

EFFECT OF OFFLINE VIRTUAL LABORATORY ON THE ACADEMIC ACHIEVEMENT OF SENIOR SECONDARY SCHOOL BIOLOGY STUDENTS IN VANDEIKYA METROPOLIS, NIGERIA

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ABSTRACT

This study investigated the effect of offline Virtual laboratory on the academic achievement of senior secondary school Biology students in Vandeikya Metropolis, Nigeria. The study has two research objectives, answered two research questions and tested two research null hypotheses at 0.05 level of Significance. A quasi experimental design was adopted. Biology Achievement Test (BAT) instrument was developed and administered to 100 sample from population of 1002 Senior Secondary School (II) Biology students in Vandeikya metropolis. A purposive sampling technique was used in the selection of the sample. Biology Achievement test (BAT) was validated by five experts. Reliability of the BAT was 0.95 using Kuder-Richardson formula (K-R20). Experimental group was taught using offline Virtual laboratory while the control group was taught using conventional or traditional laboratory. Research questions were answered using mean and standard deviation while null hypotheses were tested at 0.05 level of significance using ANCOVA. Results revealed significant difference in achievement of students taught using offline virtual laboratory and their counterpart taught using traditional or conventional laboratory. The study further revealed no statistical significant differences in the achievement of male and female students exposed to offline virtual laboratory. Based on the findings, the study concluded that offline virtual laboratory is effective and gender friendly and it was recommended for teaching and learning of sciences particularly Biology. Suggestion for further studies were made to include

replication of this study in other parts of the country, replication of this study using other topics as content scope and provision of well- equipped ICT facilities in our schools

INTRODUCTION

Science and technology education is the bed rock of human civilization and development. Many of the developed nations were able to achieve their status of development through the knowledge of science and technology. Science in general is defined as an organized body of knowledge about our natural environment (Achor, 2013). Science is a systematic enterprise that builds and organizes knowledge in form of explanation and predictions about the universe. Science education has been widely conceptualized.

Science Education is the field of study that exposes learners to contents as well as a methodology (processes) of acquiring scientific knowledge for practical application. Science learning is associated with laboratory activities. Laboratory activities provide opportunities for students to perform various kinds of hands-on experiments (Demircioglu & Yadigaroglu, 2011).

In view of the importance of science to the nation, science education curriculum is developed at various levels of education in Nigeria. National Educational Research and Development Council (NERDC) (2007) stated that Science Education curricula at the basic education level include Basic Science and Technology at lower and Middle Basic Education levels (primaries 1-6) and Basic Science at Upper Basic Education level (Junior Secondary School, JSS 1-3). At the Senior Secondary School level, Science Education includes; Biology, Chemistry and physics while at the tertiary Education level, the curricula of Science Education, Chemistry Education, and Integrated Science Education, Physics Education, Biology Education among others.

Biology occupies a unique position among science subjects offered at the Senior Secondary School level. Biology as a Science subject plays an important role in transforming the environment and improving the general quality of life. Biology is a natural science concerned with the study of all living things (both plants and animals). The field of Biology hold a paramount place in the modern world. With the sound knowledge of Biology in Secondary Schools, Students will find it easier to study professional courses like Nursing, Pharmacy, Medicine, Dietary, Geology, among others in higher institutions of learning. Hence, there is a need for effective and efficient learning and teaching of Biology in our Nigerian Secondary Schools. For effective and efficient learning of Biology and other science subjects, innovative

and interactive teaching strategies which are students centered must be adopted by science (Biology) teachers.

Teaching methods are ways through which the teachers organize and present contents and learning materials to learners (Orisa, 2011). Teaching method are being categorized into two approaches; namely: teachers centered approaches and students centered approach. Teachers centered approaches include lecture, expository, demonstration, discussion, among others. These teacher-centered approaches see the teacher as the only possessor of knowledge and they are grounded in Behaviorism. Students centered approaches on the other hand are grounded in constructivism and students are always active when such methods are used. These instructional methods(Students Centered) underscores teachers as decisive makers and problem solvers but rather as a guide in the learning process. Examples of student centered learning approaches include inquiry based learning, Discovery method, laboratory method (Virtual and physical laboratories), among others.

However, despite the importance of science to the society, it is quite disheartening to note that, there is a strong evidence of student's low academic achievement in Biology and other science subjects in Nigeria (Adeniran, 2013; Omenka & Eriba, 2013). In Nigeria for instance, a quite number of students on getting to senior secondary school drop out of science class .The trend has been described with such terms as a swing away from science “and” unimpressive enrolment in science (Eriba, 2013). There has been persistent poor performance among Biology students and Science in general leading to poor academic achievement in Sciences and Biology particularly. West African Examination Council (WAEC) and National Examination Council (NECO) results of 2011-2015 have shown the poor achievement of Senior Secondary Schools Biology Students in Sciences and Biology in particular.

