Effects of Computer Simulation Package on Academic Performance of Senior Secondary School Students in Some Science Concepts in Ekiti State, Nigeria

Ese Monica Alake[1*] and Jethro Oludare Olojo[2]

[1]*Department of Science Education, Bamidele Olumilua University of Education, Science and Technology, Ikere-Ekiti, Nigeria.*
[2]*Department of Computer Science, Bamidele Olumilua University of Education, Science and Technology, Ikere-Ekiti, Nigeria.*

Authors' contributions

This work was carried out in collaboration between both authors. Author EMA designed the study, wrote the protocol, wrote the literature searches and wrote the first draft. Author JOO performed the statistical analysis. Both authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Use of computer simulated games among children/students is common and science students are not left out. Whereas poor performance and dwindling enrolment in science subjects have been observed among students in Nigeria, not much evidence has emerged at solving the problems from computer simulation mode of teaching. This study was designed to determine the effects of computer simulation package (CSP) on academic performance of senior secondary school students on the concepts of pollution and energy. Using multi-stage purposive and simple random sampling technique, six hundred (600) Senior Secondary (SS) class two students were selected from twelve co-educational schools consisting of four (4) schools in each of the senatorial districts of the State and fifty (50) students participated. Three hundred (300) students each were used for

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*Corresponding author: E-mail: alake.ese@coeikere.edu.ng, ese_monica@yahoo.com;

experimental and control groups. A validated Students' Achievement Test (SAT) instrument, having 30 multiple choice items was used to generate pre-test and post-test data. Analysis of Covariance (ANCOVA) was used to test each of the hypotheses at 0.05 level of significance. Findings showed that the use of computer simulation package (CSP) has significant effect on students' academic performance (F_{-cal} 955.93, P = 0.00*< 0.05) while gender showed no significant influence on students' performance (F_{-cal} 1.03, P = 0.312 >0.05). Thus, science teachers should be trained and retrained in seminars, workshop and conferences on the use of computer simulation packages in order to encourage personalized learning among science students.

1. INTRODUCTION

Science teaching is fundamental to the technological development of any nation whether it will become developed, developing or underdeveloped. The present situation in Nigeria, in which learners' record poor academic performance in science may not be unconnected with inappropriate science teaching Aladejana, [1]. This corroborates the findings of Adegboyega & Adeoluwa [2] that below average performance of students could be attributed to the way they have been taught. Teaching in Nigeria still retains the old conservative approach of teachers acting as repertoire of knowledge and students acting as the dormant recipients that favours passive reception of knowledge Aladejana & Idowu, [3]. The approach focuses on mastery of content, with less emphasis on the development of skills. On the other hand, interactive technology encourages active learning; hence teaching should no longer center around transfer of content from teacher to students but learning through discovering.

1.1 Concept and Development of Programmed Instruction

A programme is a set of instructions for a computer to perform a specific task [4]. Instruction is a sequence of bits that tells a central processing unit to perform a particular operation and can contain data to be utilized in the operation. The term 'Software Development' refers to the activity of computer programming which is processed by writing and maintaining the source code. In a broader sense, it includes all that is involved between the conception of the desired software to the final manifestation of the software, which involves a planned and structured process [5]. There are three types of programmed instructions namely: Linear, branching and mathetics. Lee, Yem, Havelka &

Koh [6] argued that programmed instruction is an instructional strategy in which the students are presented with many small learning modules or pieces of information in a logical sequence. The modern day programmed instruction adopted Skinner (1954) six principles: These six principles are small step, active participation, success, immediate verification, logically graded and progress and individual pace. Thus, leaner programming that allow for students to learn better if content is presented in small units for the purpose of mastery content and self-directed constructive learning process was employed in this study.

Simulation is a technique that teaches concepts by imitating or replicating the real objects. Simulation makes significant instructional situation real when well designed. It provides an effective learning environment that enhances the teaching and learning of concepts. The use of simulation helps the teacher to play a more facilitating role that supports learners in a constructive learning process. Computer based instructional simulations provide a wide variety of learning experiences to the learners. It helps learners to assimilate incoming experiences into existing schemata. This means technology-oriented classroom can be used as a tool to overcome the traditional isolation of the classroom setting and improve overall productivity as confirmed by the work of Aladejana [7].

