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Effect of Virtual Laboratory on Academic Achievement and Attitude of Physics Students in Nigerian Colleges of Education

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Abstract:
The study investigated the effect of virtual laboratory on Academic achievement and attitude of physics students in Nigerian colleges of education. The study employed a quasi-pre-test and post-test experimental design. A sample of 120 students randomly selected by balloting from 6 Colleges of Education in the Southwest, Nigeria was divided into two groups; experimental and control groups.
For the study, virtual laboratory related to the topics 'Mechanics, Light, Electricity and heat were set up and used to instruct students in the experimental group while the control group was taught the same topic using traditional chalk and talk method. Two instruments; Achievement Test in Physics (ATP) and Attitudinal Scale in Physics (ASP) were developed and used to collect data. The data collected was analyzed using t-test. The results obtained from this study shows that the virtual laboratory used had a more positive impact on students'

Keywords: *Virtual laboratory, attitude, achievement, simulations, Physics, prerequisite*

1. Introduction

The increasing new technologies in our daily lives have affected most of socio-economic activities. All over the world, the educational system and standards at almost all levels were comparable to others within the developed world between 1970 to early 1990 (Jonassen & Reeves, 2004). However, the decline in standard became obvious from late 1990(Oliver, 2000). This is partly because over the past decades, information and communication technology (ICT) has drastically changed the techniques of teaching and learning, belief, value, culture, religion and entire way of life (Agba, 2001). The most relatively affected areas include education systems, commerce and industry, manufacturing process and social system. It is obvious that in attempting to keep abreast with some of the new advances, acceptance and applications of these newly discovered technologies to teaching and learning has become imperative. Philip (2003) opined that organizational ability to learn and subsequent applications of learnt concept could determine its survival, progress, development and proper ranking of institutions in the world-wide global competitive markets. This type of growth in part could be dependent upon ability to quick response to changes and adaptation to new found technologies.

Bamidele (2006) opined that ICT is a revolution that involves the use of computers, internet and other telecommunication technology in every aspect of human endeavour. Ofodu (2007) defined ICT as electronic or computerized devices assisted by human and interactive materials that can be used for a wide range of teaching and learning for public or personal uses. Education, particularly science education plays a vital role in the development of any nation's economic status. As a result of this, science education has been regarded with an extremely high importance and accorded a prime position worldwide (Nwagbo, 2000; Okpara, 2004; Abbas, 2007). Within this context, Physics has been widely identified as a very important science subject and its role in the scientific and technological development of any nation cannot be overemphasized. Due to its recognition, Physics was made a core subject among all science related courses in Nigerian education system. It is a major prerequisite for offering most science and technology-oriented courses in Nigerian colleges of education and other tertiary institutions. Therefore, to remain relevant in the society around us and also to be part of the development of new technologies, Physics students should be competent at mastering the necessary concepts and skills and they should be able to translate them to everyday living. Some science education researchers believe that the general level of performance of students in Physics is still not good enough (Owolabi and Olaniyi, 2003; WAEC,2011, Achor, Agogo and Orokpor,2011).

Agbo and Manliki (1999) quoted Professor Tunde Adeniran who was the Minister of Education in Nigeria then saying that the performance of students in the Sciences (Physics inclusive) was not encouraging in spite of the huge amount of money expended on the purchase of science materials and equipment. Dajili (2001) also expressed his concern about the performance of students in science examinations in Nigerian colleges of education. Achor et al (2011) reported that 'the rate at

which students fail in science examination (Physics inclusive) pose a lot of threat not only to science teaching and learning but also technological development in Nigeria both now and in future'. Education researchers have looked at the various factors that affect students' learning of Physics in Nigerian colleges of education { (Oginni, Awobodu, Alaka and Saibu(2003) }

Oginni et al (2003) highlighted some school factors as correlates of students' achievement in the subject. According to their report, some of the school factors include:

- School Types: It was found that students who attended private secondary schools generally came into Colleges of education more 'ready' for science courses than their public school's counterparts
- School location: There is a consensus among psychologist and educationists that a student's environment can exert considerable influence on his or her intellectual development.