The poor academic achievement in Science and Biology particularly during the corona virus pandemic era is stemmed from inappropriate and uninspiring traditional teaching approaches, adopted by science teachers (Eriba & Samuel, 2013). They stated that teachers that, teachers shy s away from activity oriented teaching approaches that are known to be teaching effective. They rely mostly on teaching approaches that are easy but most at times inadequate and inappropriate and thus that leads to poor academic achievement in Biology in our Senior Secondary Schools in Nigeria. Many studies have shown that, large or over crowded classes, lack of adequate textbook (indigenous textbooks), insufficient funds to purchase equipment's, lack of motivation among teachers, lack of proper monitoring and feedback mechanism have also contributed greatly to the poor academic achievement among senior Secondary Schools

Biology students in Nigeria and Benue state in particular (Adejoh, Amali, Omega & Adeniran, 2013).

Several research reports indicate that students (both Male and Female) achieve very low in Senior Secondary Schools science subjects especially Biology (Nwagbo, 2001; Azubuike, 2005). Educators today are required to be highly knowledgeable to improve the achievement and perhaps, retention among students in our Secondary Schools. Teachers have the responsibility of imparting knowledge and training the current generation with the needed knowledge and skills in science, particularly Biology fit to tackle the current challenges such as prevalence diseases. And that can only be achieved if improved teaching methods such as virtual laboratory are adopted.

Biology as subject is a very complex and covers a wide range of knowledge and that research literature on its education comes with many students misconceptions as well as their difficulties as they learn (Skamp, 2012). There is every need for science (Biology) teachers to make environment conducive to motivate students in Biology to study Biology there by, enhancing their academic achievement. Most teachers teaching Biology at the Senior Secondary School are inexperienced and perhaps not qualified. Most of them do teach Biology which is a science subject without taking students to the laboratory for practical so they can have better understanding based on what is taught in the class. As a result of this, students tends to achieve very low in Biology. The National Policy on Education (NPE) maintained that, the minimum qualification for teaching is the Nigeria Certificate in Education (NCE) (FME, 2013).

Achievements of students in Biology in Senior Secondary Schools in Nigeria is poor and this has been a recurrent problem for many years (Obomanu & Akporehwe, 2011). This low academic achievement of both male and female Biology students is therefore attributed or stemmed from non-usage of electronic teaching strategies such as zoom, virtual laboratory (offline and online virtual laboratories) in carrying out of practical (Ma & Nickerson, 2006) These e-learning strategies are students-centered and grounded in constructivism. Virtual/e-learning technique which is one of the virtual/e-learning strategies is described as a computer based activity where students interact or simulate environment through computer interface. Computers are employed in modern teaching techniques to conduct experiments to assist teachers to overcome the challenges of student's poor achievement in Science; hence the name computer-assisted instruction (CAI). Moreover, computers can be used for the instructional purpose in different modes such as tutorial mode, drill, and practice, simulation modes, play methods, etc. Some literatures investigate the uses of computer in education and

the instructional relevance of (CAI). Now the trend of research has shifted to developing virtual realities on different science concepts and challenging topics to determining their effectiveness for instructional purposes (Kara & Yesilyurt, 2007).

Virtual Laboratory is an interactive environment for creating and conducting simulated experiments. According to Karacop and Doymus (2013), a virtual laboratory is a three-dimensional computer-generated environment with appropriate equipment that can be explored and interacted with by a user in manipulating objects and performing a series of experiments. Virtual laboratories provide students with an opportunity of repeating incorrect experiment or repeat to deepen the intended experiences. Virtual laboratory is defined as electronic works place for distance collaboration and experimentation in a simulated way in research (<https://www.Vlab.co.in>). It is an activity oriented approach of learning where learners are only guided as they carry out or perform simulated experiments or learning by them serve in a bid to find a solution to instructional problems. Virtual laboratory technique equips students' abilities and competences to meet the challenges of uncertain, changing world. Virtual laboratory helps the students to perform many experiments that are difficult in real laboratories because of the risks involved or due to some certain circumstances that do not warrant the performing of experiments in the real laboratories.

