# EFFECT OF VIRTUAL LABORATORY MODES ON PRACTICAL BIOLOGY SKILLS ACQUISITION IN OPEN AND DISTANCE LEARNING

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**Abstract**
*This study examined the effect of virtual laboratory modes on practical Biology skill acquisition in open and distance learning. The study had one research question and one hypothesis focusing on the extent to which Biology students exposed to virtual laboratory improved in their practical skills than their counterparts exposed to the physical laboratory. The population for this study comprises two hundred (200) undergraduate students of the National Open University of Nigeria offering practical biology BIO (119) from ten (10) study centres. Stratified random sampling technique was used to select a sample of 200. The design of the study was the quasi-experimental research design. A 20-item questionnaire to assess the skill of the biology students was developed by the researcher. The Spearman Rank Order was employed with correlation coefficient value of 0.9. The result indicated that students' practical skills improved with the use of virtual laboratory modes after the practical compared to the physical laboratory. The recommendations were that the governments at the national, state and local should provide the internet facilities, Wi-Fi and computers to the Open and Distance learning institutions to promote science learning among the students.*
***Keywords:*** *Virtual laboratory; Open and Distance Learning; Practical skills.*

## Introduction

Biology is a very important subject; it has to be given more priority. It enables one to understand himself and his immediate environment. Nevertheless, the knowledge acquired in Biology as a subject is applied in many fields which include medicines, pharmacy, nursing, agriculture, forestry, biotechnology and nanotechnology to mention but a few (Ahmed & Abimbola, 2011). Learning biology as well as other sciences is, therefore, becoming essential

not only for the well-being of the individual but also for the entire society (Odubunmi, 2006). In spite of the vital role and much emphasis being laid on Biology; students are still performing woefully in this subject. This has been an issue of great concern to stakeholders in education, most especially those in the field of science. This has been attributed to a myriad of factors among which include methodology, poor attitudes of students towards science (FRN, 2004) and also lack of laboratory equipment. Bassey (2005) (as cited in Amuche, Thomas & Shiaki, 2013) opined that several problems are associated with the conventional method of teaching. This indirectly resulted in the poor performance of students. He also attributed this syndrome in the educational sector to lack of perceived competence among the learners. However, (Adegbite, 2006; Olaleye, 2010) also as cited in Amuche, Thomas & Shiaki, (2013), stressed that the causes of poor performance differ. They posited very strongly that teachers' skills in the assessment are related to students' achievement in a subject. Imhanlahimi & Aguele, (2006) asserted that students' attitudes towards Biology are inadequate; there are no learning facilities and no qualified teachers. With these problems, the limits to effective learning of Biology may have been minimal. Accepted methods to overcome poor academic achievements in science have included the promotion of more effective teaching strategies and the creation of more positive attitudes towards the learning of science. Ajileye (2006) reported that insufficient resources for the teaching and learning of science constitute a major cause of student underachievement.

The availability and use of teaching and learning materials affect the effectiveness of a teacher's lessons. Broom (1973), as cited by Etsey (2005) opined that the creative use of a variety of media increases the probability that the students would learn more, retain better what they learn and improve their performance on the skills that they are expected to develop. Also, as cited by Etsey (2005) that science scholars Ausubel (1973) stated that young children are capable of understanding abstract ideas if they are provided with sufficient materials and concrete experiences with the phenomenon that they are to understand.

Ahmed & Abimbola (2011); Umar (2011) and Kareem (2003) observed that the poor teaching methods adopted by teachers at senior secondary school level in Nigeria have been identified as one of the major factors contributing to poor performance of students in Biology.

Ahmed (2008); Abimbola (2011); Umar (2011) and Kareem (2003); concluded that the persistent use of a method like a talk- chalk method made students passive rather than active learners. It does not promote insightful learning and long-term retention of some abstract concepts in Biology.

It is concluded that in this 21st century, a motivating and captivating approach should be encouraged to help students learn better, understand, and retain biology concepts and promote their future involvement (Adegoke, 2010; Kuti, 2006; Mayer, Dow & Mayer 2003; Moreno & Mayer 2000). However, the promising approaches involve multimedia presentations supported in visual and verbal formats supplemented with pictures, animations, texts, and narrations. Owino, Ali and Rabiu, (2014) attached the problem with the inadequate supply of teaching and learning resources such as chemicals, charts, apparatus, models, local specimens, laboratories, textbooks, and libraries led to poor performance in Biology. However, Cimer, (2012); Gambari, Yaki, Gana & Ughovwa (2014); Crippen, Archambault, & Kern, (2012); Flowers, (2011); Anderson, (2010) and Dobson (2009), advocated for the use of virtual laboratory modes in their various studies for the effective teaching\learning process of Biology.

