British Journal of Education
Vol.9, Issue 3, pp.1-8, 2021
Online ISSN: 2054-636X
Print ISSN: 2054-6351

THE EFFECT OF INNOVATIVE COMPUTER SIMULATION INSTRUCTION ON STUDENTS' ACADEMIC PERFORMANCE IN ABSTRACT CONCEPTS IN SCIENCE

Lasisi A. R.[1*], E. Oti[2], J. G. Arowolo[3], P. Agbeyenku[3] and A. N. Ojoko[3].
1: Department of Physics, Federal College of Education, Kontagora, Nigeria.
2: Department of Biology, Federal College of Education, Kontagora, Nigeria.
3: Department of Integrated Science, Federal College of Education, Kontagora, Nigeria.
***: Corresponding Author:** lasisiar@yahoo.com (+234 8058228941)

ABSTRACT: *This study investigated the effect of innovative computer simulated instruction on students' academic performance in abstract concepts in science. The study adopted quasi-experimental research with pre-test and post-test before and after the treatment respectively. A total of 155 students participated in the study. The experimental group were taught using innovative computer simulated instructional mode while the control group were taught using conventional lecture method. An instrument named Science Concepts Achievement Test (SCAT) was employed to generate data. The data obtained were analysed using descriptive and inferential statistics to answer the research questions and test the hypotheses respectively. The study reveals that, simulation enhanced students learning of abstract concepts than the use of conventional lecture method. Results also revealed that, gender did not influence students' academic performance in abstract science concepts significantly when taught with computer simulation. The study therefore recommend based on the finding of this study that, Science teachers should integrate innovative simulation into their instructional modes especially when teaching abstract concepts. There should be in-service training for science teachers on development and how to access appropriate computer simulations for their lessons. The stereotype superiority of male in learning science should be discarded and both sexes should be equally encourage to learn Science.*

KEY WORDS: computer simulation, innovative instruction, academic performance and abstract concepts in science.

INTRODUCTION

Innovation in education is not just about technology but how to use technology to empower students to become lifelong learners and agents of change. Innovations become imperative in designing approaches that would help meet the needs of the contemporary and ever evolving society. Such innovation include the design and use of simulations in impacting knowledge to students. Simulation of a system is the operation of a model in terms of time or space. Technology is becoming increasingly important in today's classroom and has been integrated in a variety of ways. However, interactive computer simulations are among the most commonly used software in education, especially in the discipline of Physics (Adams et al., 2008).

A computer simulation is a computer programme that creates animated, interactive, game- like environments, which focuses on connecting real-life phenomena to the underlying science. Within this process, it makes the visual and conceptual models of experts and scientists simple,

so that they can be understood by learners (Adams et al., 2008). In 2000, Hartel conducted a study about a simulation program called "xyZET" for Physics teaching. In his study, Hartel believed that simulations could be considered as basic tools to enhance understanding of Physics. Although computer simulations are virtual, they give students the opportunity to observe and study physical, chemical or biological phenomena in a situation where it is impossible to carry out research, due to time restrictions, safety requirements or lack of proper equipment. They also reduce the gap between the real and theoretical worlds (Kozielska & Kedzierski, 2007).

In order to fully realize the goals of education in Nigeria and gain from its contributions to the national economy, the Nigeria government in her National Policy on Education emphasized necessary measure to be taken to ensure that teaching is made practical, activity-based, Information and communication Technology (ICT) supported and experimental. (FME, 2004). It is in the light of this, that there is a need to develop simulations for effective teaching of abstract concepts in sciences in the senior secondary school; bearing in mind that to build a technologically developed nation, the foundation of science education begins in the secondary schools. It is in consolidating such mind-set, that science teaching should inculcate the use of simulations that will enhance better conceptualization of abstract concepts in science.

