IJSCIA
International Journal of Scientific Advances
ISSN: 2708-7972
Volume: 4 | Issue: 6 | Nov – Dec 2023 Available Online: www.ijscia.com
DOI: 10.51542/ijscia.v4i6.24

Comparative Effects of Computer-Simulated Strategy and Real Laboratory Experiment on Students' Achievement and Retention in Electricity Practical

Ejimonu, Emmanuela Ifeyinwa[1*], Musa Peter Eson[1], Olayinka Folasade Oluyemisi[2], and Uwalaka Esther Ifeyinwa[3]

[1]Department of Quality Assurance, Jabi, Abuja, Nigeria

[2]Department of Science Education, Faculty of Education, Federal University Oye-Ekiti, Ekiti State, Nigeria

[3]Department of Science Education, Nasarawa State University, Keffi, Nigeria

E-mail: ejimonuemmanuela@gmail.com; dresonpm56@gmail.com; Folashade.olayinka@fuoye.edu.ng; Loveify_2006@yahoo.com

*Corresponding author details: Ejimonu, Emmanuela Ifeyinwa; ejimonuemmanuela@gmail.com

ABSTRACT

The study investigated the comparative effects of computer-simulated strategy and real laboratory experiment on students' achievement and retention in electricity practical. Quasi-experimental design of the pre-test, post-test, post-post-test, non-equivalent control group design was used for the study. The study was guided by 2 research questions and 2 null hypotheses. The hypotheses were tested at 0.05 level of significance. Two intact classes were randomly selected, one of which was the control group and the other experimental group. The experimental group was taught using Computer-Simulated Experiment (CSE)while the control group was taught using Real Laboratory Experiment (RLE/ conventional method). The instrument of data collection was Electricity Practical Achievement Test (EPAT). EPAT was reshuffled for post-post-test and named Electricity Practical Retention Test (EPRT). The reliability coefficient of EPAT was computed using Spearman-Brown's prophecy formula and was found to be 0.78. The instrument was validated by 3 experts. Data collected were analyzed using mean, standard deviation and analysis of covariance (ANCOVA). The findings of the study revealed that the students taught electricity practical using CSE achieved and retained better than those taught using RLE. One of the recommendations is that teachers should adopt CSE in teaching physics practical.

Keywords: computer-simulated strategy; real laboratory experiment; achievement; retention; electricity practical.

INTRODUCTION

Physics as a science subject is very crucial in economic, scientific and technological development of a nation. This is because without physics there will be no technology and no modern devices. Therefore, the importance of physics to the society today is evident in man's reliance on technology. Computers, Cell phones, the internet, motorized equipment are only a few examples of physics-based technological development that have revolutionalized the world today (Chukwunenye, 2022). The National Policy on Education of Nigeria clearly stated in its aims and objectives that the learner would be given opportunity to acquire basic practical skills for self-reliance and employment, Federal Government of Nigeria, FGN (2004). In realization of this laudableobjective, practical activities should be an integral part of the teaching and learning of science in secondary schools because it proffers first-hand knowledge of science concepts.

The study of physics at senior secondary school level constitutes of the theoretical aspect and practical aspect. In both internal and external examinations students are tested in both aspects, then the practical dimension is assessed separately as an integral part of the total score obtainable by the students. West Africa Examination Council (WAEC) Chief Examiner's Reports (2020, 2021, 2022) stated that students' performancein practical physics at the Senior School Certificate Examinations (SSCE) level is consistently deteriorating. No doubt this has contributed to the underachievement of students in physics (Ojo and Owolabi, 2020).

Achievement is the outcome which is obtained by the quality and quantity of students' efforts. Over the years students' achievement in physics has prompted educational researchers to continuously make relentless efforts at identifying mitigating factors that might account for the observed poor performance. According to Ilorah and Adeniji (2018) the current trend of students' underachievement in physics is as a result of lack of laboratories and scientific apparatus for higher rate of content retention, creativity, originality of thought and the inability to report appropriately practical activities.
Retention is the process of absorbing and ultimately retaining information over time. Learning retention according to Goins and Fisher (2018) is the process by which new information is transferred from our short-term memory to our long-term memory. Suleman, Hussain, Naseer Ud Din and Iqbal (2017) found that computer-assisted instruction has a significant positive effect on students' retention in physics. Guy and Jackson (2015) on the contrary found that computer simulation decreased retention in students, Have the conventional method (Real laboratory Experiment) being of help in improving students' achievement and retention in electricity practical?