described Virtual laboratories "as computer simulations that contain specific instructions, procedures methods of data analysis, and data presentation algorithms" (Flowers, Moore, & Flowers, 2011: P?). Virtual laboratory represents a novel way to convey and learn subjects using the power of visualizations and computer-generated simulations. Introducing technology into learning helps students to improve their learning ability and to remove negative perceptions about science. For example, physical science experiments can now easily be simulated in a virtual environment without any fear of a physical damage and at relatively low cost.

Kumar Pakala, Ragade, & Wong, 1998, Shin, Yoon, Park & Lee, 2000; Grob, 2000; Savvis, 2010; Jeschke, Richter & Zorn, (2010) (as cited in Tatli & Ayas, (2013) described virtual laboratory as an alternative learning environment, and can help to make this crucial educational application available to students. Woodfield, (2005) concluded that virtual laboratories simulate a real laboratory environment and processes, and are defined as learning environments in which students convert their theoretical knowledge into practical knowledge by conducting experiments. Virtual laboratories provide students with meaningful virtual experiences and present important concepts, principles and processes.

(Ardac & Akaygun; 2004, Jeschke, Richter & Zorn, 2010) as cited in Tatli & Ayas, (2013) explained that with virtual laboratories, students have the opportunity of repeating any incorrect experiment or to deepen the intended experiences. Dobson, (2009) as cited in Lawrence (2011) noted that virtual laboratories are just as effective conveyors of practical knowledge as a hands-on laboratory. The use of audio is experiencing a renaissance fueled by the ubiquity of portable audio players, broadband Internet, and software tools that allow the relatively easy creation and distribution of audio files (Schlosser, 2006).

Virtual laboratory modes are also categorized under instructional materials. Adekeye (2008) as cited in Reuben 2014 sees instructional materials available for instruction into four major categories: visual aid- these include pictures, maps, charts, graphs diagrams, chalkboard, sketches, atlas and painting; Audio-visual aids- television, computer programmes, film strips, video recording and projectors; Auditory aids- audio recordings, radios, records or cassette tapes, music and printed materials- Encyclopedias, textbooks, magazines, journals, Newspapers, pamphlets, novels, poems, simulation games, government records and publications, almanacs, biographic, editorial cartoons and case studies. According to Aduwa-Ogiegbaen and Imogie (2005) these materials and resources including audio tape recorders, video tape recorders, slide projectors, still pictures, programmed instructions, filmstrips, map, chart, graphs and many more offer a variety of learning experiences or in combination to meet different teaching and learning experiences.

For the facilitators to use virtual laboratory modes in teaching biology practical's the materials should be made available. Such materials can be prepared in the form of CD-ROM and be given to the Open and Distance Learning students at the point of registration in their various study centres. The practical could also be uploaded to the internet for the biology students' use. Once they have access to the internet, they will download it and make use of it at their convenient time before and after the examination. This promotes the flexibility of Open and Distance Learning (ODL).

Distance education is described as a method of education where students do not have face-to-face contact with their teacher and can study at a time and place of their choice (Bates, 2005). Margaret (2015) defined Open and Distance Learning (ODL) as a general term for the use of telecommunication to provide or enhance learning. She explained that the academic community is discovering and exploring the Internet, teleconferencing, and related means to

achieve an extended classroom or learning experience. Singh and Paliwa (2012) reported that Open and Distance Learning aims at the dissemination of learning and acquiring knowledge through distance education mode including the use of any communication technology to provide opportunities for higher education.

(Chikuya, 2007; Freeman, 2004) as cited in Crispen Bhukuvhani, Mathew Mupa, Misheck Mhishi and Diamond Dziva Bindura (2012) defined Open and Distance Learning as an amalgam of two approaches to education that focus on expanding access to learning and the use of multimodal delivery systems such as technology and printed modules. It is characterized by two factors; - its philosophy and its use of technology. Basson (2011) explained that the main challenges with practical work in ODL are that students are geographically scattered and that they come from very different educational backgrounds.

Distance education is defined by UNESCO (2015) as the use of specific instructional techniques, resources and media to facilitate learning and teaching between learners and teachers who are separated by time or place. Techniques, resources, and media are dependent on factors such as subject matter; student needs and context; teacher skills and experiences; instructional goals; available technologies; and institutional capacity. UNESCO (2015) ascertained that despite the proliferation of technologies in education, distance education in developing economies is still heavily reliant on printed materials.

