Effects of Computer Simulation Teaching Strategy on Senior Secondary School Students achievement in Physics in Girei, Adamawa State

Okoronka U. A. [1] and Sania. M. [2]
Department of Science Education, Modibbo Adama University of Technology Yola
Contact: Saniabdul380@gmail.com; +2348037788749

ABSTRACT

The study investigated the effect of computer simulation teaching strategy on students' achievement in physics in private senior secondary schools in Girei, Adamawa State. The target population of the study consisted of all the SS II physics students in the privately owned senior secondary schools in the area whilethe sample of the study was 62 students selected from two intact classes selected from nine senior secondary schools that qualified for the study. The study adopted pretest, post-test, non-randomized, control group, quasi-experimental design. Two hypotheses were tested using ANCOVA at 0.05 level of significance. Physics Achievement test (PAT) was used to collect data from the subjects. The instrument was validated by two experts in physics and physics education for face and content validation. The reliability of the instrument was determined using Kuder Richardson (KR_{21}) formula which yielded a reliability index of 0.77. The findings of the study revealed that (i) there is significant difference [$F = 11.142$; ($df = 1, 61$); $p < 0.05$] in the mean achievement scores of students taught using CBSM and those taught using TTM (ii) there is no significant difference [$F = 1.733$; ($df = 1, 29$); $p > 0.05$] in the mean scores of male and female students performance when exposed to CBSM. It was recommended among others, that computer simulation teaching strategy should be incorporated in the teaching of physics for conceptual understanding at the senior secondary school level as a way to improve achievement in the subject.

KEYWORDS: Computer Simulation, Gender, Physics Achievement, Secondary School

Introduction

Physics is a science that uses quantitative measurement and experimental observations in order to understand natural events. It can explain natural events mathematically and relate such events to daily life (Eren and Gurdal, as cited in Hursen and Asiksoy, 2015). Physics as a science subject at the secondary school level is an important subject that is required for the scientific and technological development of any nation. Okoronka (2004) asserted that Physics is a vehicle for achieving the long-term goals of science because it is instrumental to technological and socio-economic growth around the globe.

Among the science subjects studied in senior secondary schools, physics is said to be the most difficult, because most of the notions are abstract (Okoronka, 2004). This is so because physics equally uses mathematics to express its ideas and simply knowing definitions alone is not enough to learn the subject.

Enemali (1994) and Okorieas cited in Okoronka and Wada (2014) stated that problems occurring in physics education among others are as a result of selection of inappropriate instructional strategies by the teachers. Agommuoh and Nzewi (2003) buttressing this point, further stated that the deterioration in students' achievement in Physics can be attributed to ineffective method of teaching the subject. This implies that the continuous use of traditional teaching method to teach physics concepts does not lead to conceptual understanding of the subject. Success in teaching generally depends to a large extent on the appropriate selection and application of a teaching strategy for each subject matter (Okoronka and Wada, 2014).

According to Guvercin (2010), in order to manage effective learning in Physics, there should be learning environment where the level of the students' prior knowledge is known, real life events are discussed, students are both mentally and physically ready and cognitive change is provided. The author further opined that the learning environments should provide opportunities to students to consolidate the recently learned notion. This leads to active learning, through which students become active participants in the learning process which is an important means for developing students' skills. In the process of learning, students move from being passive recipients of knowledge to being active participants in activities that encompass analysis, synthesis and evaluation besides developing skills, values and attitudes (Orhan, 2008). Visualinstructionsuchas simulationis an aspect of active learningand can be used to solve many problems in theteaching and learning of physics. Such problems include the abstract nature and the atomistic or microscopic content in physics among others which creates abstraction and lack of understanding for learners. This can be done most effectively by using computers and educational technologies.