Moreover, schools located in urban areas are better positioned to attract more quality students and lecturers who exhibit the readiness to take academic business more seriously

- Laboratory adequacy and practical classes: It is a known fact that laboratory experiments and practical have positive effects on students by Pavlov's law of exercise/practice which states that successive repetition of stimulus leads to response connection and strengthens learning; the laboratory gives the students the opportunity to learn and reinforce theoretical knowledge through reality. The laboratory offers the students the opportunity to develop scientific attitudes such as objectivity, critical thinking, carefulness, open mindedness, etc.

In Physics education, laboratory activities imply learning by doing thus increasing students' interest in the subject matters covered in the class and help their learning.

Although laboratory application has a very important place in students' learning, it has some limitation and problems. Some of these problems are summarized as follows:

- In carrying out experiments and arranging with equipment, the laboratory activities are expensive
- For planning and application, it is much time consuming
- Checking students' performance during the activities can be difficult in overcrowded classes
- Lack of laboratory or equipment, or insufficient laboratory conditions which limits the teacher to perform a simple laboratory activity.

Owing to the factors listed above, many colleges of education in Nigeria do not perform adequate hands on Physics experiments

To further support this point, researches carried out on the limitations of colleges of education laboratories were reviewed. For example, Audu and Oghogho (2007) pointed out that "Lecturer-student interactions in many science classrooms are not healthy because of inadequate resources. In most of our colleges of education, there are no facilities for the lecturer to demonstrate himself, let alone allow students to have opportunities to find out things for themselves

Omoifo (2012) reported: *The situation in many science laboratories in Nigerian colleges of education is nothing to write home about. In many schools there are no functional laboratories. Some colleges of education merely have empty rooms labeled laboratories. Students rarely have hands-on, minds-on experiences. Few days to science courses (Physics inclusive) accreditation, most colleges of education acquire science equipment for the accreditation for the accreditation team to see. This cannot make for effective learning and eventually results in poor achievement.'*

To worsen the problem of lack of or inadequate resources, the few available ones are not properly maintained, protected and cared for. However, as a result of recent development in information Technology (IT) such experiments can be done virtually. Information Technology has provided new innovations to sustain constructing an artificial educational environment by mean of computers. Certain artificial environments sometimes go beyond natural environments such as simulations and virtual laboratory, which is a sophisticated educational technology emerging for less than a decade.

A virtual laboratory can be defined as virtual studying and learning environment that stimulates the real laboratory, which provides the students with tools, materials and laboratory sets on computer in order to perform experiments subjectively or within a group at anywhere and anytime. It was defined by Harry& Edward (2005) as "laboratory experiment without real laboratory with its walls and doors. It enables the learner to link between the theoretical aspect and the practical one, without papers and pens. It is electronically programmed in computer in order to stimulate the real experiments inside the real laboratories". This kind of educational technology provides an advanced individualized learning, perfectly meets the educational needs and provides a high level of flexibility and freedom from constrains of time and place (Barbour & Reeves, 2009). One of the most important features of virtual laboratory is the easily and continuous material update aiming to attain learning objectivity and interest (Al-Shanak & Doumi, 2009).

2. Statement of the Problem

The concept of "learning by doing" (Bruner,1990) is certainly not new; the laboratory has been given a central and distinctive role in the effective teaching and learning of science courses like Physics. However, due to lack or insufficient of laboratories, hands on experiments are rarely performed in many Nigerian colleges of education. In order to overcome some challenges associated with laboratory activities in science (Physics) classes, there is need for application of virtual laboratory to supplement classroom demonstration or adoption in the absence of physical laboratory. The study seeks to investigate the effect of virtual laboratory on academic achievement and attitude of physics students in Nigerian colleges of education

3. Purpose of the Study

The main purpose of the study is to investigate the effect of virtual laboratory on academic achievement and attitude of Physics students in Nigerian colleges of education. Specifically, the study will determine whether;

- Students taught physics using virtual laboratory will have better achievement than those taught conventionally
- Students taught physics using virtual laboratory will have better attitude than those taught conventionally
- Male and female students will differ in their achievement in Physics after being taught using virtual laboratory

4. Research Questions

- Is there any difference in students' attitude towards Physics using virtual laboratory?
- Is there any difference in students' achievement in Physics using the virtual laboratory?
- Is there any difference in the performance of male and female students who were exposed to virtual laboratory method

5. Research Hypothesis

- $H_0$1: There is no significant difference in students' attitude towards Physics using a virtual laboratory
- $H_0$2: There is no significant difference in students' achievement in Physics after the use of a virtual laboratory
- $H_0$3: There is no significant difference in the performance of male and female students after the use of a virtual laboratory