The effectiveness of virtual laboratory modes is one of the issues in educational discourse that have attracted considerable attention in both developed and developing countries. Some of the problems faced by biology students in an ODL environment include; high cost of laboratory equipment, practical in the laboratory is time-consuming; practical in the physical laboratory is difficult in crowded classes and these problems limit the teachers to perform a simple laboratory activity. It is against this background that this study investigated the effectiveness of virtual laboratory modes on ODL students' practical skills in Biology.

One research question and one hypothesis guided the study.
To what extent do Biology students improve in practical skill between those exposed to virtual and physical laboratory activities?

There is no significant difference between pre-biology and post biology skill mean scores of Biology students exposed to virtual and physical laboratory activities.

**Method**

The study was conducted using quasi-experimental research design. The target population consisted of the students in the National Open University of Nigeria. Twenty (20) students from each study centre both males and females were randomly selected to participate in the study. Stratified random sampling was used to select a total of 200 respondents comprising of 92 male students and 108 female students from the total population. Ten (10) study centres were selected as strata, which enabled every undergraduate student offering biology practical in National Open University of Nigeria to be sampled.

The instrument for collection of data for this study was a twenty (20) items self-structured questionnaire aimed at practical skills in Biology. The questionnaire is divided into two (2) sections. Section A contains personal data of the students, while section B which has twenty items. measured practical skills in Biology of undergraduate students in the National Open University of Nigeria.

On each of the items, the respondents were asked to perform a skill according to the questions and they were observed by the researcher and with the assistance of the laboratory technicians during the virtual and physical laboratories classes. The questionnaire was coded with nominal values assigned to each possible response that was expected from the respondents. Each of the items was scored on the basis of this code. Sections B` was structured on a five-point scale of excellent = 5 points, very good =4 points, good = 3 points, fair = 2 points and poor = 1 point. At the end of the exercise, the instrument was scored to determine the overall effect of virtual laboratory modes on open and distance learning students' practical skills.

The instrument was subjected to face and content validity by the experts in the Department of Science Education for their expert advice in respect to the language level, suitability and over all face validity of the instrument. Correction was thereafter made based on their inputs. The reliability coefficient of the instruments was determined after a pilot test was conducted on ODL students that were not part of the study, the Spearman Rank Order was employed with Correlation coefficient value of 0.9 as the reliability index.

The researcher administered a pilot test; the data collected from this study were analyzed using descriptive statistics (mean and standard deviation) to answer research questions while paired and independent t- test was used to test the hypothesis. The hypothesis was tested at 0.05 level of significance.

The control group was taught with the physical laboratory while the experimental group was taught with the use virtual laboratory modes. Students in the control group were not allowed to see what was happening in the experimental group. The practical took place in the biology laboratory for five weeks. At the end of the practical, the questionnaire was given to the students to respond to the practical questions therein.

**Results**

Tables are used to present the results.

**Table 1: Mean Scores of students' practical skills acquisition between those exposed to virtual and Physical Laboratory Activities.**

| | **Pretest** | | | **Posttest** | | | |
|---|---|---|---|---|---|---|---|
| **TREATMET** | **MEAN** | **SD** | **STD ERROR** | **MEAN** | **SD** | **STD ERROR** | **MEAN GAIN** |
| Virtual Laboratory (Experimental) | 46.16 | 10.377 | 1.048 | 76.78 | 14.468 | 1.462 | 30.62 |
| Physical Laboratory (Controlled) | 49.32 | 13.133 | 1.300 | 71.36 | 15.643 | 1.549 | 22.04 |

The Table 1 showed the pretest and posttest scores of National Open University of Nigeria students' practical skills in Biology using physical and virtual laboratories. The pretest mean score for the virtual laboratory is 46.16 and the mean score for posttest are 76.78. The mean gain score was 30.62 for the experimental group that was exposed to the use of virtual laboratory for Biology practical. While the pretest mean score for the physical laboratory was 49.32 and the mean score for posttest was 71.36. The mean gain was 22.04 for the control group that made use of physical laboratory for Biology practical. So, ODL Biology students exposed to virtual laboratory mode improved in practical skill more than the ones exposed to physical laboratory activities.