Simulation related education can be used in Physics lesson to make a relationship between recently learned notions and previously learned ones by engaging the eyes, ears, and the minds of the students. Simulation has emerged as one of the most popular instructional tools for delivering quality instruction. Simulation according to Bastable (2008) is an artificial or hypothetical experience that engages the learner in an activity reflecting real-life conditions without the exposure to risk. Simulation exercises can take place in the classroom or through a computer assisted environment. Simulation may be performed through solving a set of equations (mathematical model), constructing a physical model, staged rehearsal, and computer graphics model (such as animated flowchart).

This study concentrates on computer simulation method of teaching physics and its effect on learners using computer-based simulation module. It is possible to make simulations using different programs on computers in order to explain events and experiments in accordance with rules. Computer Simulation makes an abstract notion concrete and learning interactive (Rotimi, Agbeji and Akeju, 2012). Computer simulations empower students, provide unique instructional capabilities, and develop cognitive, manipulative, investigative, and communicative skills (Zacharias and Anderson, 2003). The Computer-Based Simulation Module (CBSM) used in this study was developed by a group of experts in Physics Education Technology (PhET) (Adams *et al.,* 2008). This simulation software was used to

determine the students learning outcomes in physicswhen used in teaching Ohm's law and the concept of electric circuit.

Several studies have been conducted to determine the effects of computer assisted instruction on learning outcomes. For instance, Basaraba (2012), and Akaagit and Tekin (2011) in their studies found that computer assisted instruction enhanced learners' conceptual understanding, interaction, and influenced their performance. These results seem to contradict the results of other researchers (Steinberg, 2000; Kelly, Bradley, and Gratch, 2008) who found no significant difference in students' performance when exposed to computer assisted learning. Such discrepancies underline the need for further studies on the use of computers especially in the physics classroom, hence the need for this study.

Available research reports also seem to suggest conflicting reports on the effect of gender on learning outcomes in science. For instance, Peter and Ndonga (2014); Ogunleye (2002); Katcha, and Wushishi (2015) found no significant difference between male and female students' achievement in science subjects. On the other hand, Wambugu and Wachanga, (2009); Gitonga and Robert (2014) found that male students outperformed their female counterparts in science subjects. These conflicting reports call for further research on the role of gender in achievement in science subjects. It is against this background that this study sought to determine the effect of computer simulation teaching strategy on senior secondary school students' achievement in physics and also examine the influence of gender on students' achievement when exposed to computer assisted instruction.

The study is aimed at establishing that computer simulation instructional strategy is an effective tool in the teaching- learning of Physics capable of not only actively engaging the learner but also revealing hidden details as a way to remove abstraction in the learning of physics concepts. The study was therefore designed to determine the effect of computer simulation teaching strategy on students' achievement in physics using a Computer Based Simulation Module (CBSM) in enhancing the understanding of Ohm's law and electric circuitthrough the following specific objectives:(i) determine the pretest mean scores of students in the control and experimental groups; (ii) determine the difference in the mean achievement scores of students taught using CBSM and those taught using Traditional Teaching Methods (TTM); (iii) examine if there is gender difference in students' achievement in Physics when exposed to CBSM.

1.1 Research Hypotheses

The following null hypotheses are stated and tested at the significance level of 0.05:

$H_{01:}$ There is no significant difference in the pretest mean scores of students in the experimental and control groups.

$H_{02:}$ There is no significant difference in the mean achievement scores of students taught using CBSM and those taught using TTM.

$H_{03:}$ There is no significant difference between male and female students'mean achievement scores in the experimental group

1.2 Methodology and Instrumentation

The research adopted the pre-test, post-test, non-randomized, control group, quasi-experimental, research design. This design made use of a 2 x 2 matrix design for the matching of the variables. These involved teaching methods manipulated at two levels as well as gender categorized at two levels. The research design is conceptualized as shown below:

Control Group 0_1 X_1 0_2
Experimental Group 0_3 X_2 0_4

Where 0_1 and 0_3 is pre-test; 0_2, 0_4, is posttest and X_1 is the traditional teaching method (TTM) and X_2 is the treatment where students were taught using CBS module.