While some researchers have argued that there is no direct link between learning and the use of computer assisted instructions, the weight of evidence now clearly shows that indirectly, there can be a significant positive impact as effective instructional design can positively influence academic performance as ascertained by Alake [8], Aladejana & Idowu [9]. Okwuduba, Offiah & Madichie [10] had earlier recognized the use of computer simulation as an important feature of the educational process that makes learning

more meaningful. Similar view was expressed by Okwuduba, Offiah & Madichie [10] posited that simulation package enhances teaching and learning by providing real opportunity for individualized instruction, accelerating, enriching and deepening skills as well as engaging students actively in learning. The computer assisted learning both within the setting of developed and developing countries has shown positive effect of the use of computers to promote students' achievement as corroborated by Jongur, Mohammed & Abba [11]. They further stated that the use, guides a user through a course of instruction at a Video Display Unit in such a way as to facilitate understanding of the subject matter. The student's learning process is thereby speeded up faster than when a human teacher is available.

In Computer Aided Instruction, the computer can also provide instruction to students, ask questions (usually multiple choices) and grade students to determine through their performance whether to move forward or repeat the lesson just concluded. Asuka [12] posited that Computer Aided Instruction can be used where the class size is too large. According to Johnstone [13] the major objective of education is to bring about desirable change in the behaviour of individuals who undergo educational training. The role of computer assisted programmes and simulations include motivating students' interest, stimulating learning and independence as highlighted by Yilji & Wadaki [14], Alake [15]

Simulations are imitation of real life/objects. This may be as a result of non–availability of real objects, complexities in making use of real materials, abstract nature of the concepts, long distance and time involved in getting the materials. Where any of the instances mentioned above occurs, simulation may turn out to be a better alternative.

The use of computer simulation for classroom instructions is increasingly becoming a common phenomenon in many disciplines of the world Barnea & Don [16]. Materials and software are now available online to simulate situation which may be difficult to describe/present in a classroom situation to pupils of primary and secondary schools. In Ekiti, whereas the use of computer is being felt in the areas of administration, research, publishing, etc not much of its use is in operation in the area of teaching and learning in secondary schools.

Persistent poor performance and dwindling enrolment of students in science in the Senior School Certificate Examination is worrisome and puts one in doubt about the effectiveness of the teaching method used in the science teaching-learning process as opined by Adegboyega et al [2]. Effective and meaningful teaching of science concepts requires active students' involvement in the teaching-learning process. The inadequate and obsolete teaching and learning facilities used today militate against good performance in science Oloruntegbe & Alake [17]. This is further corroborated by the findings of Adegboyega et al. [2] that below average performance of students could be attributed to the way they have been taught. Furthermore, other problems which hinder active involvement of students include abstract nature of the concept, inability to get the real objects and complexity in making use of the real object even when available. There is therefore, the need to find substitutes for these real objects. Hence, the research work is aimed at using a developed computer simulation package in the teaching of science concepts and determining its effect on secondary school students' academic performance in science.

Thus, the general objective of the study investigated the effect of the developed computer simulation package on students' performance in Senior Secondary Schools in Ekiti State, Nigeria. Specifically, the study was designed to find out if students exposed to computer simulation package have better academic performance than their counterparts who were not. It was also meant to see if there would be profound gender influence between and within groups of students taught with simulation package and those not taught.

1.2 Research Questions

1. Is there any difference between academic performance of science students taught with the developed computer simulation package and those not taught in conventional way?
2. Is there any difference in the academic performance of male and female science students taught with developed simulation package and those not?

1.3 Research Hypotheses

Based on the above, two null hypotheses were formulated:

HO1:   There is no significant difference in the academic performance of science students taught using developed computer simulation package and their counterparts taught using conventionally method.

HO2:   There is no significant difference in the academic performance of male science students taught with developed computer simulation package and their female counterparts.

2. METHODOLOGY

The study is applied research of computer simulation package type that involves quasi-experimental of pre-test and post-test control group design. The population of the study consists of all Senior Secondary Two (SS2) science students in the 186 Government owned co-educational senior secondary schools in Ekiti State for 2014/15 academic session. SS2 students have been exposed to scientific skills and they had enough time for the experiment. The class was chosen since they were not preparing for any external examination. Also, the students were willing to express their opinions towards scientific concepts.