6. Methodology

A quasi-experimental research design involving pre and post-test, experimental-control group model was used. The subjects were divided into experimental group and control group. The population of this study consisted of all N.C.E 1 students of Physics departments of Nigerian colleges of education totaling 78 schools made up of both public and private schools. Six colleges of education were randomly selected from the colleges of education in the south west, Nigeria using balloting method. Twenty (20) students were then selected from each of the Six (6) schools through balloting. The experimental group consists of 70 students made up of 35 males and 35 females while the control group consists of 50 students made of 25 males and 25 females. The instrument used for data collection was Achievement test in Physics (ATP) and Attitudinal scale in Physics (ASP). The Achievement test in Physics (ATP) had 4 questions each was selected from Mechanics, Light, Electricity and Heat. All the questions are alternative to practical considering the number of participant in the study each question is 25 marks making a total of 100marks. The minimum scores a student could achieve was Zero (0) and the maximum was hundred percent (100). The Attitudinal Scale in Physics (ASP) was developed for measuring the interest levels and attitudes of the students toward Physics. The questionnaire was designed in two sections: the first section dealt with personal information of the respondent while the second section dealt with students' attitude towards Physics. The questionnaire had 24 items of 4-point Likert scale, thus the minimum scores a student could achieve was 24 and the maximum was 96. Draft forms of the tests were given to Physics experts to ascertain the validity of the instruments. Kuder-Richardson instrument (KR-20) was used to determine the reliability of ATP. A reliability coefficient of 0.86 was obtained. Cronbach∝-reliability test was used on ASP and a reliability coefficient of 0.92 was obtained. Before the treatment, the students were divided into two groups; control group and experimental group.ATP and ASP were administered as pre-test to both groups, in the next step, the units "Mechanics, Light, Electricity and Heat'' which are parts of N.C.E 1 Physics curriculum were taught to control group by using chalk and talk method commonly known as traditional method. The same units were taught to experimental group using computer animations (virtual Laboratory) at the computer laboratory. For this purpose, ICT software related to Mechanics, Light, Electricity and Heat were loaded to the Computers in the school's laboratory. The treatment lasted for Three weeks. At the end of the instruction, ATP and ASP were applied to both groups as post-tests. The data collected were analyzed by using SPSS/PC statistical program and t-test was conducted to determine whether there was a significant difference between pre-test and post-test results in each group.

7. Results

7.1. Hypothesis Testing

H_{01}: There is no significant difference in students' attitude towards Physics using a virtual laboratory.

	GROUP	N	X	SD	T	P
PRE-TEST	EG	70	34.51	4.73	0.390	0.895
	CG	50	34.40	4.64		
POST-TEST	EG	70	45.14	5.90	2.489	0.001
	CG	50	38.24	5.55		

Table 1: Result of Attitudinal scale in Physics (ASP)

Result in table 1 shows that, there was no significant difference in ASP pre-test results of all students in both control and experimental groups (p>0.05). This means that all students had similar attitudes toward Physics before the instruction. However, the post-test results show that there was a significant difference in the students' attitude towards Physics depending on the methods used (p>0.05). Therefore, hypothesis one is rejected. In addition, ASP pre-test mean score of experimental group had an increase from 34.51 in pre-test to 45.14 in post –test mean while that of control group increased from 34.40 in pre-test to 38.24 in post- test. The simply implies the use of virtual laboratory affected students more positively than the use of traditional chalk and talk method

H_{02}: There is no significant difference in students' achievement in Physics after the use of a virtual laboratory.

	GROUP	N	X	SD	T	P
PRE-TEST	EG	70	12.09	2.78	0.343	0.960
	CG	50	12.06	2.69		
POST-TEST	EG	70	21.23	2.40	4.233	0.001
	CG	50	16.24	3.13		

Table 2: Result of Achievement Test in Physics (ATP)

Table 2 above shows that there was no significant difference between the pre-test results of both groups (p>0.05). This can be interpreted to mean that both control and experimental groups were selected from students with similar knowledge level before the instruction. However, as can be seen from the table, there was a significant difference in the post-test results of both groups (p<0.05). Hence, hypothesis two is rejected. Moreover, there was a major increase in mean score of experimental group from 12.09 in pre-test to 21.23 in post-test while the same mean score increased in control group from 12.06 in pre-test to 16.24 in post-test. This implies that students who were taught the topic using virtual laboratory were more successful than those who were taught using traditional method

H_{03}: There is no significant difference in the performance of male and female students after the use of a virtual laboratory.