The population of the study consists of private senior secondary school (II) students offering physics in Girei Local Government of Adamawa State. Private schools were chosen because of their greater use of computers for teaching-learning purposes compared with public schools in the area of study. SS II was chosen because the topic Ohm's law and electric current is taught at this level. The researcher visited the schoolsin the study area to ascertain that they had computer laboratories and were suitable for the research. Based on this criterion, purposive sampling technique was used to select two private schools as the sample of the study out of the entire nine private senior secondary schools in the area which served as the sampling frame. Two intact classes selected from two out of the nine schools were selected for the study. The schools used are Zamaki Academy and First Ghana experimental schools. Each school formed a treatment group to avoid contamination among the subjects. The number of students in each group is as follows:

Group 1 (control group) N = 32
Group 2 (experimental group) N = 30

The sample size was made up of 62 SS II students in two intact classes of the selected schools whose ages ranged between 16 and 19 years. Fraenkel and Wallen (2000) recommend at least 30 students per group. Hence, this number was considered adequate for the study.

Physics Achievement Test (PAT) constructed by the researchers was used to collect data. This was a 20-item instrument meant to assess students' academic achievement and their understanding of the concept of voltage, current and resistance. The initial 25-item instrument was given to two experts in physics and physics education in Modibbo Adama University of Technology, Yola, for face and content validation. The comments and observations of these experts were used to produce the final drafts of the instrument containing 20-items.

PAT was pilot tested in a different senior secondary school that was not part of the study. The school is a co-educational school and has the same characteristics as the sampled schools. The school used for the pilot study was Concordia College, Yola. Kuder Richardson (KR-21) formula was used to obtain a reliability index of 0.77 which implied that the instrument was reliable.

Procedure

Before treatment, pre-test was administered to both groups to determine the entry level of the subjects. This was necessary to determine if the students were homogenous in nature. The treatment took a week involving: training the research assistants, field testing, administering the instrument, and pre-post testing. All the groups were taught the same content of Ohms'law and electric current by the researcher. The experimental group was taught using CBSM in the school's computer laboratory while the control group was taught using TTM in the classroom. The programmed simulated modules that were used in this study were used to imitate the mathematical formulas of Ohm's law and the features of electric circuit such as wires, battery, current flow, and electrons on a computer system. Students were allowed to manipulate variables such as voltage, current, and resistance and immediately see the resultsand also construct series and parallel circuits using the programmed software. The changing of variables was made through typing figures through the keyboard. This program required subjects to recordthe measured data, and the calculatedresults as produced by the software, and answer a series of thought-provoking questions. The learners in the control group did manipulation and calculation on the whiteboard and results were also recorded. At the end of the training, post-test was administered to measure the students' achievement. The pre-tests and post-tests were scored to obtain quantitative data. Each correctly answered question was scored one mark while incorrect answers attracted zero mark. The maximum score obtainable was 20.

Results and Discussion

The independent sample t-test was used to check the students' level of homogeneity while the one-way Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. This was undertaken using Statistical Package for the Social Sciences (SPSS) for Windows Version 21. The pretest served as the covariate while the posttest served as the dependent variable.

The result presented in Table 1 shows the students' pretest mean scores in the experimental and control groups. The result revealed that there was not a significant difference ($t = 0.42$, $df = 60$, $p > 0.05$)in the pre-test mean scores of students in the experimental ($\overline{X}$= 7.23, SD = 2.635) and control group ($\overline{X}$ = 7.50, SD = 2.36). This result indicates that the groups were homogeneous and thus suitable for the study.

From the result presented in Table 2, there was a significant difference [$F = 11.14$; $df = (1, 61)$; $p< 0.05$] in the mean achievement scores of students taught using CBSM and those taught using TTM. The null hypothesis of no significant effect was therefore rejected. This means that CBSM was more effective than TTM.

