Frontiers of Knowledge Journal Series | International Journal of Education and Educational Research ISSN: 2635-3636 | Vol. 2 Issue 2(September, 2019)

Effects of Physical and Virtual Laboratories on the Achievement of Secondary School Geography Students in North Central Nigeria

USMAN, Hussaini [1] ALABI, T. O. (PhD)[2] FALODE, O. C. (PhD) [3] MUHAMMED, B. Y. (PhD)[4]

Department of Educational Technology, Federal University of Technology, Minna, (Nigeria)
babankhadija73@gmail.com
+2347037132138

Abstract

This study investigates the effects of Physical and Virtual Laboratories on the Achievement of secondary school Geography students in North Central Nigeria. The study adopts a quasi-experimental research design. The sample size of this research consist of 768 students from twelve secondary schools in North Central States of Nigeria were used as research sample. Four schools each from the three sampled states were purposively chosen and assigned to experimental groups; I, (Physical Laboratory), experimental group II (Virtual Laboratory) and Control Group (Lecture Method). One instrument used for collecting data in this study and its titled Geography Achievement Test (GAT). It is a 30 – item instrument covering topics in physical Geography, a Pearson product moment correlation formula was used to determine the reliability coefficient of GAT which yielded 0.76. The data were analyzed using descriptive statistics of mean and standard deviation and inferential statistics of Analysis of Covariance (ANCOVA). The hypotheses were tested at 0.05 level of significance. The results of the study revealed that physical laboratory enhances secondary school students' achievements in geography despite which Virtual laboratory could be used to complement physical laboratory. it was therefore recommended that students and teachers should be exposed to physical laboratory environments in order to promote and encourage social interaction, active learning, learning by doing and learning by experience among other benefits.

Keywords: *Achievement, Geography, Laboratory, Physical, Students, Virtual*

1. INTRODUCTION

The revolution in technology has brought new innovations into classroom teaching and learning (Falode, 2016). Technology usage in schools today has influenced the way educators plan, design instruction, and assess their students. Similarly, innovations in educational technology have changed systems of communication, learning resources, lesson ideas, and professional development and facilitate creativity and learning productivity (Garrett, 2015; Falode, Usman, Sobowale, Folarin & Saliu 2016; Mohammed, 2017). In addition, Mahya (2017) revealed that with the increasing usage of modern technologies, students are becoming better and faster at using new innovations.

The recent attention received by educational technology has therefore turned educators, practitioners, and researchers' focus towards the effects that technological tools may have on students' performance, both academically and behaviourally Garrett, (2015). Even though the use of technological tools such as educational games, online simulations, and virtual learning environments have increased in the field of education over the years, educational researchers need to better understand how these technological tools like virtual laboratories can affect learning (Mahya, 2017).

Furthermore, Sundara (2013) opined that the application of current technologies such as interactive multimedia tools, virtual learning environments, animations, simulations, audio and their applications to deliver courses in the science disciplines require a laboratory component to provide activity-based practices to the learner, ranging from Learning Management Systems (LMSs) to virtual avatars in digital games and virtual laboratories.

Significantly, virtual laboratories allow learners to visualize, interact, and experiment with certain visual effects, such features they may not see in their traditional face-to-face environment in a science classroom (Trindale, & Almeida, 2002, Kotsilieris & Dimopoulou, 2013).

Categorically, physical laboratory has been given a central and distinctive role in science and technology education (Hofstein, 2015). According to Ratamun and Osman (2018) physical laboratory is a setting using actual experimental equipment and materials as well as undergoing 'hands-on' activities where students hold and

experience experimental experiences like a scientist. This laboratory makes it easy for students to change concepts from real to abstract and help them to connect the concept with the real world. It implies that physical laboratory is a place of practical work activities where science students manipulates and observe objects and materials in science and technology.

Science and technology educators believe that physical laboratories are the most important means of instruction in science since the 19th century. For science to be taught properly and effectively, physical laboratories must be an integral part of the science curriculum (National Science Teachers Association, 2009).

The physical laboratory is a workplace for scientific research; it is where a student develops scientific thinking, conducts scientific investigations, and obtain knowledge of physical principles and experimental techniques through the usage of equipment. At different levels of education, starting with senior secondary school to the university level, Science laboratories are designed with certain goals, which includes to enhance the understanding of scientific concepts, interests and motivations, practical skills, and problem solving abilities (Russell & Weaver, 2008). The role of the laboratory is central in secondary school Geography courses; students construct and develop a personal understanding of Geographic ideas. This type of knowledge is developed by students in interactions by the use of experiments and practical skills. Meaningful learning will occur when laboratory activities become a well-integrated part of a learning sequence. In traditional laboratory experiments, students have direct physical involvement with laboratory materials in order to study the observable facts of the real world. Research and experience suggest that these laboratory activities promote optimal learning for students (Tracy, 2009 & Garrett, 2015).

