that virtual laboratories can provide a valuable alternative to the traditional laboratory applications (Ozdener, 2005).

Therefore, the use of virtual science laboratories will not only provide an effective learning environment but go a long way in minimizing school expenditures and also reduce time and risk involved in carrying out practical activities. Also, the development of virtual laboratories can be fully supported by the existing computer laboratories, without the need of additional investments and infrastructure.

Recommendation

Higher institutions of learning should explore the possibility of adopting virtual laboratories in the teaching of laboratory-driven disciplines as these will help in catering for the lack of equipment, insufficient time and capital.

References

Aina, K. J. (2012): Challenges and prospects of primary science teaching in Nigeria. *Continential Journal of Educational Research,* 5(2), 32- 37

Akinbote, O. (1988). *Teaching and general methodology. An introduction*, Ibadan: Global Books.

Al-Baiati, M.M. (2006). The applied and scientific dimensions in electronic learning.*The Arbatian net for open electronic learning.* Amman Jordan.

Avaa, A. (2007). Improving performance in the Sciences. A support paper presented at a workshop held at Federal Government Girl's College, Zaria.

Ayas, A., &Demirbas, A. (1997). Turkish secondary students' conceptions of chemistry concepts.*Journal of Chemical Education*, 745, 518-521.

Babateen H. M. (2011). The role of virtual laboratories in science education. *International Journal of Developmental Biology,*47,231-236.

Bagci, N.,&Simsek, S. (1999). The influence of different teaching methods in teaching Physics subjects on students' success. *The Journal of Gazi Education Faculty,* 19(3), 79-88.

Carnival, D. (2003). The virtual lab experiment some colleges use computer to expand science offerings online. *The Chronicle of Higher Education,* 49(21), 30-32.

Dillion, J, (2007). *Virtual science labs.* New York Times. p. 10.

Doukelli, M. (2012). Virtual laboratories in teaching physics in secondary schools. An Unpublished Masters Project submitted to the Department of Digital System University of Piraeus.

Faronbi, M. (1998). Resource concentration, utilization and management correlate of students' learning outcomes a study in school quality in Oyo state. An Unpublished PhD Thesis, University of Ibadan, Ibadan.

Gejdis, M. & Leader, G. (2016). Using computer programs in teaching in secondary schools. Dublin ISBCRTI,pp 81-89

Guncage, J. & Robert, J. (2016). Virtual labs and geometrical software as a tool for more effective teaching. *The International Journal of E-learning and Educational Technologies in the Digital Media,* 2(3), 28-40.

Harry, E.,& Edward, B. (2005). Making real virtual lab. The Science Education Review.

Hohenwarter, M., &Lavisa, K. (2010). Gaining momentum: Geogebra inspires educator and students around the world.*Journal of Chemical Education*, 7(1),111-116.

Jeschke, S. Richter,T., & Zorn, E. (2010). Virtual labs in mathematics and natural sciences. International conferences on technology, supported learning and training.*Online Education.*Retrieved from http//www.ibi-tu-berlin.Retrieved on Feb 10, 2017.

Majherova, T., Palasthy, H., &Janigiva, E. (2014). Pupils on the virtual world and education. Lecture Notes in Computer Science. 8130 pp 112-123.

Ogunmade T. O., Okedeyi S. A., &Bajulaiye, A. A. (2006). The status of resources in secondary science teaching and learning in Lagos State, Nigeria. *Journal of Science Teachers Association,* 8(2), 55-61.

Okoro, S.U.C. (2013). Attaining the MDGs through effective STAN education delivery. *STAN 54th Annual Conference Proceeding*. pp 108 -118

Omoifo, C. N. (2012). Dance of the limits, reversing the trends in science education in Nigeria. Inaugural Lecture. University of Benin, Benin city.

Ozdener, N.,&Erdogan, B. (2001). Improving the virtual laboratories which give the possibility of evaluating the experimental data and giving feedback. *Educational Science Journal of MU Faculty of Ataturk Education*, 14,107- 120.

Ozender,N. (2005). Using simulation for experimental teaching methods. Turkish *Online Journal of Educational Technology,* 4(4), 93-98.

Pearson, C., &Kudzai, C. (2015). Virtual laboratories: A solution for tertiary science education in Botswana. *European Journal of Logistics Purchasing and Supply Chain Management,* 3(1), 29 -43.

Seweje, R. O. (2000). The challenges of science teaching in Nigeria today. *Journal of Education Foundation,* 1,216-217.

Tasdelen, K. (2004). Internet-based interaction virtual micro controller laboratory design for engineering education. An Unpublished Master project, submitted to University of SuleymanDeirel, Ispartas, Turkey.

Woodfield, B. (2005). Virtual chemistry lab getting started. Pearson Education,Retrieved from http://www.mypearsontraining.com/pdfs/Vcl=gettingon May 25, 2016.

Zaitoun,H. (2005). *New vision in electronic learning.*Aldar Al-Soltiah, Riyadh.