From the result presented in Table 3, there was not a significant difference [$F = 1.73$; $df = (1, 29)$; $p > 0.05$] in the mean achievement scores of male and female students when exposed to CBSM. The null hypothesis of no significant effect was therefore retained. This means that male and female students' academic performances when exposed to CBSM were statistically equal.

Table 1: t-test Analysis of Students Pretest Mean Scores in the Experimental and Control Groups

Group	N	Pretest $\bar{X}$	SD	t	df	p-value
Experimental	30	7.23	2.635	0.421	60	0.676
Control	32	7.50	2.356			

*Significant at $P \leq 0.05$

Table 2: ANCOVA Summary of Effects of Treatment on Students' Achievement in Physics

Dependent Variable: posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	157.544[a]	2	78.772	25.654	.000	.465
Intercept	328.701	1	328.701	107.048	.000	.645
Pretest	130.103	1	130.103	42.371	.000	.418
Strategies	34.213	1	34.213	11.142	.001*	.159
Error	181.166	59	3.071			
Total	8700.000	62				
Corrected Total	338.710	61				

a. R Squared = .465 (Adjusted R Squared = .447)* Significant at $P \leq 0.05$

Table 3: ANCOVA Summary of Effects of Gender on Students Achievement

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	78.083[a]	2	39.042	9.708	.001	.418
Intercept	227.177	1	227.177	56.489	.000	.677
Pretest	57.435	1	57.435	14.282	.001	.346
Gender	6.969	1	6.969	1.733	.199	.060
Error	108.583	27	4.022			
Total	4750.000	30				
Corrected Total	186.667	29				

a. R Squared = .418 (Adjusted R Squared = .375)

Discussion

The results of the study showed that there was a significant difference between the performance of physics students exposed to CBSM and those exposed to TTM in favor of those exposed to CBSM. This finding is in agreement with earlier findings by Akaagit and Tekin (2011); Basaraba (2012) who individually found that computer assisted instruction enhanced learners' conceptual understanding, interaction, and influenced their performance. Exposing students to computer assisted instruction leads to activity-based lesson in which individuals actively participate and interact with each other thereby resulting in knowledge construction and acquisition of science process skills. In addition, the computer provided mental models/ scaffolds that helped to create understanding in the learner thereby leading to improved performance. The result of the study disagrees with the findings of Steinberg (2000) and Kelly, Bradley and Gratch (2008) who individually found no significant difference on students' performance when exposed to simulated assisted instruction.

The result of the study also showed no significant difference in the mean scores of male and female students in the experimental group. This finding is in agreement with Peter and Ndonga (2014) and Katcha and Wushishi (2015) who found no significant difference in students' performance when exposed to computer assisted instruction. The result of no significant effect implies that the gender disparity in senior secondary school students' achievement already documented in literature can be bridged by computer assisted instruction. However, the finding is in disagreement with Wambugu and Wachanga, (2009); Gitonga and Robert (2014) who reported a significant effect of gender on learning outcomes in science subjectswhen exposed to computer assisted instruction.

Conclusion

Based on the findings of this study, it was concluded that students who were taught the topics Ohm's law and electric circuit using Computer Based Simulation Module performed better than their counterparts who were taught the same topics using Traditional Teaching Method. Thus, CBSM was considered as the better teaching strategy.

Recommendations

In the light of the findings, it was recommended that:

1. Computer simulation teaching strategy should be introduced in teacher education programs and also made a requirement for practicing teachers in Physics education.
2. Computer simulation teaching strategy should be incorporated in the teaching of physics for conceptual understanding at the senior secondary school level.
3. The school proprietors should equip their schools with computer and active boards to ensure easier access of the facility. This would enable proper and easy implementation of the strategy by physics teachers

References

Adams, W. K., Reid, S., LeMaster, R., McKagan, S. B., Perkins, K. K., Dubson, M., andWieman, C. E. (2008). A Study of Educational Simulations Part 1- Engagement and Learning. *Journal of Interactive Learning Research,* 19(3), 397-419.