The phrase 'Real laboratory Experiment (RLE)' as used here refers to hands-on experiment. This is a teaching method where electric circuit components required for a particular experiment are provided for students. Then, following the given circuit diagram and under teacher's guidance students connect the circuit. By varying one parameter or the other the changes are observed and recorded. The data obtained are plotted on a graph from which valid deductions are made. Vila thong (2011) asserts that laboratory works contrives learning experiences in which students interact with materials to check and observe phenomena in a practical classroom.

Effective teaching and learning of physics require adequate practical activities as this help to bring to bear abstract principles and concepts of the subject matter. According to Ojo and Owolabi (2020) effective teaching and learning of physics is a measure of students' experience, understanding and skills acquired as a result of frequent engagement of the students in practical activities which enable them to think and act in a scientific manner. It is unfortunate that most public secondary schools in Nigeria are faced with lack or inadequate laboratory equipment. Also, carrying out practical lessons in large class which characterize Nigerian science class is laborious. Consequently, the need to explore alternative methods for successfully performing physics practical becomes expedient. Hence, the use of computer simulated experiment may be of help.

Computer- simulated experiment (CSE) is the use of computer programmes to form simulations and animations of physics experiments. In computer simulations, students have opportunity to receive supplemental contact with variables tested in real experiences or dangerous one.

Previous research indicates that simulations have a constructive influence on learning goals and is effective in enhancing students' performance in physics practical (Vlachopoulos & Makri, 2017, Ilorah and Adeniji, 2018, Pember and Achor, 2018). The software used for teaching the CSE group is Proteus 7. It contains electrical components and worksheets required to connect different circuits. Lee (2021) documented that the cognitive dimension is the most noticeable and is facilitated by the perceived usefulness and usability of the computer simulations for teaching.

Statement of Problem

It has been observed with great dismay that senior secondary students in public schools are not exposed early to practical work in physics for several reasons – late resumption of senior secondary one (SS1 students, over-loaded syllabus (which tends to compel teachers of physics to rely mostly on lecture method for coverage of syllabus), Inadequate laboratory materials/ equipment, poor method of instruction, students' negative attitude towards physics, and large class size. The urgent need to tackle the challenges posed by inadequate laboratory materials and poor method of instruction necessitated this research work. It is expected that the use of alternative instructional strategy like computer-simulated experiment may be of help.

Research Questions

The following research questions guided the study:

(1) What are the achievement scores of Senior Secondary One (SS1) physics students taught electricity practical using CSE and those taught using RLE?

(2) What are the mean retention scores of SS1 physics students taught electricity practical using CSE and those taught by RLE?

(3) Research Hypotheses

(4) Two null hypotheses were formulated and were tested at P = 0.05 level of significance:

HO1: There is no significant difference in the mean achievement scores of SS1 physics students taught electricity practical using CSE and those taught using RLE.

HO2: There is no significant difference in mean retention scores of SS1 physics students taught using CSE and those taught by RLE.

METHODOLOGY

The quasi-experimental design of pre-test, post-test and post-post-test control group was used. A 30-item expert-validated instrument was used. It was named Electricity Practical Achievement Test (EPAT). EPAT was reshuffled for post-post-test and named Electricity Practical Retention Test (EPRT). The reliability coefficient of EPAT was computed using Spearman-Brown's prophecy formula and was found to be 0.78.

Jean Piaget's theory of learning, Jerome Brunner's theory of learning by doing and Edward Thorndike's decay theory formed the theoretical framework for the study. The target population f or the study was the Senior Secondary One (SS1) students of the four senior science secondary schools in Federal Capital Territory. As at 2022/2023 academic session, there were 1440 (823 males and 617 females) SS1 students. The sample comprised of 103 SS1 students from two intact classes (55 males and 48 females).

The experimental group (CSE group) has 48 students (15 males and 33 females), while the control group (RLE group) has 55 students (40 males, 15 females).

Data Analysis and Results

The analysis of data collected for the study are presented here based on the research questions and hypotheses that guided the study.