Scientific concepts can be described as systematic mental representations of the natural world, they have a central place and role in science. In contrast, ambiguity is possible because of features that are inherent in the concepts themselves. While the 'being' of an abstract concept emerges out of the logical 'relations' between other concepts, Mathematical objects are usually considered to be abstract concepts. An abstract concept is an idea that people can pictured as possessing physical form. The ability to identify, understand and communicate abstract concepts is a fundamental element of human intelligence. It is a mistake to think that all abstract concepts are not real as they can be documented with evidence. Foundational concepts of science such as time, events and causation, likewise, elements of the scientific methods such as hypothesis, experiments or control are abstract concepts. Increasing academic proficiency in Science, Technology, Engineering and Mathematics (STEM) fields is not only a goal of educators in these disciplines but also a national priority spurred on by international comparisons.

With the experiencing imbalances in the present standard of education especially in the science subjects, there is a need to put all hands on deck to rescue the situation. Among such effort could be the designing of simulations to enable science teachers effectively teach abstract concepts that students find difficult to comprehend. This research therefore correlated senior secondary school students' academic performance in some abstract concepts when taught with simulations that have been developed to teach such abstract concepts.

Research Questions

1. What is the effect of integrating computer simulations in to teaching on learning of abstract concepts in science?
2. Does students' gender have effect on their academic performance when taught with computer simulation?

Research Hypotheses

HO_1 There is no significant difference in the use of simulations in enhancing learning of abstract concepts in science.

HO_2 There is no significant difference between the academic performance of the male and female students taught with computer simulations instruction.

RESEARCH METHODOLOGY

The study adopted a quasi-experimental design for the entire operation of data development. The research population targeted for the study comprised all students offering science in senior secondary schools in the North Central Zone of Nigeria. The population of public and private senior secondary school students offering science was estimated at 207,150 (state ministry of education, 2018).

The sample for the study captured only students from the selected secondary schools. Systemic sampling method was adopted to streamline the selection of the states in the zone to two (2). In each state, two (2) local government councils were purposefully selected, one each from the urban and rural localities respectively. Similarly, one (1) school was selected from each of the local government council as categorized respectively. In each school selected an intact science class of senior secondary school 1 (SSS1) was selected and assigned purposefully into the experimental and control groups (i.e. for experimental group, there were one urban and one rural school, while the same applied to the control group). In all, a sample of 155 students participated, with the experimental group consisting of 76 and the control group with 79 students. The average age of the students is 16 years.

A package on simulation was developed for teaching abstract concepts selected from biology (osmosis and diffusion), chemistry (mole concept) and physics (vibrations) in the experimental group. The control group was taught the same concepts but with the conventional lecture method. The researchers engaged the teachers in the schools assigned to the experimental group in the applicability of the simulation packages after which the teachers carried out a micro teaching while the Researchers assessed their proficiency in the use of the packages.

An instrument was drafted for data generation in the study, this is Science Concepts Achievement Test (SCAT). It consists of twenty (20) four options (A-D) objective items. The drafted instruments were presented to three science educators along with the packages for their face and content validity. Their remarks provided remarkable guide for the refinement of the instrument. This was later trier tested on a sample from a school in a local government council that was not involved among those selected for the study. The data collected from the pilot test of the SCAT was analysed by computing its Richard Kuderson 21 which yielded 0.712 reliability coefficient. This assured the confidence of use of the instrument.

A pre-test was administered on both groups using the instrument before the commencement of the treatment to ascertain the level of equivalence of the groups. After contact with both groups for duration of eight (8) weeks, post-test was administered to the two groups using the same instrument in a scramble form which was graded to obtain raw data that was subjected to statistical analysis to determine if the development and use of simulation has an effect in

helping students understand abstract concepts better. The statistical tools employed to analyse the relevant data gathered in the course of this study were purely qualitative and quantitative. The qualitative statistics include the computations of means and percentages for answering the research questions, while the quantitative statistics involved the use of t-test to test the hypotheses.

RESULTS

Bio-data/demographic data

Table 1: Sample for treatment, respondents and sex

Variable	**No**	**%**
Treatment:		
Simulation	76	49.03
Control	79	50.97
Sex: (students)		
Male:		
Experimental	40	25.80
control	38	24.52
Female :		
Experimental	36	23.23
Control	41	26.45

Answering the Research Questions

Research Question 1: What is the effect of simulations at enhancing learning of abstract concepts in science?

