EFFECT OF VIRTUAL LABORATORY STRATEGY ON THE ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS IN PHYSICS PRACTICAL IN MINNA, NIGERIA

By

[1]Gambari, A. I. (Ph.D); [1]Falode, O. C.; [2]Fagbemi, P. O.; & [3]Idris, B.

[1]Department of Science Education,
Federal University of Technology, Minna, Nigeria,
[2]Department of Curriculum & Instruction,
FCT College of Education, Zuba, Abuja,
[3]Logigate Computers, Minna, Niger State.

Corresponding Author: gambari@codelfutminna.edu.ng; +2348036897955; +2348055586716

Abstract

This study examined the influence of virtual laboratory strategy on the achievement of secondary students in physics practical in Minna, Nigeria. The study also investigated the influence of gender and retention on the use of virtual laboratory strategy. Pretest, posttest experimental and control groups design was adopted. Three hypotheses were formulated at 0.05 level of significance. Two co-educational secondary schools were selected from Minna metropolis for this study. The sample consists of thirty two (32) senior secondary two (SS II) physics students. 16 students were randomly selected from each school and assigned Experimental and Control groups. The experimental group (n =16) was exposed to virtual laboratory strategy while the control group (n = 16) was exposed to conventional laboratory method. Two research instruments were used in this study: (i) Practical Physics Achievement Test (PPAT) was used as a testing instrument, it comprised of 40-item multiple-choices physics achievement test; (ii) Virtual Laboratory Strategy Package (VLSP) was used as a treatment instrument, made up of three components (text, video and simulated experiment). The instruments were validated by experts. The Kudar-Richardson (KR=21) formula yielded 0.92 reliability coefficient. t-test, mean and standard deviation were used to test the hypotheses at 0.05 levels of significance. The results from the findings revealed that students' taught physics practical using virtual laboratory strategy performed better than those taught using conventional laboratory method (t_{cal}= 0.247, df = 30, p = 0.000). There was no significant difference between the mean achievement scores of male and female students taught physics practical using virtual laboratory strategy (t_{cal}= 0.247, df = 14, p = 0.809). Students' taught physics practical using virtual laboratory strategy performed better in retention test than those taught using conventional laboratory method (t_{cal}= 7.777, df = 30, p = 0.000). There was no significant difference between the retention mean scores of male and female students taught physics practical using virtual laboratory strategy (t_{cal}= 0.837, df = 14, p = 0.417). Based on the findings, it was recommended that virtual laboratory strategy should be used to supplement physics practical in conventional laboratory setting or adopted as alternative in the absence of standard physics laboratory for practical physics.

Keywords: Virtual laboratory, Physics, Achievement, Retention, Gender

Introduction

Science and technology would be incomplete without physics. Physics is applied to almost every human activity, as every profession involves some elements of physics (Michael, 2006). The significance of physics has made it imperative for its inclusion in the Nigerian senior secondary school curriculum for science oriented students (FRN, 2004). In spite of the importance of physics as a requirement for many specialized science and engineering courses at the tertiary educational institutions, students' performance at the secondary school level (high school) in Nigeria is not encouraging.

The performance of students in physics as a subject in the Senior School Certificate Examinations (SSCE) in Nigeria from 2007 to 2011 has been poor. The percentage of students that passed physics at credit levels and above (A1 - C6) had consistently been less than 50% (West African Examination Council [WAEC] Report, 2011). This can be traced to poor performance in physics practical which consist of 40% of the total marks in physics examination.

Students need practical experiences to enable them understand some abstracts concepts in physics, therefore, effective use of laboratory equipment and facilities will improve the mastery of physics concepts. However, most of the public secondary schools in Nigeria are faced with lack of laboratory or equipment, or insufficient lab conditions which limits the teacher to perform a simple laboratory activity (Adekunle & Hussaini, 2001). Also, the cost of carrying out experiments, arranging the equipment and laboratory activities are laborious and much time consuming. Checking students' performance during the laboratory activities can be tasking and laborious especially when dealing with large class (Yuysuz, 2010). When taking these challenges into consideration, looking for appropriate alternatives is inevitable, hence, the use of virtual laboratory in supporting the laboratory methods can be a logical one.