Research Question 1: What are the mean achievement scores of SS1 Physics students taught electricity practical using CSE and those taught using RLE?

TABLE 1: Mean Scores and Standard Deviation in EPAT of Students in CSE and RLE.

(Convectional) Groups.

Teaching Method	Type of Test	No. of students	Mean	Standard Deviation
CSE	Pre-test	48	6.52	1.786
	Post-test	48	21.23	4.363
RLE	Pre-test	55	5.65	1.336
	Post-test	55	17.82	2.919

From Table 1, the standard deviation scores of the test for both groups indicate a homogenous distribution. The effect of this test is that students taught with CSE had higher achievement gain than those taught with RLE.

Research Question 2: What are the mean retention scores in electricity practical of SS1 physics students taught using CSE and those taught with RLE.

TABLE 2: The Mean Retention Scores and the Standard Deviation in EPAT of SS1 Physics Students Taught Using CSE and those Taught Using RLE.

Method	Type of Test	No. of students	Mean	Standard Deviation
CSE	Pre-test	48	21.23	4.363
	Post-test	48	19.73	4.078
RLE	Pre-test	55	17.82	2.919
	Post-test	55	15.47	2.911

From Table 2, the achievement loss of students in CSE group was 1.50 while that of students in RLE group was 4.26. The standard deviation score indicates a homogeneous distribution. From these results students taught using CSE retained better than those taught using RLE.

Hypothesis H_{O1}: There is no significant difference in the mean achievement scores of SS1 physics students taught using CSE and those taught using RLE.

TABLE 3: One-way ANCOVA Results on Students' Achievement in EPAT.

Source	Type III sum of squares	df	Mean Squares	F	Sig.
Corrected Model	877.499	2	438.750	56.585	0.000
Intercept	648.334	1	648.334	83.616	0.000
Group	103.133	1	103.133	13.301	0.000
Pretest	579.286	1	578.286	74.711	0.000
Error	775.375	100	7.754		
Total	40449.000	103			
Corrected	1652.874	102			

S = significant at P=0.05.

Table 3 shows the summary of the one-way ANCOVA result on students' achievement scores in EPAT. The results revealed that the noted differences between the mean achievement scores of the two groups are significant at 0.05 alpha levels. This is from the fact that F (1,100) = 13.30 and P = 0.000 < α= 0.05.

The null hypothesis was therefore rejected indicating that there is significant difference in the mean achievement scores of students taught using CSE and RLE.

Hypothesis **H_{02}:** There is no significant difference in the mean retention scores of SS1 physics students taught using CSE and those taught using RLE.

TABLE 4: ANCOVA Results on test of Retention for SS1 physics students for CSE and RLE groups.

Sources	Type III sum Squares	df	Mean Square	F	Sig.
Corrected Model	1429.968	2	714.984	261.338	0.000
Intercept	4.290	1	4.290	1.568	0.213
Post-test	965.603	1	965.603	352.944	0.000
Group	39.810	1	39.810	14.551	0.000
Error	273.585	100	2.736		
Total	33090.000	103			
Corrected Total	1703.553	102			

S= Significant at P=0.05.

Table 4 shows the ANCOVA results on test of retention for students taught using CSE and RLE methods. The result reveals that the noted difference between the CSE and RLE method groups is significant at 0.05 alpha level. This is because F (1,100) = 14.551 and P = 0.000 < α 0.05. The null hypothesis is therefore rejected indicating that there is a significant difference in the mean retention scores of students taught using CSE and those taught using RLE method.

DISCUSSION OF FINDINGS

The results of the study revealed that CSE improved the achievement of the students than RLE. This is in agreement with the findings of Vlachopoulos & Makri, 2017, Ilorah and Adeniji, 2018, Pember and Achor, 2018. The findings of this study also showed that CSE group obtained better mean score in EPRT (19.73) when compared with those in RLE group who had 15.47. This aligns with the findings of Suleman, Hussain, Naseer Ud Din and Iqbal (2017) but contradicts the findings of Guy and Jackson (2015).