In view of this, (Jaakola & Nurmi, (2008) stressed that much of the researches on physical and virtual science investigations has treated physical experimentation as competing methods in science classrooms, recent research also showed that virtual and physical laboratories each has unique but somewhat overlapping affordances for learning and several authors are beginning to suggest that a combination of physical and virtual laboratories should be considered in science classrooms (Olympiou & Zacharia, 2012)

Virtual laboratory is perceived by Falode (2014), Chaurura and Chuma (2015) as an interactive environment without real laboratory apparatuses meant for creating and conducting simulated experiments. Similarly, Virtual laboratory is viewed by Ratamun and Osman (2018) as a computer-assisted teaching through the integration of computer simulations with laboratory activities. Virtual laboratory can change the concept of abstract teaching into concrete, linking the concepts learned with everyday life and students can learn at their own pace and needs . It is a tool that students can use to run their own experiments using mouse to control physical actions such as pushing objects, turning objects, lifting objects, changing tools or materials, heating materials, measuring material and mixing two materials. Animation and simulation concepts are used to allow students to interact with materials and apparatus to see the results of the reaction in an experiment. In view of these, Virtual laboratory enhances the interaction of teachers and students during an experiment and could also save the cost of doing experiments when compared to physical laboratory (Ibrahim, 2011). Hence, it provides students with tools and materials on computer in order to perform experiments saved on CDs or on web site (Babateen, 2011; Nurmi, 2008). An example of a virtual laboratory is a collection of digital simulations supported by discussion forums, video demonstrations, hyperlinked glossaries, and e-mail lists organized in a World Wide Web format or on a CD in a shell produced by an authoring language.

Falode (2014) categorized virtual laboratory into five enclaves based on different sorts of simulations. They are: classical simulations which have certain elements of laboratory experiments and are available locally (Simulations);classical simulations which have certain elements of laboratory experiments and are accessible on the web and are available as JAVA-Applets (Cyber Labs); simulations which attempt to represent laboratory experiments as closely as possible (Virtual Labs); simulations of lab experiments using virtual reality techniques (VR Labs); and real experiments which are controlled via internet (Remote Labs).

The roles of virtual laboratory in teaching and learning process cannot be over-emphasised, therefore, it was proposed by Ay and Yilmaz, (2015) that virtual experiments can be used in different contexts and steps to increase accessibility of laboratory activities and to assist students who previously had no access to physical

laboratory. Such limit may emanate from a student's reduced dexterity, physical disability, or geographic distance (Chaurura & Chuma 2015). Virtual laboratory makes students become active in their learning, provide opportunities for students to construct and understand difficult concepts more easily (Gambari, Falode, Fagbemi & Idris 2012).

The use of both physical and virtual environments are useful in Geography contexts, where the virtual representations can be used to shape how students interpret the physical world. This approach has assisted in the development of a special type of interactive animation and computer simulations especially in the field of Geography in secondary schools.

Geography is viewed by Iwena, (2015) as the study of people, their activities, place and physical things within the earth as Geography has captured the imagination of people as buttressed by (Rosenberg, 2014). Analysts in the field of Geography still concentrate on people, culture and the planet earth. The elements of the earth are the area physical geographers and their work incorporates research about atmospheres, arrangement of area structures, plant and animal dispersion.

On this note, Rosenberg (2014) further asserted that being able to geographically investigate allows students to comprehend the world in which they live. Geography has continued to play significant role in the national development. It is taught in schools to offer learners a sound knowledge of their immediate environment and develop in them the ability to comprehend and give details of natural occurrence.

Achievement is the outcome of students' results in subjects taken at a particular situation. In view of these, a lot of studies have been carried out with respect to the use of laboratory approach, the approach is regarded as an indispensable element of education, students subjected to laboratory instruction exhibit higher achievement scores, deeper attention, and more frequent participation in science courses (Koseoglu, 2015).

Consequently, Mallory (2012) assesses the effect of virtual laboratories on student learning and motivation in science laboratory instruction. The results indicated that the interaction effect of time point and lab order group on motivation and quiz scores was not significant. Equally, Mahya (2017), explores the achievement of a Virtual

Science Laboratory (VSL) on middle school students' cognitive knowledge, skill development, and attitudes toward science. The findings of the study revealed that students' cognitive knowledge and attitudes toward science were positively changed as expected, however, the results from paired sample *t*-tests found no statistical significance. However, the result of the research conducted Reese (2013) revealed statistical significant differences in student achievement defined by averages on quiz scores in virtual labs compared with traditional face-to-face laboratories and traditional laboratories. The result is also in conformity with the similar study by Garrett (2015) that investigates the ways in which the unique perceptual-motor features of science laboratory environments can affect students' learning. The study employed several different measures to answer the research questions, including concept tests and interviews. The findings indicated that the perceptual-motor features of science laboratory environments did indeed shape learners' understanding of the underlying science concepts, Similarly, the findings of Sundra (2014) indicated that Virtual Laboratory had higher learning outcome than the traditional laboratory, however there was no significant difference in either of the laboratory instructions. Similarly, the findings of Sundra (2014) indicated that Virtual Laboratory had higher learning outcome than the traditional laboratory, however there was no significant difference in either of the laboratory instructions. Also, the result of Ratamun and Osman (2018) showed that the interaction effect between group and gender in Virtual Laboratory and Physical Laboratory towards chemistry is not significant. This means the group's influence on the mean score of attitude towards chemistry lessons ATCLS is not caused by the gender and the gender influence on the mean score of ATCLS is not caused by groups.