The potential benefits of virtual laboratory environment for physics practical cannot be underestimated in the contemporary world. Virtual laboratory makes students become active in their learning, provide opportunities for students to construct and understand difficult concepts more easily. Furthermore, it affords the learners to overcome mistakes that occur as a result of such laboratory conditions or misuse of the laboratory and enable them to easily overcome the possible dangers that can be seen in the real laboratory conditions (Karamustafaoglu, Aydin & Ozmen, 2005). Pyatt and Sims (2012) explain that using virtual lab increases motivation and desire for the lectures and laboratory in the process of learning. It also provides an affordable, safe, easy and ideal working environment. Furthermore, Budhu (2000) asserts that the short-term purpose of virtual lab programmes is to support actual physics laboratories, while their long-term purpose is to replace them.

In a review of empirical studies on virtual laboratory, Tatli and Ayas (2012) and Shegog; Lazarus; Murray; Diamond; Sessions; and Zsigmond (2012) found significant improvement in the performance of students exposed to virtual lab than their counterparts in the conventional laboratory method. Flint and Stewart (2010) reported that virtual laboratory was less expensive and ten times faster than a traditional laboratory exercise yet achieved the same learning outcomes for students who were already familiar with laboratory techniques. Tuysuz (2010) found that virtual laboratory strategy made positive effects on students' achievements and attitudes when compared to conventional laboratory method. Karamustafaoglu, Aydin & Ozmen, 2005) found that the teaching by the virtual laboratory strategy with an applied dynamic system is more successful than the teaching implemented by traditional laboratory method. Alkazemi (2003) also found that the treatment group who completed the virtual lab activities in electrochemistry before the actual physical lab performed slightly better than the other group. Van-LeJeune (2002) found that use of computer-simulated experiments and interactive videodisc simulation in science education classrooms improves student problem solving ability and other higher-order thinking skills as compared to traditional science laboratory activities.

However, Hall (2000); Jimoyiannis and Komis (2000); Bayrak, Kanlı & Kandilİngeç (2007) did not find any différence between the performance of students taught with virtual lab and those taught with traditional lab method. Similarly, Moslehpour (1993) reported no significant difference between the students taught using computer simulation in an electronics class laboratory and those taught using conventional class laboratory method.

Gender issues have been linked with performance of students in academic tasks in several studies but without any definite conclusion. Some studies revealed that male students performed better than the female in science courses. For instance, Kost, Pollock and Finkelstein (2009) found that male students performed better than female in interactive physics, while Anagbogu and Ezeliora (2007) found that girls performed better than boys using science process skills method of teaching. However, Adeyẹmi (2008), Gambari (2010) and Orabi (2007) reported that gender had no effect on academic performance of students.

Retention is a crucial issue in learning science concepts. In some review of empirical studies on retention in science concepts, Lux (2002) found that there was 80% increase in retention rate when students were exposed to virtual laboratory during microbiology class. Similarly, Kara (2008) reported that using computer assisted instructional package improved the achievement and retention of students in science education. Also, they did not find any gender difference in achievement and retention of students taught with virtual laboratory strategy and computer assisted instructional package with microbiology and science.

Virtual lab is an innovation in Nigerian education system particularly at secondary school level, therefore, this study examined the effect of virtual laboratory on the performance of secondary school students in physics practical in Minna, Niger State, Nigeria,

Statement of the Problem

Physical experiments are rarely performed in some public secondary schools in Nigeria due to lack of equipment, facilities and other logistic problems. (Adekunle & Hussaini, 2001). In order to overcome some challenges associated with laboratory activities in science classes, there is need for application of virtual laboratory to supplement classroom demonstration or adoption in the absence of physical laboratory. Most of the earlier studies indicate that virtual lab could be an effective instructional tool for enhancing students' performance in sciences. However, there is very little quantitative and qualitative research on the effectiveness of virtual laboratory strategy for conducting physics practical; gender influence; and effect of retention with virtual laboratory and its potential as a substitute for physical laboratory activities at the senior secondary school level in Nigeria. At present, many science laboratories are not properly functioning, incorporating virtual laboratory strategy at the senior secondary school level is desirable, therefore, this study examined the effect of virtual laboratory strategy on the achievement of secondary school students in physics practical in Minna, Nigeria.