CONCLUSIONS AND RECOMMENDATIONS

In the light of the above findings, it is concluded that CSE strategy improved the academic achievement and knowledge retention of students in electricity practical. From the revelation of the study both strategies are good. They can be used to supplement each other. In Nigeria, many secondary schools are faced with inadequacy of laboratory materials and near absence of computer-simulation based teaching. It is then obvious that a lot needs to be done in the area of teaching and learning using computer simulation. In view of findings of this study, the following recommendations are made:

(1) Teachers should adopt the use of CSE as it fosters student's achievement and retention.

(2) Curriculum planners should recommend the use of computer as one of the strategies of teaching electricity practical since it helps the students to understand the internal working of the circuit.

(3) Ministry officials, Zonal education authority and local education authority can organize in-service re-training courses, seminars and workshops using schools with functional computer laboratories as venues. This will help to educate practicing teachers on how to implement computer simulation strategy in schools at all levels.

(4) Students' should be encouraged to own their personal computers (e.g. Laptops) for use during their private studies.

(5) The government and non-government should equip schools with computers and new technologies for easy access by both teachers and students.

REFERENCES

[1] Guy, R.S. & Lownes-Jackson, M. (2015). The use of Computer Simulation to compare students' performance in traditional versus distance learning environments. Issues in informing Science and Information Technology, 12, 95-109. Retrieved on July 31st,2015 from http://www.iisit.org/vol12/IJSITv12p095-109Guy1767.pdf

[2] Chukwuenye, J. N. (2022). Effects of Computer-Simulated Instructional Strategy on Senior Secondary School Students' Interest and Achievement in practical Physics in Imo State, Nigeria. Retrieved on 4th September, 2022 from https;//Afribary.com

[3] Vilaythong T. (2011). The role of practical work in physics education in Lao PDR-DIVA. Retrieved on 25th February 2014 from www.diva-portal.org/smash/getdiva 2:408814/FULL TEXT 01.pdf Federal Republic of Nigeria (2004). National Policy on Education. Federal Government Press, Lagos.

[4] Goins, T. & Fisher, J. (2018). Knowledge retention tactics for more effective learning (PLP). Downloaded on June 18, 2019 from www.fklearning.com

[5] Ilorah, S.O. & Adeniji, J.K (2018).Enhancing Students' Academic Performance in Physics Practical: The Computer Simulations Experience. International Journal of Innovative Information Systems and Technology Research, 6(2), 71-81.

[6] Lee, J. (1994). Effectiveness of Computer-Based Instructional Simulation: A Meta-Analysis. International Journal of Instructional Media. 26 (1), 71-85.

[7] Lee, J. (2021). Effectiveness of Computer-Based Instructional Simulation: A Meta-Analysis. International Journal of Instructional Media 26 (1). 71 – 85. Retrieved on 22 August, 2022 from https://www.researchgate.net

[8] WAEC (2020). Chief examiner report. Nigeria: WAEC Press WAEC (2021). Chief examiner report. Nigeria: WAEC Press WAEC (2022). Chief examiner report. Nigeria: WAEC Press.

[9] Ojo, M. O. & Owolabi, O. T. (2020). Relative Effects of Two Activity-Based Instructional Strategies on Secondary School Students. Attitude towards Physics Practical. European Journal of Educational Sciences, 7(3), 1857-6036.

[10] Pember, S.T, & Achor, E.E (2017). Computer-Simulated Experiments and Senior Secondary Students' Achievement in practical Physics in Nigeria. Journal of the International Centre for Science, Humanities and Education Research, 3(2), 1-17 Retrieved on 30th November, 2022 from https://ssrn.com

[11] Suleiman, Q., Hussain,I ., Naseer Ud Din, M. & Iqbal, K. (2017). Effects of Computer-Simulated Instructions on Students' Academic Achievement in Physics at Secondary Level. Computer Engineering and Intelligent Systems, 8(7). Retrieved on 30th December, 2022 from https://core.ac.uk

[12] Vlachopoulos, D., & Makri, A. (2017). The efect of games and simulations on higher education: a systematic literature review. International Journal of Educational Technology in Higher Education, 14(1), 1–33. https://doi.org/10.1186/s41239-017-0062-1

[13] WAEC (2020). Chief examiner report. Nigeria: WAEC Press WAEC (2021). Chief examiner report. Nigeria: WAEC Press WAEC (2022). Chief examiner report. Nigeria: WAEC Press.