Gender has been recognized as one of the attributes that affects student's achievement in science subjects at senior secondary school (Gambari, 2010). The issue of students' achievement as a cause of discrepancy in learning outcome has drawn the attention of educational researchers. It is a common attribute in most educational settings to find students of mixed academic aptitude given the same treatment. Gender issues also have been linked with performance of students in academic task in several studies some of which are those conducted by Ismail (2015) but without any definite conclusion. This trend of gender imbalances in academic achievement necessitates the

need for more work. Gender as one of the variable investigated in this study could help clarify the assumptions and other associated issues in gender study which includes differences in acquisition of scientific knowledge through computer based learning, disparity in academic achievement, retention and other laboratory activities in Geography related to the use of computers as investigated by previous studies of Aremu, (2008). Contrarily to the above, recent research studies by Akiengin (2011); Yusuf and Afolabi, (2010); Aniodoh and Ngozi (2012) found no significant difference between male and female students in science subjects. Aguele and Agwugah (2007), in their studies found that male students performed better than female students in the cognitive, effective and psychomotor skill achievements.

Despite the importance attached to Geography as stated in the National Policy on Education (FRN, 2009), students' achievement is unsatisfactory. Following this assertion, the researcher projected that among other factors responsible for the trend of students' unsatisfactory performance in Geography to be the teaching methodology as substantiated by Odili (2006); Idoko (2009); WAEC Chief examiner's report (2010). Similarly, Sofowora and Agbedokun (2010) observed that the study of Geography from its inception was through verbal description of geographical features, which made the study very abstract and quite uninteresting.

This has become a source of concern to all stakeholders in Nigerian education system, as most teachers in Nigeria that teach Geography, particularly Physical aspect of Geography across secondary school stages, (SS I to SS III) have decried the effectiveness of methods used in the teaching and learning of the subject. Those who teach subjects like urban and regional planning and environmental studies that require the application of Geography also complained of the challenges they face. One of such challenges as stated in the NECO Chief Examiner's Report of 2009 was the method and little knowledge of the content of the Geography syllabus and general phobia for questions that require diagrams, sketches and charts in the physical aspect of Geography.

In spite of the widespread application of various effective interactive strategies like the use of laboratories, simulation and animation packages at various times to improve classroom instruction in Nigeria, the trend persisted. Following these,

Literature appeared to prove that there has been insufficient research that specifically examines effect of Physical and Virtual Laboratories on learning outcomes in Geography among senior secondary school students in North Central Nigeria. Consequently, to the researcher's knowledge, from the reviewed work, none of the studies seek to address the issue of contour representation of land forms, gradient and cross section in physical Geography. Therefore, as a step towards addressing these problems, a more interactive strategy that will actively involve the students in Geography lesson becomes imperative. Hence, the strategy that might salvage the problem may be the use of physical and virtual laboratories. Therefore, the study investigates the effectiveness of Physical and Virtual Laboratories on learning outcomes in Geography among senior secondary school students in North Central Nigeria.

1.1 Aim and Objectives of the Study

The aim of this study is to determine the effects of Physical and Virtual Laboratories on learning outcomes in Geography among senior secondary school students in North-Central, Nigeria. Specifically, the study intends to achieve the following objectives;

i. Determine the effects of physical laboratory (PL), virtual laboratory (VL) and conventional lecture method (CLM) on the achievement of secondary school students in geography.
ii. Examine the influence of gender on the academic achievement of students in geography when taught using physical laboratory.
iii. Investigate the influence of gender on the academic achievement of students in geography when taught using virtual laboratory.

1.2 Research Questions

The following research questions were raised for the study.

i. Is there any difference in the mean achievement scores of Geography student taught using physical laboratory, virtual laboratory and those taught with lecture method?
ii. Is there any difference in the mean achievement scores of male and female Geography students taught Geography using physical laboratory?

iii. Is there any difference in the mean achievement scores of male and female Geography students taught Geography using virtual laboratory?

1.3 Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 alpha level of significance.

HO_1: There is no significant difference in the mean achievement scores of Geography Students taught using physical laboratory, virtual laboratory and those taught with conventional lecture method.

HO_2: There is no significant difference in the mean achievement scores of male and female

students taught Geography using physical laboratory.

HO_3: There is no significant difference in the mean achievement scores of male and female

students taught Geography using virtual laboratory.

2. METHODOLOGY

The study adopted a quasi-experimental research design, a non-randomized, non-equivalent pre-test, post-test experimental design. The design entails the use of non-randomized sample where the researcher cannot randomly sample and assign subjects hence intact classes was used. The population for this study was made up of the entire Senior Secondary school students of 2018/2019 session in North-Central geo-political zone of Nigeria.