Research Questions

The following research questions were raised for the study:

(i) Is there any difference between the mean achievement scores of students taught physics practical using virtual lab strategy and those taught using conventional laboratory method?

(ii) Is there any difference between the mean achievement scores of male and female students taught physics practical using virtual laboratory strategy?

(iii) Is there any difference in the mean retention scores of secondary school students exposed to virtual lab strategy and those exposed to conventional laboratory method?

(iv) Is there any difference in the mean retention scores of male and female secondary school students exposed to virtual laboratory strategy?

Research Hypotheses

The following null hypotheses where formulated:

HO1 There is no significant difference between the mean achievement scores of students taught physics practical with virtual laboratory strategy and those taught with conventional teaching method.

HO2 There is no significant difference between the mean achievement scores of male and female students taught physics practical using virtual laboratory strategy.

HO3: There is no significant difference in the mean retention scores of students exposed to virtual laboratory strategy and those exposed to conventional laboratory method.

HO4: There is no significant difference in the mean retention scores of male and female students exposed to virtual laboratory strategy.

METHOD

Research Design: The research design adopted was a pretest, posttest, experimental and control group design. The senior secondary class II (SS II) students were first pretested and thereafter, taught the practical physics using virtual laboratory strategy and conventional laboratory method. After the treatment, a posttest was administered to both experimental and control groups. Four weeks later, retention test was administered to both groups.

Sample and Sampling Techniques: The target population for the study was all the year II Senior Secondary (SS II) physics students, in Minna, Niger State. The sample for the study was made up of 32 Senior Secondary II (SS II), 16 male and 16 female students from two state government - owned co-educational secondary school. Three stages of sampling technique were adopted. Firstly, two senior secondary schools in Minna, Niger State were purposively sampled based on: equivalent (manpower and physics facilities); composition (mixed schools); facilities (under School Net programme); exposure (availability and usage of computer); years of experience (presenting candidates for SSCE physics examination for a minimum of ten years). Secondly, the schools were randomly assigned to each of the experimental groups (virtual lab experiment) and control group (Convectional lab). Thirdly, a stratified random sample of 16 students (8 males and 8 females) from each school was employed.

Research Instruments: The following research instruments were employed in this study:

(i) **Treatment Instrument:** This is a Virtual Laboratory Strategy Package (VLSP) for senior secondary physics practical. It was developed by the researchers and a programmer. The necessity for researcher-made virtual laboratory experiment package was based on the fact that the commercially produced VLSP are not common in Nigeria. Even, when available they may not be directly relevant to the topic or objectives to be achieved in a lesson as they may not be culturally relevant to implement physics instruction in Nigeria. The VLSP package was written in html format using "Macromedia Dreamweaver 8" as the overall platform. Other computer programmes and applications that were also utilized during the development process are Microsoft Word 2003, Macromedia Fireworks 8, and Macromedia Flash 8. Macromedia Fireworks was used for specific texts, graphics and buttons, while Macromedia Flash was used for simulation. The video demonstration of physics practical embedded in the VLSP was recorded using digital camcorder camera. The package was validated by computer programmers and educational technology experts; subject content (physics) specialists; and finally field tested on sample representative similar to the students used for the final study. The VLSP contained four topics, namely: Simple pendulum, Mass on spring; Change in momentum; and Image on a convex lens. The main menu of the package consisted of introduction, students' registration, list of practical lessons as in lesson 1, 2, 3, & 4 and exit. The VLSP is divided into three section, namely: Lesson Note section, where students read the contents of the experiment; Video section, where the students watch a practical demonstration of the experiment; and virtual Lap section, where the students perform the experiment. VLSP adopted the simulation modes of CAI. The production of the package was effected through a team of professionals and specialists including the system programmer, computer operator, cameraman, video editor and the instructional designers (the researchers). Dick and Carey (2005) instructional development model was adapted to develop the package.