	GROUP	N	X	SD	T	P
PRE-TEST	EG	70	12.09	2.78	0.343	0.960
	CG	50	12.06	2.69		
POST-TEST	EG	70	21.23	2.40	4.233	0.001
	CG	50	16.24	3.13		

Table 3: Result of Achievement Test of male and female students in experimental group

From table 3, it can be seen that there was no significant difference in the post-test result of male and female students in the experimental group. This shows that gender does not play any role in the way virtual laboratory affects students' achievement in Physics in Physics. Therefore, hypothesis three is retained

8. Discussion

It was identified as a result of this study that the use of virtual laboratory increased students' achievement levels and made a positive impact on students' attitudes toward Physics. This finding is supported by many researchers in the field. For example, Russel,Kozma,Jones,Wykoff,Marx and Davis (2000) and Sanger and Greenbowe (2007) separately noted as a result of their studies that the proportion of correct statements increased and misconceptions decreased after instruction using computer simulations. It was also reported by Cengiz (2010) that the use of virtual laboratory is effective in increasing students' achievement and attitudes toward Physics. Similarly, Josephen and Kristensen (2006) prepared a Simulab and investigated the students' reactions and learning gain from the program. Results clearly indicated that the students enjoyed working with the simulation programs and their learning of the performed task improved.

Also, it was identified from the result of this study that gender does not play any important role in the way virtual laboratory influences students' achievements. Both male and female students gained similarly from the virtual laboratory and computer simulations used in this study. This is supported by Owolabi et al (2003) who reported as a result of their research that there is no significant difference in the performance of both male and female students who was taught using computer animations. Also, Wiesner and Lan (2006) supports that there is no difference in male and female achievement tests after being taught with virtual laboratory

9. Conclusion

Although, the results of this study reports that the use of virtual laboratory increased students' achievement levels and attitudes towards the course, it does not claim that virtual laboratories are more effective than the real laboratory, rather it claims that when it is impossible to perform real laboratory activities due to dangers of connectivity, time concern, lack of laboratory or insufficient laboratory conditions, a virtual laboratory can be an alternative. It is obvious from the results of this

study that instead of using chalk and talk or making demonstrational experiments in schools where there is lack of or insufficient laboratory equipment, simulations can be an alternative.

However, in order to achieve the best result from this method, the use of virtual laboratory must be supported with appropriate instructional methods and detailed lesson plan

10. Recommendation

- Courses in virtual laboratory and computer simulations should be integrated into all science education programmes in order to equip lecturers in Science education with the knowledge and applications of virtual laboratory in instruction
- Examination bodies such as JAMB and WAEC should replace alternative to practical with computer-based experiments in external examinations such as U.M.E and G.C.E
- Education administrators such as Vice-chancellor, Rector and Provost should liaise with the government to make funds available which would be used to supply computers to schools that cannot afford either an effective and efficient science laboratory or computer laboratory especially when there is shortage of laboratory apparatus
- Science laboratory software developers and designers should be trained and employed by the ministry of education to supply Virtual laboratory software which are suitable and relevant to the curriculum
- Students should also be encouraged to practice virtual science experiments instead of computer games on their personal computers
- Physics lecturers should encourage the use of virtual Physics laboratory package by students in their schools in order to enhance learning physics practical
- Physics lecturers should expose students to virtual learning strategies to promote student's autonomy to knowledge acquisition, discovery learning and students-centered instructional approach
- Students should endeavor to explore the opportunities offered by virtual Physics laboratory package. The package can be utilized for revision purpose as well as for individualized learning
- In addition, Federal and State ministries of education and other educational agencies (NERDC, NTI, NUC, etc.), NGOs, UNICEF, UNESCO, and other education and stakeholders should organize workshops on the use of virtual laboratory strategy to enhance better performance of secondary school students.
- Teacher education programme in Nigerian tertiary institutions should be improved upon to prepare teachers who can apply innovative approached (virtual laboratory instructional strategy), which will promote effective teaching and learnings.

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