The sample size were 768 Senior Secondary School Geography students in SS II. This sample comprises of (Exp I; 242= Males= 142, Females= 95); (Exp II; 269= Males= 159, Females= 110); (Control group; 257= Male= 185, Female= 72) students from 12 co-educational public senior secondary schools in North-Central Geopolitical Zone of Nigeria. The study was conducted in 12 co-educational public senior secondary schools in the North-Central geo-political zone of Nigeria; the zone is made up of Niger, Kwara, Kogi, Benue, Plateau, Nasarawa states and the Federal Capital Territory (FCT). The seven states of the North Central were further clustered, out of the seven clustered states in the zone, three states were randomly selected. Thereafter, four schools were purposively chosen from each of the three states. The reason for

purposive sampling of the schools is to select schools with a common environmental condition such as manpower, gender composition, exposure to the use of computer, and school type (public schools). Specifically, four schools each from the three states was assigned to experimental group I, experimental group II and control group.

The concepts that was taught are Contour representation of land forms, Gradient and Cross section, the content was selected because they are difficult and fell in SSII geography syllabus. There were three independent variables (Physical Laboratory PL: experimental group I, Virtual Laboratory VL: experimental group II and Lecture Method LM: control group and one dependent variables, which are the learning outcomes, (achievement). The experimental Group I, II and control group undergo learning using physical laboratory, virtual laboratory and lecture method respectively. The students were pretested before exposing them to the different learning strategies, the main objective of administering the pretest is to determine the academic equivalent of students in the three groups before administration of instruments.

The research instrument that was used for this study is (Geography Achievement Test (GAT). The instruments were validated by experts. Virtual laboratory package on Nigerian secondary school geography concepts was developed using Adobe Flash Professional as the development environment and Actionscript 3.0 for the logic. Adobe flash professional is a multimedia authoring and computer animation program developed by Adobe Systems, this program helps in developing interactive animations, games, gif images, presentations and other media. ActionScript 3.0 is a powerful, object-oriented programming language that signifies an important step in the evolution of the capabilities of the Flash Player runtime. ActionScript is used primarily for the development of websites and software targeting the Adobe flash player platform, used on web pages in the form of embedded SWF files. The virtual laboratory is a combination of different key frames arranged in a timeline, each key frame contains different entities e.g. texts, images, audio files, buttons. The timeline is arranged in such a way that it plays different scenes from the combination of key frames depending on user interaction (click of a button or graphic).

Geography achievement test which comprises of 30 multiple choice items was developed by the researcher. The test was designed to measure the six levels of

cognitive domain of the students. The students were required to indicate the correct answers by ticking or circling the right answers corresponding to the questions. Only one option was the correct answer from the options A-E.

In order to determine the reliability of the instruments, pilot test was conducted within the targeted population but outside the school sampled for the study. The result obtained from pilot test administered to SS II Geography students was used for reliability test of the instruments. Pearson Product Moment Correlation formula was used to determine the reliability coefficient of GAT which yielded 0.76 indicating that the instrument is reliable for the study. The data collected were analysed using descriptive and inferential statistics with the use of statistical package for social sciences (SPSS) version 23.0. the significance of the statistical analyses was ascertained at 0.05 alpha level of significance. The three objectives were achieved by administering Geography Achievement Test (GAT) on participating sample at pretest and posttest. The pretest was analysed with ANOVA statistics while, posttest was analysed with ANCOVA. Where significant difference is observed on the effects of the three modes of instructions, multivariate analysis was conducted (Scheffes' Post hoc).

3. RESULTS

3.1 Research Question One:

Is there any difference in the mean achievement scores of students taught Geography using physical laboratory, virtual laboratory and lecture method?

In answering research question one the pretest and posttest mean achievement scores of experimental group I, II and control group were analyzed using mean and standard deviation as shown in table 1.

Table 1: Mean and Standard Deviation of Pretest and Posttest Scores of Experimental Group I, II and the Control Group

Group	N	Pre-test		Post-test		Mean Gain
		$\bar{X}$	SD	$\bar{X}$	SD	
Experimental 1	242	44.69	10.63	80.62	9.68	35.93
Experimental 2	269	43.02	11.47	78.02	11.47	35.00
Control	257	40.25	11.31	73.12	11.56	32.87

Table 1 shows the mean and standard deviation of achievement scores of experimental group one, two and control groups at pretest and posttest. From the table, it can be deduced that the mean and standard deviation scores at pre-test and posttest for Experimental Group I (physical laboratory) is X= 44.69, SD= 10.63 and X= 80.62, SD= 9.68 respectively. This gives the mean gain of 35.93 in favour of posttest. Similarly, the mean and standard deviation scores at pre-test and posttest for Experimental Group II (virtual laboratory) are X= 43.02, SD= 11.47 and X= 78.02, SD= 11.47 respectively. This gives the mean gain of 35.00 in favour of posttest. On the other hand, the mean and standard deviation scores at pre-test and posttest for the Control Group (lecture methods) are X= 40.25, SD= 11.31 and X= 73.12, SD= 11.56 respectively. This gives the mean gain of 32.87 in favour of posttest. The table also revealed that Experimental Group I, II and control group had a mean gain of 35.93, 35.00 and 32.87 respectively and with experimental group I having the highest mean gain of 35.93.