(ii) ***Test Instrument:*** The instrument used in collecting data for this study was a researcher-adopted Physics Practical Achievement Test (PPAT). The PPAT consisted of 40 multiple choice objective items adopted from past examination of West African Examination Council (WAEC, May/June, 1988-2010) and National Examination Council (NECO, June/July, 2000-2010). The PPAT was based on the contents of the VLSP package. Each of the items of the PPAT had five options (A - E) as possible answers to the question. Students were required to indicate their correct answers by ticking one of the letters (A - E) that corresponds to the correct option in each item. This instrument (PPAT) was administered to the experimental and control groups as pre-test, posttest and again for the retention test after it had been reshuffled. On the scoring of the multiple-choice items, '1' was awarded for each correct answer and '0' for each wrong answer. Thus, maximum possible score was 40 marks. The items were validated and tested for reliability using 20 randomly selected SSII students. The test was administered once on the pilot samples. A reliability test using the Kudar Richardson (KR-21) revealed a reliability of 0.92 which was considered adequate for the research study.

Method of Data Collection: The researcher visited the selected schools and sought the cooperation of students and staff in the selected schools. The physics teachers in the experimental group were trained as research assistants in the use of the VLSP for one week. The control group teachers were informed to prepare the lab for conventional laboratory method. The treatment period for all groups covered four weeks.

At the commencement of the experiment, PPAT was administered on students in the sampled schools as pre-test. Thereafter, treatment which lasted for four weeks followed. The VLSP was installed on stand-alone computer systems. The physics practical contents were presented through the computer and the learners interact and respond to the computer prompts. The VLSP presents information in textual, video and simulation formats and students studied the topics in such order. In the simulation section of the package, an interactive animation platform displayed, students selected some parameters required and started the virtual experiment.

During the experiments, the experimental group was exposed to the use of VLSP as treatment, while students in the control group were exposed to the conventional laboratory method. Each group was given a pre-lab instruction for ten minutes followed by laboratory activities specifically designed for each group. Immediately after the treatment, PPAT was administered as posttest and after four weeks, it was re-administered as a retention test to both groups.

RESULTS

To test for the hypotheses, the data were analysed using t-test statistics with Statistical Package for Social Sciences (SPSS) version 11 at 0.05 alpha level. To analyse the pretest data, the mean scores of the experimental and control groups were computed and compared using t-test. Table 1 present the mean, standard deviations and the result of the t-test for the two groups.

Table 1: **t-test comparison of pretest mean scores of the experimental and control groups**

Variable	No. of	df	Mean	SD	t-value	Sig.(2-

	samples					tailed)
Control Group	16	30	3.19	1.167	1.640^{ns}	0.111
Experimental Group	16		3.88	1.204		

ns: Not Significant at 0.05 level.

Table 1 shows the t-test comparison of the posttest mean scores of the experimental and control groups. From the table, t-value calculated (*t* = 1:640, *df*= 30, *p* = 0.111,) was not significant at 0.05 alpha level. This indicates that there was no significant difference between the mean scores of the experimental group and the control group. This implies that the experimental and control groups have equal academic ability before the experiment started.

HO_1: There is no significant difference in the posttest mean scores of students taught physics practical using virtual laboratory strategy and those taught using conventional laboratory method. The results of the posttest are shown in Table 2.