Virtual labs which are example of computer based simulations reduces the logistics load required both in the classroom and real lab when learning and perhaps, enhance the academic achievements among science students (Biology students inclusive). Virtual laboratories have found to be effective in promoting active learning and increasing students' academic achievement in science, (Lewis, 2014).

So the achievement of Senior Secondary School Biology Students may improve positively, if teacher adopt offline Virtual laboratory to teach students. Teachers' ineffectiveness in teaching and conducting practical on some complex topics in a conventional laboratory could lead to low achievement among the Senior Secondary Schools Biology students. Virtual laboratory helps to explore topics that are complex to be investigated in real or traditional laboratories in Secondary schools due to safety constraint (Chandra & Fisher, 2009). Virtual laboratory can be effectively used to give laboratory demonstration to large classes (Vlab, 2012).

Achievement in Biology and other science subjects is more often than not low due to inability of students to carry out practical in the traditional or conventional laboratory. Could this poor achievement in Biology among Senior Secondary Schools be as a result of unawareness of e-learning or virtual learning strategies like offline virtual laboratory? This research therefore

intends to examine the effect of offline Virtual laboratory on the academic achievement of Senior Secondary School Students in Biology in Vandeikya Metropolis, Nigeria.

Research Objectives

The following objectives were formulated to guide the research study.

- i. determined the mean academic achievement scores of Biology Students taught with offline virtual laboratory and those taught without offline virtual laboratory.
- ii. ascertained the mean academic achievement scores of male and female Biology Students taught with offline virtual laboratory

Research Questions

The following research questions were raised to guide this study;

1. What are the mean achievement scores of Biology Students taught with offline virtual laboratory and those taught without offline Virtual laboratory?
2. What is the difference in the mean achievement scores of male and female Biology students taught with offline virtual laboratory?

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance;

H₀₁: There is no significant difference between the mean achievement scores of Biology Students taught with offline virtual laboratory and those taught without offline Virtual laboratory.

H₀₂: There is no significant difference between the mean achievement scores of male and female Biology Students taught with offline virtual laboratory.

METHODOLOGY

The research design used for this study is quasi-experimental design of non-equivalent group. Specifically, non- randomized, pretest, post-test control group design was used for this study. The population of the study is 1005 Senior Secondary School (11) Biology students from the 48 Secondary Schools in Vandeikya metropolis that offer Biology. The sample size of this study consisted 100 (45 male and 55 female) Biology students that was drawn from two government Schools in Vandeikya Metropolis. The purposive sampling technique was used for the selection of those schools .The secondary Schools that constitute the sample were of comparable standard and purposively selected based on the following criteria. The schools must have computers facilities such as laboratories facilities, Co-educational because gender

is a moderating factor in the study and the school must have at least one professional Biology teacher with a NCE or B.Sc (Ed). The instrument used for data collection was Biology Achievement Test (BAT) comprising of 30 multiple choice items each and was structured based on Biology topics for SS11 the Biology Achievement Test (BAT) was given face and content validation by five experts. The researcher therefore determined the internal consistency of BAT using Kuder-Richardson's formula (K-R20). The reliability of the instrument (BAT) was found to be 0.95. The researcher used mean and standard deviation to answer all the research questions. The analysis of covariance (ANCOVA) was used to test the hypothesis at 0.05 level of significance.

RESULTS

This results for this study were presented in order of the research questions and hypotheses as follows

Research question one: What are the mean achievement Scores of students taught Biology with offline virtual laboratory and those taught without it?

Table 1: Mean Achievement Score and Standard deviation of Experimental and Control Groups in BAT.

Groups	N	Pre- test		Post- test		Mean Gain	
		S . D	M e a n			S . D	
Experimental	50	40.28	17.54	73.00	9.419	32.72	
Control	50	35.38	13.34	42.06	14.41	6.68	
Mean dif.		4.90		30.94		26.04	
T o t a l						1 0 0	

Table 1 shows that in the pre-test, the experimental group had mean achievement score of 40.28 with a standard deviation of 17.54, while the control group had a pre-test mean of 35.38 with a standard deviation of 13.34. The table also shows that in the post-test, the experimental group had a mean score 73.00 with standard deviation of 9.419 while the control group had a mean achievement score of 42.06 with standard deviation of 14.41. The mean difference between the mean achievement scores of experimental and control groups was 26.04 in favor of experimental group .This shows that the experimental group gained more in achievement as compared to control group.

Research Hypothesis One: There is no significant difference between the mean achievement scores of students taught Biology with offline virtual laboratory and those taught without it.

Table 2: Summary of analysis of experimental and control groups mean Achievement scores in BAT.