From the above scenario, it could be concluded that the Physical Laboratory is effective in increasing the mean overall achievement of the geography students who took part in the study. To determine if the difference is significant, ANCOVA was used as presented in Table 2

Hypothesis One ($HO_{1)}$: There is no significant difference in the mean achievement scores of Geography Students taught using physical laboratory, virtual laboratory and those taught with conventional lecture method

Table 2: Summary of Analysis of Covariance (ANCOVA) of Posttest Scores of Experimental Group I, II and the Control Group

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	284200.989	3	94733.663	1474.405	.000
Intercept	77412.697	1	77412.697	1204.827	.000
Covariate (Pretest)	37940.144	1	37940.144	590.488	.000
Treatment	212564.310	2	106282.155	1654.142*	.000
Error	49088.631	764	64.252		
Total	3737296.000	768			
Corrected Total	333289.620	767			

*: Significant at 0.05 level

Table 2 shows the ANCOVA result of the comparison of posttest scores of students in Experimental Group I, II and the Control Group. An examination of the Table shows $F(2, 764) = 1654.14$, $p < 0.05$. On the basis of this, hypothesis one was rejected. Therefore, there was significant difference in the achievement of students taught Geography using physical laboratory, virtual laboratory and those taught with conventional lecture method. Sidik post-hoc analysis was carried out to locate where significant difference exists as presented in Table 3

Table 3: Sidak Post-hoc Analysis of the Post-test Mean Scores of Pupils in Experimental Group I, II and the Control Group

Treatment	Experimental I	Experimental II	Control
Experimental I	-		36.457*
Experimental II	1.553		34.905*
Control	-36.457*	34.905*	-

Table 3 showed the Sidak post-hoc analysis of posttest mean scores of pupils in Experimental Group I, Experimental Group II and the Control Group. The table indicates that no significant difference exists between the mean scores of Geography Students taught using physical laboratory and virtual laboratory (mean difference = 0.1.553). The table however reveals that significant difference exist between the mean scores of Geography Students taught using physical laboratory and those taught with conventional lecture method (mean difference = 36.457) and also between the mean scores of Geography students taught using virtual laboratory and those taught with conventional lecture method (mean difference = 34.905).

3.2 Research Question Two:

Is there any difference in the mean achievement scores of male and female Geography students taught Geography using physical laboratory?

Table 4: Pre-test and post-test scores of male and female students taught Geography through Physical Laboratory

Gender	**N**	**Pretest**		**Posttest**		
		X	**SD**	**X**	**SD**	**Mean Gain**
Male	147	45.02	10.375	80.565	9.4071	35.545
Female	95	44.15	11.041	80.705	10.1467	36.555
Total	242	44.68	10.627	80.620	9.6836	35.95

Table 4.3(a) shows the mean and standard deviation of male and female students taught Geography through physical laboratory at pretest and posttest. From the table, it can be deduced that the mean and standard deviation scores at pre-test and posttest for the male students) are X= 45.02, SD= 10.375 and X= 80.565, SD= 9.4071

respectively. This gives the mean gain of 35.545 in favour of posttest. Similarly, the mean and standard deviation scores at pre-test and posttest for the female students are X= 44.15, SD= 11.041 and X= 80.705, SD= 10.146 respectively. This gives the mean gain of 36.555 in favour of posttest. The table also revealed that male and female students had the mean gain of 35.545 and 36.555 respectively with female students having the highest mean gain of 36.555. As a result of this identified difference in mean achievement scores, hypothesis 2 was tested at 0.05 level to determine if the observed difference was significant. From the above scenario, it could be concluded that the to determine if the difference is significant, ANCOVA was used as presented in Table 4

Hypothesis Two (HO_2): There is no significant difference in the mean achievement scores of male and female students taught Geography using physical laboratory.

Table 5: Summary of Analysis of Covariance (ANCOVA) of Posttest Scores of Male and Female Students taught Geography using Physical (Experimental I)

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	19854.539[a]	2	9927.270	864.504	.000
Intercept	23343.117	1	23343.117	2032.805	.000
Covariate (Pretest)	19853.398	1	19853.398	1728.908	.000
Gender	45.314	1	45.314	3.946 *	.048
Error	2744.486	239	11.483		
Total	1595492.000	242			
Corrected Total	22599.025	241			

*: Significant at 0.05 level

Table 5 showed the ANCOVA result of the comparison of posttest scores of male and female students taught Geography using using physical laboratories. An examination of the table shows a significant main effect between the mean scores of the two groups $F(1, 241) = 3.946$, $p < 0.05$). On the basis of this, hypothesis two was rejected. Therefore, the result revealed that there was significant difference between male and female students taught Geography using physical laboratory.