Agommuoh P. C., andNzewi, U. M. (2003). Effects of videotaped instruction on secondary school students' achievement in Physics. *Journal of the Science Teachers Association of Nigeri*a 38, 1 and 2: 88-93.

Akkagit, S. F. andTekin, A. (2012). Effects of simulation based learning on success in basic electronic and assessment courses of secondary school students. *Journal of Education*, 2(13), 1-121

Basaraba, K. R. (2012). *What are the effects of computer simulations on students' conceptual understanding of Newtonian mechanics?* Unpublished Master's Thesis, Montana State University.

Bastable, S. B. (2008). *Nurse as educator* (3 ed.). Sudbury, Massachusetts: Jones and Bartlett.

Enemali, J. D. (1994). A study of mechanisms for improving effectiveness in managing of Technical Colleges in Northern State of Nigeria: *Spectrum Journal*, 1 (2), 12-28.

Frankel, J. R., andWallen, N. E. (2000). *How to design and evaluate research in education.*NewYork: McGraw- Hill Inc.

Gitonga, H. M. and Robert, K. (2014). Effects of computer interaction in learning strategy on students' achievements in secondary School mathematics in Murang'acounty, Kahuro Sub- County, Kenya. *International Journal of Scientific Engineering and Research.* 2347-3878, Impact Factor (2014): 3.05

Guvercin, Z. (2010). *The effect of simulation based software on students' academic achievement, attitudes and retention in Physics lesson* Unpublished Master's Thesis, Cukurova University, Institute of Social Sciences, Adana.

Hursen, C. andAsiksoy, G. (2015). The effect of simulation methods in teaching physics on students' academic success. *World Journal on Education Technology*, 7, 87-89.

Katcha, M. A. andWushishi, D. I. (2015). Effects of laboratory equipment on secondary school students' performance and attitude change to biology learning in federal capital territory, Abuja, Nigeria. *Journal of Education Research and Behavioral Sciences*, 4(9), 250-256.

Kelly, J., Bradley, C. andGratch, J. (2008). Science Simulations: Do They Make a Difference in Student Achievement and Attitude in the Physics Laboratory?

Ogunleye, B. O., (2002). Optimal Utilization and Management of Resources for the Effective Teaching and Learning of Physics in Schools. Proceedings of the 41st Annual Conference of the Science Teachers' Association of Nigeria, (STAN'00), University of Lagos, Nigeria, 215-220.

Okoronka, A. U. and Wada, B. Z. (2014). Effects of analogy instructional strategy, cognitive style and gender on senior secondary school students' achievement in some physics concepts in Mubi Metropolis, Nigeria. *American Journal of Educational Research*, 2(9), 788-792.

Okoronka, A. U. (2004). *Model based instructional strategies as determinants of students learning outcomes in secondary Physics in Lagos State*. An unpublished Ph.D Thesis. University of Ibadan, Nigeria.

Orhan, K. (2008). *Active learning strategies in physics teaching.* Energy Education Science and Technology Part B: *Social and Educational Studies* 1(1) 27-50

Peter, K. R. andNdonga, M. (2014). Effects of computer based mastery learning on secondary school students' motivation to learn biology by gender. *Journal of Education and Practice,* .5(33)

Rotimi, C. O., Agbeji, O., andAkeju, S. (2012). A new kind of visual model instructional strategy in physics. *Eurasian Journal of Physics and Chemistry Education*, 28-32.

Steinberg, R. N. (2000). Computers in teaching science: To simulate or not to simulate? *American Journal of Physics,* 68(7), 37-41.

Wambugu, P. W. and S. W. Wachanga (2009). Investigations of students' motivation towards learning secondary school physics through mastery learning approach. *International Journal of Science and Mathematics Education*, 4(3), 293–302.

Zacharia, Z. and Anderson, O. R. (2003). The effects of an interactive computer-based simulation prior to performing a laboratory inquiry-based experiment on students' conceptual understanding of physics. American Journal of Physics, 71(6). 618- 629.