Table 2: Mean test scores of students according to treatment

Treatment	**Number (N)**	**Mean ($\overline{x}$)**		**Std. Dev. (σ)**	**Mean gain score**
		Pre-test	**Post-test**		
Simulation	76	8.50	14.42	2.874	5.92
Control	79	9.29	11.05	3.250	2.21

The result on table 2 confirmed that the post-test mean score of sample exposed to simulation was 14.42 with a standard deviation of 2.874 and mean gain score of 5.92 while those in the control group was 11.05 with a standard deviation of 3.250 and mean gain score of 2.21. This shows that simulation did enhance students learning of abstract concepts in science than the conventional lecture method.

Research Question 2: Does students' gender have effect on their academic performance when taught with computer simulation?

Table 3: Post-test mean scores according to gender.

Sex	**Number (N)**	**Mean** $(\overline{x})$	**Std. Dev.** (σ)	**Diff. btw. the means**
Male	40	11.90	3.081	0.36
Female	36	12.26	3.732	

Table 3 reveals that post-test mean score of male is 11.90 with standard deviation of 3.08 while that of female is 12.26 with standard deviation of 3.732 and the absolute difference between the male and female post-test mean scores is 0.36. This implies that, gender does not have effect on students' academic performance of students taught using computer simulation.

Research Hypotheses

HO₁: There is no significant difference in the use of simulations in enhancing learning of abstract concepts in science.

Table 4: t-test of students' post-test scores according to treatment groups

Treatment	**Number (N)**	**Mean** $(\overline{x})$	**Std. Dev.** (σ)	**df.**	**t**	**Sig (2-tailed)**
Simulation	76	14.42	2.874			
Control	79	11.05	3.250	153	3.858	.000

Significant at $p < 0.05$

The result on table 4 reveals that there was a significant difference in the learning mean score of students exposed to simulation ($\bar{x}$ = 14.42) and control (11.05). t (153) = 3.858 at p<0.05. The hypothesis which states that, no significant difference in the use of simulation in enhancing learning of abstract concepts in science was therefore rejected. This revealed that those in simulations had a higher mean score over those of control. Thus, the integration of innovative computer simulation into instructional mode has significant impact on students' academic performance in abstract concepts in science.

HO₂: There is no significant difference between the academic performance of the male and female students taught with computer simulations instruction.

Table 5: t-test of students post test scores based on gender.

Sex	**Number (N)**	**Mean** $(\overline{x})$	**Std. Dev.** (σ)	**df.**	**t**	**Sig (2-tailed)**
Male	40	11.90	3.081			
Female	36	12.26	3.732	74	.375	709

No significant at $p < 0.05$

The result on table 5 shows that there was no significant different in the mean scores of male ($\bar{x}$ =11.90) and female ($\bar{x}$ = 12.26) students taught abstract concepts using simulations, t (74) = 0.375 at p<0.05. The hypothesis of no significant difference was in this case not rejected. This implies that there is no significant difference in the use of simulations in enhancing learning abstract concepts in science between male and female students. Thus, no gender influence on academic performance of students taught using computer simulation.

DISCUSSION OF RESULTS

From the answers to the research questions put forward, it was found out that simulation enhanced students learning of abstract concepts than the use of conventional lecture method. Analysis of the data to test hypothesis one shows that there is a significant difference in the use of simulation in enhancing learning of abstract concepts in science. This could be as a result of the fact that students were able to relate the simulations to the abstract concepts to create a better conceptualization of the concepts. These findings appeared to be consistent with those of Kotoka and Kriek (2014) that students taught electromagnetism using computer simulation performed better than those taught with lecture method. Also Sentongo et al. (2013) findings are aligned with the findings of the present study. They found that learners exposed with computer simulations performed better than those taught without computer simulations. Findings of Ezeudu and Okeke (2013) also confirmed the results of the present study. They found that simulations increase students' achievement in chemistry more than the lecture method. Also this finding agreed with that of Bello, Ibi & Ibrahim (2016) that discovered that student taught with simulation games technique had a significant positive impact on students' academic performance. Earlier studies by Adoke (2015) and Dauda (2015) on the effect of simulation games technique on students' academic performance also found that simulation games technique was more effective in comparison to other teaching techniques of teaching especially the teacher-centre approaches. This study also corroborated work done by Junghee, Jin and Sujin (2016), Devasagayam and Hyat (2007), Foster et al. (2006) and Helliar et al. (2000) whose works found a positive between simulation and academic performance. This study is also in agreement with the findings of Moffit, Stull and McKinney (2010) and Olorukooba, Sanda and Suleiman (2016) that reported that students taught with computer simulation performed better than those taught using lecture method. This work is at variance with that of Steven and Mark (2011) study on "The Influence of Simulation Performance on Student Interest" which found out that simulation performance has no significant influence on the students' feelings about their knowledge attainment or their level of interest in the discipline. In similar vein, the result of this study is also in variance with the work of Lasisi, Daniel & Abdulazeez (2010) that found out that, the students that learn Physics practical through conventional method acquire better practical skills than their counterpart that learn through simulation. This observe variance may be because the two studies measured different domain of Bloom's taxonomy of education objectives while this study focus on cognitive domain the above studies focuses on affective and psychomotor domain respectively. Thus, it could be stated that, integration of computer simulation into teaching strategies is good in enhancing students' academic performance.