3.3 Research Question Three:

Is there any difference in the mean achievement scores of male and female Geography students taught Geography using virtual laboratory?

Table 6: Pre-test and post-test scores of male and female students taught Geography through virtual laboratory

Group	N	Pretest		Posttest		
		X	SD	X	SD	Mean
Male	159	44.30	10.884	79.27	10.915	34.97
Female	110	41.18	12.073	76.09	11.967	34.91
Total	269	43.02	11.446	77.97	11.443	34.89

Table 6 shows the mean and standard deviation of male and female students taught Geography through virtual laboratory at pretest and posttest. From the table, it can be deduced that the mean and standard deviation scores at pre-test and posttest for the male students are X= 44.30, SD= 10.884 and X= 79.27, SD= 10.915 respectively. This gives the mean gain of 34.97 in favour of posttest. Similarly, the mean and standard deviation scores at pre-test and posttest for the female students are X= 41.18, SD= 12.073 and X= 76.09, SD= 11.967 respectively. This gives the mean gain of 34.91in favour of posttest. The table also revealed that male and female students had the mean gain of 34.97 and 34.91 respectively with male students having the highest mean gain of 34.97. As a result of this identified difference in mean achievement scores, hypothesis 3 was tested at 0.05 level to determine if the observed difference was significant. From the above scenario, it could be concluded that the to determine if the difference is significant, Ancova was used as presented in Table 7

Hypothesis Three (HO_3): There is no significant difference in the mean achievement scores of male and female students taught Geography using virtual laboratories.

Table 7: Summary of Analysis of Covariance of Posttest Scores of Male and Female Students taught Geography through Virtual Laboratory (Experimental II)

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	34944.961[a]	2	17472.481	31659.747	.000
Intercept	21881.870	1	21881.870	39649.462	.000
Covariate Pretest	34287.661	1	34287.661	62128.480	.000
Gender	1.986	1	1.986	3.599[ns]	.059
Error	146.801	266	.552		
Total	1670440.000	269			
Corrected Total	35091.762	268			

* [ns]: Significant at 0.05 level

Table 7 showed the ANCOVA result of the comparison of posttest scores of male and female students taught Geography using virtual laboratory. An examination of the table shows that there is no significant main effect between the mean scores of the two groups ($F(1, 266) = 3.599$, $p > 0.05$). On the basis of this, hypothesis three was retained. Therefore, the result revealed that there was no significant difference between male and female students taught Geography using virtual laboratory.

4. DISCUSSION OF FINDINGS

The result of this study is in line with the findings reported by Reese (2013) which show statistical significant differences in student achievement defined by averages on quiz scores in virtual labs compared with traditional face-to-face laboratories and traditional laboratories. This result is also in conformity with the similar study by Garrett (2015) the study investigates the ways in which the unique perceptual-motor features of science laboratory environments can affect students' learning. The result was statistically significant, this indicated that the perceptual-motor features of science laboratory environments did indeed shape learners' understanding of the underlying science concepts. The significant differences observed could be attributed to the uniqueness and practical nature of physical laboratories. The enhancing effect of physical laboratory on the students' achievement in geography could also be as a result of extra help provided by the teacher to those who need it. However, the result of this study in contrast with the study of Sundra (2014). The results of the experiment indicated there was no significant difference in learning outcomes with either type of lab instruction.

Similarly, the result of Ratamun and Osman (2018) contradict the finding of this study, the analysis showed that the interaction effect between group and gender in Virtual Laboratory and Physical Laboratory towards chemistry is not significant. Opposing the result of this study is the work of Mahya (2017), the result from paired sample *t*-tests found no statistical significance.

Gender issues have been connected with students' achievement, the fundamental emphasis of great concern in the field of science education is the predispositions and misconceptions about females and science, i.e. Science is a male enterprise (Erinosho,

2005). The result of the analysis on influence of gender on the performance of students exposed to Physical Laboratory indicated that both male and female students that were taught Geography using physical laboratory perform significantly different. This finding however, disagree with the findings of Yusuf and Afolabi, (2010); Aniodoh and Ngozi (2012) which show no significant difference between male and female students in science subjects. However, the result is in agreement with the findings of Aguele and Agwugah (2007), whose results revealed that male students performed better than female students in the cognitive, effective and psychomotor skill achievements.

5. RECOMMENDATIONS

Based on the major findings of this study, the following recommendations are proffered as follows:

i. It is recommended that geography students should be exposed to physical laboratory to promote and encourage social interaction, active learning, motivation, learning by doing and learning by experience.
ii. Virtual laboratory should be used to complement physical laboratory as a mutually beneficial interface between both (laboratories) could impact positively on the learners.
iii. The use of the package will enhance the achievement of students in geography irrespective of their gender.
iv. As physical laboratory is unique teaching strategy in Nigeria, geography teachers should be provided with training. To achieve this, the Federal and State ministry of education and other educational agencies such as NTI, NERDC, NGOs, UNICET, UNESCO and other education stakeholders should organize workshops on the use of laboratory to enhance better performance of pupils.
v. Curriculum developers should embrace and include physical laboratories in order to bring about improvement in learning, acquisition of critical thinking, social interaction, problem solving and performance skills in students.