Table 2: t-test comparison of posttest mean scores of the experimental and control groups

Variable	No. of Samples	df	Mean	SD	t-value	Sig.(2-tailed)
Control Group	16	30	5.75	0.775	6.400*	0.000
Experimental Group	16		9.13	1.962		

*Significant at 0.05 level

Table 2 shows the t-test comparison of the posttest mean scores of the experimental and control groups. From the table, the calculated t-value (t_{cal}= 6.400, *df* = 30, *p* = 0.000) was significant at 0.05 alpha level. On this basis, the null hypothesis is rejected, therefore there is significant difference between the experimental and control group result favouring the experimental group which used virtual laboratory strategy.

HO_2: There is no significant difference in the posttest mean scores of male and female students taught physics practical using virtual laboratory strategy. The result is presented in the Table 3.

Table 3: t-test comparison of posttest mean scores of male and female students taught physics practical using virtual lab strategy

Group	Gender	No. of Samples	Df	Mean	SD	t-value	Sig(2-tailed)
Experimental Group	Male	8	14	9.00	2.070	0.247^{ns}	0.809
	Female	8		9.25	1.982		

ns: Not Significant at 0.05 level

Table 3 presents the result of male and female students taught physics practical using virtual laboratory strategy. From the table, the calculated t-value (t_{cal} = 0.247, *df* = 14, *p* = 0.809) was not significant at 0.05 alpha level. On this basis, hypothesis 2 was not rejected. Therefore, there is no significant difference between the mean achievement scores of male and female students taught physics practical with the virtual laboratory strategy.

HO_3: There is no significant difference in the mean retention scores of students exposed to virtual laboratory strategy and those exposed to conventional laboratory method. The result is shown in Table 4.

Table 4: t-test comparison of retention mean achievement scores of the experimental and control groups

Variable	No. of Samples	df	Mean	SD	t-value	Sig.(2-tailed)
Control Group	16	30	11.88	1.408	7.777*	0.000
Experimental Group	16		8.75	0.775		

*: Significant at 0.05 level

Table 4 shows the t-test comparison of the retention mean scores of the experimental and control groups. From the table, the calculated t-value (t_{cal} = 7.777, df = 30, p = 0.000) was significant at 0.05 alpha level. On this basis, the null hypothesis is rejected, therefore, there is significant difference between the experimental and control group result favouring the experimental group which used virtual laboratory strategy.

HO_4: There is no significant difference in the mean retention scores of male and female students exposed to virtual laboratory strategy. The result is presented in Table 5.

Table 5: t-test comparison of posttest mean achievement scores for male and female students taught physics practical using virtual laboratory strategy

Group	Gender	No. of Samples	Df	Mean	SD	t-value	Sig(2-tailed)
Experimental Group	Male	8	14	12.50	1.309	0.837^{ns}	0.417
	Female	8		12.00	1.069		

ns: Not Significant level 0.05

Table 5 presents the result of male and female students that were taught physics practical using virtual laboratory strategy. From the table, the calculated t-value (t_{cal} = 0.837, df = 14, p = 0.417) was not significant at 0.05 alpha level. On this basis, hypothesis 4 was not rejected, therefore, there is no significant difference between the mean retention scores of male and female students taught physics practical with the virtual laboratory strategy.

Discussion of Findings

The results indicated that students taught physics practical using virtual laboratory strategy performed better than those taught with conventional laboratory method. This finding agrees with the earlier findings of Tatli and Ayas (2012) and Shegog; Lazarus; Murray; Diamond; Sessions and Zsigmond (2012) who established that virtual laboratory strategy improved the performance of students taught chemistry and molecular biology respectively than their counterparts taught with the conventional laboratory method. The finding is also supported by the findings of Tuysuz (2010) who found that virtual laboratory applications made positive effects on students' achievement and attitudes when compared to traditional laboratory method. It also agrees with the conclusion of (Karamustafaoglu, Aydin & Ozmen, 2005) who found that teaching by the virtual lab program with an applied dynamic system is more successful than the teaching implemented by traditional method. Likewise, it agree with Alkazemi (2003) who found that the treatment group who completed the virtual lab activities in electrochemistry before the actual physical lab performed slightly better on the posttest achievement than the other group. It also support the findings of Van-LeJeune (2002) who found that use of computer-simulated experiments and interactive videodisc simulation in science education classrooms improved student problem solving ability and other higher-order thinking skills as compared to traditional science laboratory activities.