**Table 2: t-Test Analysis of students' Skill Acquisition in Biology practical Between Those Exposed to Virtual and Physical Laboratories Activities.**

| | N | Mean | SD | S ERROR | t | df | P | Remark |
|---|---|---|---|---|---|---|---|---|
| Pretest Biology Skills | 200 | 47.78 | 11.939 | .844 | -20.974 | 199 | .000 | Significant |
| Post Biology skills | 200 | 74.02 | 15.283 | 1.081 | | | | |

The Table 2, showed the mean score for the pretest Biology Skills obtained (x=47.78, SD=11.939). While posttest Biology Skills Obtained (x=74.02, SD=15.283). Furthermore, A t-test for the quality of mean yielded t value of (-20.974) which is less than P value of (.000) with 199 degrees of freedom at 0.05 Level of Significance. This was significant at 95% confidence interval. Thus, a significant mean difference exists in pre-biology and posts biology skills scores of Biology students exposed to virtual and physical Laboratory activities. The null hypothesis which states that there is no significant difference between pre-biology and post biology skills scores of Biology students exposed to virtual and physical Laboratory activities is rejected while the alternate hypothesis is accepted.

## Discussion

The findings of the research question revealed that the use of Virtual Laboratory modes to teach Biology Practical in Open and Distance Learning Institution improved students' Practical Skills in Biology. This agrees with Lawrence (2011) that carried out research on investigating the effectiveness of Virtual Laboratories in an undergraduate Biology course: he found out that students preferred to participate in Virtual Laboratory to the Traditional mode (e.g., face-to-face) Laboratory. It can be seen therefore that research question which seek to find out the extent to which Biology students improved in Biology Practical Skill between those exposed to Virtual and Physical Laboratory activities has a higher mean gain for the students exposed to Virtual Laboratory than for those exposed to Physical Laboratory.

The result for hypothesis which states that there is no significant difference between Pre-Biology Skills scores of Biology Students exposed to Virtual and Physical Laboratory activities. Responses showed that there is a significant difference in mean score of pre-test and post-test of the students that were exposed to Virtual and Physical Laboratory for. Mean score for pre-test (x=47.78) and posttest (x=74.02) with Standard Deviation (SD=11.939 and SD=15.283) respectively. This is in favour of the use of virtual laboratory modes in Open and Distance Learning. However, this agrees with the findings of Yapici &Akbayin (2012) on the effect of Blended Learning Model on High school students Biology achievement and other attitudes towards the internet. The results revealed that the blended Learning model contributed more to the student's biology achievement than those traditional teaching methods did.

Findings of Unlu & Dokme (2011) in Effect of combining Analog Based Simulation and Laboratory activities on Turkish Elementary School Students' understanding of Simple Electric Circuits showed that the post-test result was higher than the pretest after exposure to the virtual laboratory and physical laboratory. The study revealed that students were extremely satisfied after learning through the use of virtual laboratory for the practical biology. They have gained more knowledge in Biology as a subject.

## Conclusion

The study proved that Biology students in the Experimental group exposed to Virtual Laboratory improved in practical skills more than the students in the controlled group exposed to physical laboratories before and after the practical. The use of Virtual Laboratory mode yielded a good result in the National Open University of Nigeria. Realising the flexibility and convenient use of Virtual Laboratory modes in an overcrowded environment by enhancing the Learning of Biology students' practical skills, some recommendations were made for future improvement to science teaching and learning.

## Recommendations

1. Government at the national state and local should provide the internet facilities Wi-Fi and computers to the Open and Distance Learning institution to promote science learning among the students.

2. The facilitators of Biology practical should download the practical for each semester and put them in the CD Rom and make them available at

the registration centres for students to enable the flexibility in Open and Distance learning institution.

## References

Ahmed, M. &Abimbola, I., (2011). Influence of teaching experience and school location on biology teachers' rating of the difficult levels of nutrition concepts in Ilorin, Nigeria. *Journal of Science, Technology Mathematics and Education, 7(2), 5261.*

Ajileye, *Ajileye*, O.O. (*2006*). Towards Effective Science Education Issues in Universal Basic Education (U.B.E) Programme. *Journal of Sports Management and Educational Research, 1, 337.*

Ajadi, B. M. (2021) Issues and Trends in Science Education for Sustainable Economic Development in Nigeria New Trends in Science, Technology, Management and Social Sciences in Africa; 3rd *International Conference of Villanova Polytechnic, Imesi-Ile, 2nd to 4th June, 2021 63.*

Akbayin, H., &Yapici I. U. (2012). The Effect of Blended Learning Model on High School Students' Biology Achievement and on Their Attitudes towards the Internet: *The Turkish Online Journal of Educational Technology,* 11(2). *TOJET*,11 (2), 228-237.