6. REFERENCES

Aguele, L. I. & Agwugah, N. V. (2007). Female Participation in Science, Technology and Mathematics (STM) Education in Nigeria and National Development. *Journal of Social Science,* 15 (2), 121-126.

Akengin, G. (2011). Computerizing traditional and computer assisted education in the teaching of colour to 6th grade students and determination of its retention. *Educational research and reviews,* 6(5), 432-435.

Aniodoh, C. O. & Ngozi, O. E (2012). Effects of concept mapping on students' achievement in some selected difficult concepts in chemistry. *African Journal of Allied Education,* 6(1), 36-43.

Aremu, A. (2008). *A cry for help endangered species in the science and technology classroom.* Paper presentation at the joint staff – student Seminar, Department of Teacher Education. Ibadan, Nigeria: University of Ibadan.

Ay, Ö. S., & Yilmaz, S. (2015). Effects of Virtual Experiments Oriented Science Instruction on Students' Achievement and Attitude. *Elementary Education Online, 14,* 609-620

Babateen, H. M. (2011). *The role of virtual laboratories in science education.* Singapore: *IACSIT press.*

Chaurura, P. Chuma, K. (2015) Virtual Laboratories- a Solution for Tertiary Science Education In Botswana*European Journal of Logistics Purchasing and Supply Chain Management* Vol.3, No.1, pp.29- Published by European Centre for Research Training and Development UK.

Erinosho, Y. E. (2005). Women and Science.*36th Inaugural Lecture*, Olabisi Onabanjo University, Ago-Iwoye, 1-37.

Falode, O. C. (2014). A BATES' ACTIONS' *evaluation of virtual physics laboratory package for senior secondary school students in Nigeria.* Unpublished PhD Thesis. Department of Educational Technology, University of Ilorin, Nigeria.

Falode, O. C. Usman, H. Sobowale, F. M. Folarin, M. E & Saliu R. M. (2015) Effect Of Computer Simulation Instructional Package On Secondary School Geography Students' Achievement In Map Reading In Bida, Niger State, Nigeria. *3rd annual international conference of school of science and technology education, federal university of technology minna*Pp.73-80.

Federal Republic of Nigeria, (2009). *National Policy on Education*. Lagos: Federal Government Press.

Gambari, A. I. (2010). *Effectiveness of computer-assisted instructional package in cooperative settings on senior school students' performance in physics, in Minna, Nigeria.* Unpublished Ph.D thesis, Department of Science Education, University of Ilorin.

Gambari, A. I., Falode, O. C., Fagbemi, P. O. & Idris, B. (2012). *Effect of virtual laboratory strategy on the achievement of secondary school students in Nigeria.*Proceedings of the 33rd Annual Convention and National Conference of Nigeria Association for Educational Media and Technology (NAEMT) held at Emmanuel Alayande College of Education, Oyo, Oyo State. October 8-13.

Garret, W. S. (2015). combining physical and virtuallaboratories: effects of perceptional features of science laboratory enviroment on learningconceptions. *Thd Thesis*, 1.

Hofstein, A. (2015). Forms of laboratory work. *Encyclopedia of Science Education, New York: Springer*, 563-564.

Ibrahim, D. (2011). Engineering Simulation with MATLAB: Improving Teaching and Learning Effectiveness. *Procedia Computer Science, 3*, 853-858. https://doi.org/10.1016/j.procs.2010.12.14

Ibrahim, I. (2014). Effect of computer assisted instruction with animation and concept mapping on achievement and retention of secondary school Biology students. *Phd thesis unpublished* Science Education Department Federal University of Technology Minna, Nigeria

Idoko, J. E. (2009). *Correlation of student O'level Entry Grade in Mathematics and performance in National Diploma in Engineering, Kaduna Polytechnic Nigeria.* An Unpublished M.Tech thesis federal University of technology Minna.

Ismail, I. (2015). *Effects of computer assisted instruction with animation and concept mapping on o achievement and retention of secondary school Biology students in Minna, Niger State.* Unpublished Ph. D Federal University of Technology, Minna.

Iwena, O. A. (2015). *Essential Geography for Senior Secondary Schools.* Ikeja, Lagos: Tonads Publishers Limited.

Jaakkola, T., & Nurmi, S. (2008). Fostering elementary school students' understanding of simple electricity by combining simulation and laboratory activities. *Journal of Computer Assisted Learning, 24*(4), 271-283.

Koseoglu, Y. (2015). Self-efficacy and academic achievement: A case from Turkey. *Journal of Education and practice,* 6(29),131-141. Retrieved from http://files.erc .ed.gov/fulltext/EJ1081281.pdf

Kotsilieris, T., Dimopoulou, N. (2013). The evolution of e-learning in the context of 3D virtual worlds. Electronic Journal of E-Learning, 11(2), 147-167. Retrieved from ERIC database. (EJ1012880)

Lindgren, R., & Johnson-Glenberg, M. (2013). Emboldened by Embodiment Six Precepts for Research on Embodied Learning and Mixed Reality. *Educational Researcher, 42*(8), 445-452.