Sources	type III sum	d.f	Mean square	F	sig.
				o f s q u a r e	
Corrected Model	29798.260	2	14899.130	166.774	.000
Intercept	21440.889	1	21440.889	239.999	.000
Pretest	5856.887	1	5856.887	65.589	.000
Groups	19835.900	1	19835.900	222.034	.000
Error		8665.721		97	89.337
Total			369468.590		100
Corrected total		38463.981			99

a. R=775(Adjusted R squared =.770)

From table 2, the P. value for experimental and control groups is 0.00. Hence $0.00 < 0.05$, the null hypothesis is rejected. This implies that, there is a significant difference in the mean achievement score of students taught biology using virtual laboratory and those taught without it. **Research Question 2:** What are the mean achievement scores of male and female students taught Biology with offline virtual laboratory?

Table 3: Mean Achievement scores and standard deviation of Male and Female students in Experimental group in (BAT)

Groups	N	Pre- test Mean	Post- test S.D	Mean	Mean Gain S.D
Male	21	36.33	16.11	72.04	6.321
Female	29	43.13	18.25	73.71	11.20
Mean diff.		-6.80		-1.67	5.13
T o t a l					5 0

From table 5, the pre-test scores of male students was 36.33 with standard deviation of 16.11 while the female students had a pre-test scores of 43.13 with a standard deviation of 18.25. Also, the mean achievement score of male in the post-test is 72.04 with a standard deviation of 6.321, while the mean achievement score of female in the post-test is 73.71 with a standard deviation of 11.20. The result shows a mean difference of 5.13 in favor of the male students, implying that both male and female students improved upon their mean achievement scores after treatment but the male students achieved slightly higher than the female students.

Research hypotheses 2: There is no significant difference between the mean achievement scores of male and female students taught Biology with offline virtual laboratory

Table: 4 Summary of Analysis of Covariance of Experimental Group “Male and Female “students mean Achievement scores in BAT.

Sources	type III sum	d.f	Mean square	F o f s q u a r e	sig.
Corrected Model	846.196	2	423.098	5.679	.006
Intercept	31181.457	1	31181.457	418.508	.000
Pre-test	812.275	1	812.275	10.902	.002
Gender	0.41	1	0.41	.001	.981
Error	3501.793	47		74.506	
Total		270841	790		50
Corrected total		4347988			49

a. R squared=.195(Adjusted R squared=.160)

From table 6, the P. value for gender is 0.981. Hence, $0.98 > 0.05$, the null hypothesis is not rejected. This implies that there is no significant difference in the mean achievement scores of male and female students taught Biology with offline Virtual laboratory.

DISCUSSION OF FINDINGS

Analysis of data in table 1 show that, students in the experimental group who were taught Biology using offline virtual laboratory recorded higher achievement in post-test more than those in the control group who were taught without offline virtual laboratory. The findings of this study is in agreement with the result of the earlier study carried out by Gambari, Falode and Idris (2014) who found out significant higher achievement difference in favor of students in the experimental group who were taught science using virtual laboratory as against those in the control group who were taught without virtual laboratory. The findings of this study also support the previous study carried out by Peason and Kudzai (2015), who found out that, the Biology Virtual laboratory (offline and online) was more effective than physical biology laboratory.

In regard to gender, the study found out that the use of offline virtual laboratory in teaching science, particularly Biology improved both male and female academic achievement. This was confirmed by the analysis of data in table 4 which shows the higher achievement of both male and female students in their post-test scores after being taught using offline virtual laboratory. Also from the test of hypothesis, in table 6, which shows a P. value of $0.981 > 0.005$, implying that there is no statistically difference between the mean achievement scores of male and female students taught Biology with offline virtual laboratory. The finding of this study supports the earlier result of the study carried out by Thisgaard and Makransky

(2017) who found no statistically significant difference gender difference in the post-test achievement of male and Female student taught science using virtual learning simulations.

CONCLUSION

Conclusively, this study found that, the use of offline virtual laboratory significantly enhanced higher academic achievement among Biology students as compared to conventional or traditional teaching strategy .While using the strategy, there were no significant difference in the academic achievement and retention between male and female students indicating that, the strategy is appropriate, efficient, effective and gender friendly.

Recommendations

The following recommendations were made

1. The government, school administrators, should introduce use of innovative/electronic teaching approaches such as offline virtual laboratory in teaching and learning of science (Biology) in schools in order to improve and perhaps brings about higher achievement among students in Biology.
2. The ministry of education should provide well equipped ICT facilities in schools to support the application of offline and online laboratory in teaching and learning of Biology of both genders.

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