Amuche C., Thomas, N. & Shiaki, B. (2013). Comparative Analysis of Students' Performance in Two Formats of a Biology Practical Test in Taraba State. *Journal of Education and Practice 4 (4).270-276.*

Archambault, L., & Crippen, K. (2009). Examining TPACK among K-12 online distance educators in the United States. *Contemporary Issues in Technology and Teacher Education*, 9(1), 71-88.

Bates, T. (2008) *Technology, E-Learning and Distance Education:* Online Learning & Distance Education London: Routledge.

Batomalaque, A.E (2015). Basic Science Development Program of the Philippines for International Cooperation. *University of San Carlos, Cebu City, Philippines.*

Broom, L. (1973). *Sociology: A text with adopted reading (4th Ed.). New York*: Harper and Row.

Federal Republic of Nigeria. (2004). *National Policy on Education*. Lagos: NERDC Press.

Flowers, L. O., (2011) Investigating the Effectiveness of Virtual Laboratories in an Undergraduate Biology Course *the Journal of Human Resource and Adult Learning* 7(2), 110-116.

Gambari, A. I., Yaki, A. A., Gana, E. S. & Ughovwa, Q. E. (2014) Improving Secondary School Students' Achievement and Retention in Biology through Video-Based multimedia Instruction. *InSight: A Journal of Scholarly Teaching, 9, 78-91.* http://repository.futminna.edu. ng:8080/ jspui/handle/123456789/5910 dated 20th April, 2019.

Imhanlahimi, E. O. and Aguele, L.I. (2006). Comparing three instruments for assessing biology teachers' effectiveness in the instructional process in Edo State, Nigeria. *Journal of Social Sciences13 (1), 67-78.*

Ityokyaa, F. M., (2010). Repositioning Science Education in Nigeria for National Development. *Journal of Education innovators 3(2), 40-46.*

Margeret R. (2015) ODL (Open and Distance Learning) definition Retrieved from http://searchsqlserver.techtarget.com/definition/odl dated on 12th May, 2021.

Maphosa, C. & Bhebhe, S. (2019) Digital Literacy: A Must for Open Distance and E-Learning (Odel) Students *European Journal of Education Studies, 5(10),186-199.*

Maulidah, S. S. & Prima E., C. (2018) Using Physics Education Technology as Virtual Laboratory in Learning Waves and Sounds. *Journal of Science Learning Indonesian Society for Science Educator 1(3),116-121.*

Odubunmi, E. (2006). Science and technology education in Nigeria*: the euphoria, the frustration and the hopes. 21st Inaugural Lecture, Lagos State University. Lagos: Faculty of Education. 3 (1) Retrieved* from http://afrrevjo.net/journals/multidiscipline/Vol_3_num_%201_%20art_26.pdf dated 15 February 2020.

Ofole, N.M. (2018). Curbing attrition rate in Open and Distance Education in Nigeria: e- *counselling* as a panacea. Unpublished Ph.D. Thesis, University of Ibadan, Nigeria.

Owino, O. A., Osman A. & Yungungu A. (2014) 'An investment of factors that influence performance in KSCE biology in selected secondary schools in Nyakach District, Kisumu Country Kenya' *Journal of Education and Human Development*. 3(2), 957-977

Reuben, B., (2014) *Assessment of Instructional Technologies and Academic Performance in Colleges of Education in Adamawa and Taraba State.* (Master's thesis). Educational Technology National Open University of Nigeria.

Tatli, Z. & Ayas, A., (2013). Effect of a Virtual Chemistry Laboratory on Students' Achievement. *Educational Technology and Society, 16 (1), 159–170.*

United Nations Educational Scientific and Cultural Organization (2015). Open-and-distance-Learning, Geneva.

Unlu, Z. K., & Dokme, I., (2011). The effect of Combining Analogy-Based Simulation and Laboratory activities Turkish Elementary School Students Understanding of simple Electric circuits. *The Turkish Online Journal of Educational technology. 10(2)101-115.*

Sparks, J.R., Katz, I.R., & Beile, P.M. (2016). Assessing digital information literacy in higher education: A review of existing frameworks and assessments with recommendations for next-generation assessment (Research Report No. RR-16-32). Princeton, NJ: Educational Testing Service.

Schlosser, C.A. (2006). Audio in online courses: Beyond podcasting. Paper presented at World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2006, Honolulu, 13-17.

Woodfield, B. (2005). Virtual chemlab getting started. Pearson Education website. 25, 2005.