Results also showed that there is no significant difference in the use of simulation in enhancing learning abstract concepts in science between male and female students. The finding of this study reveals that the mean achievement scores of male and female students taught abstract concepts in science using simulation were at the same achievement level. More so, the finding indicates that gender did not influence students' achievement in science significantly. These findings were in agreement with the findings of Ezeudu & Okeke (2013); Egara (2010); Udousoro (2011) that there is no significant difference in academic achievement of students in chemistry due to gender. Contrary to the present findings was the report of Uwaleke (2013); Offiah & Egolum (2007). Among the results of Uwaleke's study was that female students perform better than male students in science while Offiah & Egolum study revealed a significant gender difference on students' achievement in favour of males. The difference in their performance can be attributed to gender stereotyping which encourage male and female

students to show interest in subjects relevant and related to the roles expected of them in the society. Our findings suggest that the students perceived their basic psychological needs to be met and that the use of simulation can potentially enhance self-determined motivation as well as improve learning in general. This finding is in line with previous research of Ozel (2008), Pektas (2008) and Azar and Sengulec (2010).This may be due to the effect of simulation package used in teaching science that motivates students and gets them to take an active part in the learning process.

CONCLUSION AND RECOMMENDATIONS

In a bid to develop simulation as an innovation in teaching and learning of abstract concepts in science in senior secondary school students, questions were asked and hypotheses were tested. It was found out that using simulations improved academic performance of students, when they were taught abstract concepts in science with innovative computer simulation. The study therefore recommend as follows based on the outcomes of this study. Science teachers in secondary schools should integrate innovative simulation into their teaching strategies. There should be workshop for secondary schools science teachers on how to access, design and develop innovative computer simulations on abstract science concepts. The stereotype male superiority in leaning science should be discarded and equal opportunity should be given to both sexes in chosen science subjects in secondary schools.

REFERENCES

Adams, W. K., Reid, S., LeMaster, R., McKagan, S. B., Perkins, K. K., Dubson, M., & Wieman, C. E. (2008). A study of educational simulations part 1 - engagement and learning. *Journal of Interactive Learning Research, 19*, 3, 397-419.

Adoke, I.M. (2015). Effect of simulation games teaching strategy on academic performance of upper basic level students in civic education in Kaduna state: unpublished M.ed thesis, ABU, Zaria.

Azar, A. & Sengulec, O. A. (2010). Computer assisted and laboratory assisted teaching method in physics; the effect on students' physics achievement and attitude towards physics. *Eurasian J. Phys. Chem. Educ., (Jan Special Issue)* 43 – 50.

Bello, S, Ibi, M. B. & Bukar, I. B. (2016). Effect of Simulation Techniques and Lecture method on Students' academic performance in Marfony Day Secondary School, Maiduguri, Borno State, Nigeria. *Journal of Education and practice.* 7, 23, 113-117.