However, Hall (2000); Jimoyiannis and Komis (2000); Bayrak, Kanlı & Kandilingeç (2007) did not find any difference between the performance of students taught with virtual laboratory and those taught with traditional laboratory method. Similarly, Moslehpour (1993) reported no significant difference between the students taught using computer simulation in an electronics class laboratory and those taught using conventional class laboratory method.

The superiority of virtual laboratory strategy over the conventional laboratory method stems from the fact that they are task structured (i.e. reading the pre-laboratory instruction; watching the video demonstration; and practice as many times as possible by varying the parameters in a simulated platform). Virtual laboratory strategy is activity based which arouses students' interest; it is stress free because virtual materials, facilities, and equipment are readily available. These could be part of factors that are responsible for students' better performance.

On the influence of gender on the students' achievement in physics practical when taught using virtual laboratory strategy, no significant difference was established. These findings showed that gender had no influence on the achievement of students in physics practical when taught using virtual laboratory strategy. This finding agrees with the earlier findings of Adeyemi (2008), Gambari (2010) and Orabi (2007) who reported that gender had no effect on academic performance of students in chemistry, physics and biology respectively.

However, the finding disagree with the findings of Kost, Pollock and Finkelstein (2009) who found that male students performed better than female in interactive physics. The finding contradicts the findings of Anagbogu and Ezeliora (2007) who reported that girls performed better than boys using science process skills method of teaching. The finding is not supported by the findings of ChanLin and LihJuan (2001) who found that gender effect was significant among girls and insignificant among boys while using computer assisted learning with different presentation formats (animation; still graphics, and text).

Students taught physics practical with virtual laboratory strategy had better retention of the contents than those taught with conventional laboratory method. However, no significant difference was established between male and female students taught physics practical using virtual laboratory strategy in the retention test. This finding agree with earlier findings of Lux (2002) who found that students retention was increased by 80% after exposed to virtual laboratory in microbiology course. Similarly, it agrees with the findings of Kara (2008) who reported that using computer assisted instructional package improved the achievement and retention of students in science education. It also agrees with their findings on gender.

The findings in this study have strong implications for teaching and learning of physics practical in secondary schools in Nigeria using virtual laboratory strategy. Major implication of these findings is that virtual laboratory strategy is better than conventional laboratory method. Furthermore, the findings provide sound empirical basis which indicate that performance of students in physics practical would be improved if students are exposed to varieties of virtual laboratory strategy in all aspect of physics curriculum in particular and science in general.

Conclusion

From the above findings, it can be deduced that virtual laboratory strategy produced more positive effect on students learning outcomes. It is gender friendly and improves students' retention in physics practical. This strategy is therefore better approach for teaching practical physics at senior secondary schools in Nigeria. Through the use of virtual laboratory strategy, practical content can be delivered in simplest, motivating and interactive manners. This would put into rest the age long poor performance in physics practical in Nigeria.

Recommendations

Based on the major findings of this study, the following recommendations are proffered.

(i) Teachers should expose physics students to virtual laboratory strategy so as to promote active learning, discovery learning, motivation, learning by doing and learning by experience among students.

(ii) 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.

(iii) 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 learning.

(iv) The instructional designers, computer programmers, instructional developers should develop relevant virtual laboratory strategy packages for use within the Nigerian school systems.

References

Adeyemi, B. A. (2008). Effects of cooperative learning and problem-solving strategies on junior secondary school students' achievement in social studies. *Electronic Journal of Research in educational Psychology, 6*(3), 691–708. Retrieved February 13, from http://www.springerlink.com/content/c19u25816754q5j5/

Alkazemi, E. (2003). *The effect of the instructional sequence of a computer simulation and a traditional laboratory on middle-grade students' conceptual understanding of electrochemistry.* Unpublished doctoral dissertation, University of Florida.