Mahya. B. (2017) Cognitive Knowledge, Attitude Toward Science, And Skill Development In Virtual Science Laboratories

Mallory C. R. (2012) *Evaluating Learning Outcomes in Introductory Chemistry Using Virtual Laboratories to Support Inquiry Based Instruction*. Ph. D Thesis Capella University

Marincola, E. (2006). Why is public science education important? *Journal of Translational Medicine, 4, 7*. http://doi.org/10.1186/1479-5876-4-7

Mohammed, H. A. (2017). Effects of Computer Simulation Instructional Package on primary school pupils' motor skills development and interest towards physical education in Niger state, Nigeria.Unpublished Phd Thesis. Department of Educational Technology, Federal University of Technology Minna, Nigeria.

National Science Teachers Association. (2009). Position statement about Quality Science Education and 21st- Century Skills. Accessed in August, 2012 http://www.nsta.org/about/positions/21stcentury.aspx

Nurmi, S. (2008). Fostering elementary school students' understanding of simple electricity by combining simulation and laboratory activities. *Journal of Computer Assisted Learning*, 24(4), 271-283

Odili, G. A. (2006). *Mathematics in Nigeria secondary school – A Teaching perspectives*. Lagos Rex Charles and Patric Limited.

Olympiou, G., & Zacharia, Z. C. (2012). Blending physical and virtual manipulatives: An effort to improve students' conceptual understanding through science laboratory experimentation. *Science Education, 96*(1), 21-47.

Ratamun M. M. Osman. K. (2018) The Effectiveness comparison of virtual laboratory and physical laboratory in nurturing students' attitude towards chemistry. *Creative Education, 9*,1411-1425. https://doi.org/10.4236/ce.2018.9910

Reese M. C. (2013) *Comparison of student achievement among two science laboratory types: Traditional and virtual.* Ph. D Thesis in Agriculture Science Education and Extension in the College of Agriculture and Life Sciences Mississippi State, Mississippi

Russel, A. & Weaver, R. (2008). Student Perception of the Purpose and Function of the Laboratory in Science: A Grounded Theory Study. *internation journal of scholarship of teaching and learning, 2*, 2.

Rosenberg, M. (2014). A Basic Overview of the Discipline of Geography *journal of National Science Teachers Association. 2 (4), 28-36.*

Sofowora, O. A. & Egbedokun, A. (2010).An Empirical Survey of Technology Application in Teaching Geography in Nigerian Secondary Schools. *Ethiopian Journal of Environmental Studies and Management* 3 (1), 67-68.

Sundara L. G. (2013) Assessing Students' learning outcomes, Self-Efficacy And Attitudes Toward The Integration Of Virtual Science Laboratory In General Physics. Ph. D Dissertation Submitted to the College of Sciences of Southern University and A&M College. Doctor of Philosophy in Science and Mathematics Education. Baton Rouge, Louisiana

Tracy, D. (2009) "Are Biological Virtual Lab Investigations as Effective as Traditional Hands on Laboratory Method on Conceptual Understanding?" (Poster) Retrieved from http://www.montana.edu/msse/posters/Dickerson%20poster.pdf

Trindale, J., Fiolhais, C., Almeida, L. (2002). Science learning in virtual environments: A descriptive study. British Journal of Educational Technology, 33(4), 471-88. http://dx.doi.org/10.1111/1467-8535.00283

Usman, H. (2016). *Effects of Computer Simulation Instructional Package on Secondary School geography Students Achievement and attitude towards Map Reading in Bida Niger State.* M. Tech Thesis. Federal University Technology, Minna.

West African Examination Council, (2010). June/July. *Analysis of performance of candidate in Geography result*. Lagos.

Yusuf, M. O. & Afolabi A. O. (2010). Effect of computer assisted instruction CAI on secondary school students' performance in Biology. *The Turkish Online Journal of Educational Technology,* 9(1), *62-69.* Retrieved from http://www.tojet.net/article/918/ptt./ 31/9/11.

Zufferey, G., Jermann, P, Do Lenh, S. & Dillenbourg, P. (2009). *British HCI 2009,Cambridge (UK), September 1-4, 2009*

Author(s)

1 **Usman, Hussaini**

He is a PhD sutudent in the department of Educational Technology, Federal University of Technology Minna. He is caring out research work in the area physical and virtual laboratories.

2 **Dr. Alabi T. O.**

He is an erudite scholar and Science Education expert of is a lecturer in the department of Educational Technology, Federal University of Technology Minna. He is into research work and selfless service to humanity.

3 **Dr. Falode O. C.**

He is a lecturer in the department of Educational Technology, Federal University of Technology Minna. He is into teaching, research and community services.

4 **Dr. Mohammed B. Y.**

He is a staff of Geography Department, Federal University of Technology Minna. He is into teaching, research and an environmentalist.