Dauda, A.D. (2015). Effect of inquiry and simulation games techniques on academic performance of JSS students in kaduna state, Nigeria: unpublished M. ed. Thesis, ABU Zaria

Devasagayam, R., & Hyat, S. (2007). Pedagogical value of computer-based simulations: A cross disciplinary study. *International Journal of Business Research,* 7, 5, 89-95.

Egara, O.F. (2010). Effect of computer simulation on achievement and interest of students in algebra at junior secondary school level. Unpublished Master's Thesis. University of Nigeria, Nsukka.

Ezeudu, F.O. and P.E. Okeke (2013). Effect of simulation on students' achievement in senior secondary school chemistry in Enugu East local government area of Enugu State. *Journal of Education and Practice.* 4, 19, 84 – 89.

Federal Ministry of Education (2004) *National Policy on Education, Revised Edition.* NERDC Press, Yaba-Lagos, Nigeria.

Foster, F.D., Gregor, S., Heaney, R., Northcutt, W., O'Neill, T., Richardson, A., Welch, E., & Wood, R. (2006). Impact of computer based share market simulations on learning: A link between self-efficacy and understanding. *Journal of College Teaching and Learning,* 3, 2, 4560-4572.

Hartel, H. (2000). xyZET: A Simulation Program for Physics Teaching. *Journal of Science Education and Technology, 9* , 3, 275- 285.

Helliar, C.V., Michaelson, R., Power, D. M., & Sinclair, C. D. (2000). Using a portfolio management game (Finesse) to teach finance. *Accounting Education,* 9, 1, 37-51

Junghee, K., Jin-Hwa, P. and Sujin, S. (2016). Effectiveness of simulation-based nursing education depending on fidelity: a meta-analysis. *BMC Med Educ*. 16, 152.

Kotoka, J. and J. Kriek, (2014). The impact of computer simulations as interactive demonstration tools on the performance of grade 11 learners in electromagnetism. *African Journal of Research in Mathematics, Science and Technology Education,* 18, 1, 100 – 111.

Kozielska, M., & Kedzierski, R., (2007). Computer Simulation in Learning Physics as a Useful Teaching Method- A report of Research. *The New Educational Review,* 83- 94.

Lasisi, A. R., Daniel, T. A. and Abdulazeez, S. A. (2010) Effect of Computer Simulated Experiment on Senior Secondary School Students' Level of Practical Skills Acquisition in Physics. *Journal of Science, Technology and Mathematics Education (JOSTMED)* 7, 1, 146-150.

Moffit, T., Stull, C., & McKinney, H. (2010). Learning through equity trading simulation. *American Journal of Business Education,* 3, 2.

Offiah, F. C. & Egulum, E. O. (2007). Effect of prior Knowledge of some relevant Mathematical Concepts on students' achievement stoichiometry. *Journal of Science, Engineering and Technology.* 14, 3, 7676-7685.

Olorukooba, Sanda & Suleiman (2016) The Impact of Computer Simulations on Performance and Retention of Students in Qualitative Analysis at Senior Secondary Schools in Zaria, Kaduna state. *ATBU Journal of Science Technology and Education,* 4, 2, 167-179

Ozel, S. (2008). Effects of computer supported education materials' on students' attitudes and success. Unpublished Master's Thesis University of Gazi, Ankara, Turkey.

Pektas, M. (2008). The effect of the constructivist approach and computer-assisted instruction on students' achievement and attitude in Biology. Unpublished Doctoral Dissertation University of Gazi, Ankara, Turkey.

Sentongo, J., R. Kyakulaga and I. Kibirige, (2013). The effect of using computer simulations in teaching chemical bonding: Experiences with Ugandan learners. *International Journal of Education Science,* 5, 4, 433 – 444.

Steven D. D. and Mark K. P. (2011). The Influence of Simulation Performance on Student Interest. *Journal of Economics and Economic Education Research,* 12, 3, 35 - 48

Udousoro, U.J. (2011). The effects of gender and mathematics ability on academic performance of students in chemistry. *An International Multidisciplinary Journal, Ethiopia,* 5, 4, 201 – 210

Uwaleke, C.C. (2013). Analytical skill as a correlate of chemistry achievement among senior secondary school students in Anambra State. Unpublished Master's Thesis, Nnamdi Azikiwe University, Awka, Nigeria.