Anagbogu, M. A. and Ezeliora, B. (2007).Sex differences and scientific performance. *Women Journal of Science and Technology, 4, 10-20.*

Bayrak, B., Kanlı, U. & Kandilİngeç, Ş. (2007). To compare the effects of computer based learning and the laboratory based learning on students' achievement regarding electric circuits. *The Turkish Online Journal of Educational Technology*, 6(1), 15-24.

Budhu, M. (2000). *Interactive multimedia web-based courseware with virtual laboratories.* In Proceedings of the CATE Computers and Advanced Technology in Education 2000 Conference. Cancun, Mexico, 19-25.

Dick, W. & Carey, L. (2005). *The systematic design of instruction (4th edition).* New York: Harper Collins College Publishers.

Federal Republic of Nigeria, (2004). *National policy on education.* Lagos: Federal Government Press.

Flint, S, & Stewart, T. (2010). Food microbiology-design and testing of a virtual laboratory exercise. *Journal of Food Science Education, 9(4), 84-89*

Gambari, I. A. (2010). *Effect of computer-supported cooperative learning strategies on the* *performance of senior secondary students in physics, in Minna, Nigeria.* Unpublished Ph.D thesis, University of Ilorin, Ilorin, Nigeria.

Hall, T. (2000). Quantitative analysis of the effectiveness of simulated electronics laboratory experiments, *Journal of Engineering Technology*, 17(2), 60-66.

Jimoyiannis, A. &Komis, V. (2000). Computer simulations in physics teaching and learning: A case study on students' understanding of trajectory motion. *Computers & Education, 36, 183-204.*

Kara, İ. (2008). The effect on retention of computer assisted instruction in science education. *Journal of Instructional Psychology*, 35(4), 357-364.

Karamustafaoğlu, O., Aydın, M. & Özmen, H. (2005). Bilgisayar destekli fizik etkinliklerinin oğrenci kazanımlarına etkisi: BasitHarmonik hareketorneği. *The Turkish Online Journal of Educational Technology, 4(4), 67-81.*

Kost, L. E., Pollock, S. J. & Finkelstein, N. D. (2009). Characterizing the gender gap in introductory physics. *Physics Education Research, 5(1) 1-14.*

Lux, M. F. (2002). An activity-based format increased student retention in a community college microbiology course. *Journal of microbiology and biology education, 3(1).* Retrieved on the 2nd Feb., 2012 from http://jmbe.asm.org/index.php/jmbe/article/view/64/html 34

Michael, P. (2006). *The importance of physics: Breakthroughs drive economy, quality of life, world leaders, public increasingly take scientific advances for granted.* Retrieved April 29 2007, from http://www.physics2005.org.

Moslehpour, S. (1993). *A comparison of achievement resulting from learning electronics concepts by computer simulation versus traditional laboratory instruction.* Unpublished doctoral dissertation, Iowa State University.

Orabi, I. I. (2007). Gender differences in student academic performance and attitudes in an introductory engineering course. *American Society for Engineering Education Journal, 9(3), 68-75.*

Pyatt, K. & Sims, R. (2012). Virtual and physical experimentation in inquiry-based science labs: Attitudes, performance and access. *Journal of Science Education and Technology, 21(1), 133-147.*

Tatli, Z. & Ayas, A. (2012). Virtual chemistry laboratory: Effect of constructivist learning environment. *Turkish Online Journal of Distance Education, 13(1), 183-199.*

Tuysuz, C. (2010). The effect of the virtual laboratory on students' achievement and attitude in chemistry. *International Online Journal of Educational Sciences, 2010, 2 (1), 37-53.*

Van-LeJeune, J. (2002). *A meta-analysis of outcomes from the use of computer simulated experiments in science education.* Unpublished Ph.D dissertation, Texas A&M University.

West African Examination Council, (2007, 2008, 2009, 2010 & 2011). May/June. *Chief Examiner's Report.* Lagos: WAEC