The sample for the study consisted of 600 senior secondary school class two (SSII) students, selected from twelve co-educational schools using multi – stage random sampling technique. At the first stage, random sampling was used to select four schools from each of the three senatorial districts while purposive random sampling technique was further used to select fifty (50) students from each of the participating schools. From each senatorial district, two schools were later randomly assigned to each of the two groups (experimental and control groups). Thus, one hundred (100) students were randomly assigned to each of the experimental and control groups in each senatorial district, i.e three hundred (300) students were each used for experimental and control groups in the research. The instructional package consisted of pictures and voice simulated and animated concepts on energy and pollution with teaching manual validated by the researchers. A thirty (30) item multiple choice test namely Students' Achievement Test (SAT) having reliability coefficient of 0.75 determined by using Alpha Cronbach was used to collect pre-test and post-test data for the study.

The data collected were analyzed using both descriptive and inferential statistics. The general questions were answered using descriptive statistics while ANCOVA was used to test the hypotheses at 0.05 level of significance.

3. RESULTS

3.1 Question 1

1. Is there any difference between academic performance of science students taught with the developed computer simulation package and those taught in the conventional way?

Table 1 shows that the experimental group pre-test has mean scores of 12.61 which was less than that of the control group with a mean score of 13.60. However, after the treatment the experimental group has a mean score of 25.87 and control group has mean score of 15.02 indicating improvement in performance in the experimental group with mean score difference of 10.85.

3.2 Question 2

Is there any difference in the academic performance of male and female science students taught with developed simulation package?

Table 2 shows that male students in experimental group have a mean score of 12.47 in pre-test and a mean score of 26.11 in post-test with a mean score difference of 13.64. While in the control group, male students have a mean score of 12.82 in pre-test and a mean score of 14.85 in post-test with a mean score difference of 2.03. This shows a wide variation in the mean scores of male students' performance between experimental group and control group. The table also shows that female students have a mean score of 12.73 in pre-test and a mean score of 25.17 in post-test with a mean score difference of 12.44 in experimental group. On the whole, the post-test mean score of the male students in experimental group 13.64 is greater than the female experimental group 12.44. This meant that mean difference between male and female students was 1.2 when exposed to simulation package.

3.3 Hypotheses Testing

Ho$_1$: There is no significant difference in the academic performance of science students taught using developed computer simulation package and their counterparts taught using conventionally method.

Table 1. Pre-test post-test mean scores of students' academic performance in science concepts taught

Variable	N	Pre-test		Post-test	
		Mean	S.D	Mean	SD
Experimental	300	12.61	3.59	25.87	3.68
Control	300	13.60	3.01	15.02	4.84

Source: Authors' Computation

Table 2. Pre-test post- test mean scores of male and female students' academic performance

	Male					Female			
	Pre-test		Post-test			Pre-test		Post-test	
	N	Mean	SD	Mean	SD	N	Mean	SD	Mean	SD
Experimental	131	12.47	3.28	26.11	3.07	169	12.73	3.83	25.17	4.10
Control	128	12.82	2.83	14.85	4.65	172	13.23	3.13	15.14	4.99

Source: Authors' Computation

Table 3. ANCOVA of students' academic performance in science concepts by treatment

Source	SS	Df	MS	F_{cal}	P
Corrected Model	17684.77	2	8842.38	478.38	0.00
Covariate (pre-test)	26.39	1	26.39	1.43	0.223
Group	17670.64	1	17670.64	955.93	0.00*
Error	11035.19	597	18.48		
Corrected Total	28719.96	599			
Total	279437.00	600			

*Key: *P < 0.05*
Source: Authors' Computation

Table 3 reveals that F_{-cal} 955.93 is significant at P = 0.00*. Hence, the null hypothesis is not retained, which implies that there is a significant difference in the mean scores of students in experimental and control groups after treatment. Hence, post-hoc analysis of multiple classifications was carried out to know where the difference existed.

Table 4 reveals that students exposed to the treatment had adjusted mean scores of 25.42 (20.44 + 4.98), The adjusted mean score of control group was equally calculated to be 15.30 i.e. (20.44 - 5.14 = 15.30). The result reveals that

students exposed to treatment (25.42) performed better than the students in control group (15.30). This implies that the treatment influenced the performance of students in science concepts. The table also shows the co-efficient of determination to be 0.00 and joint relationship of 0.22, which was very low and positive.

HO2: There is no significant difference in the academic performance of male science students taught with developed computer simulation package and their female counterparts.

Table 4. Multiple classification analysis (MCA) of students' performance in science by treatment

Variable + Category	N	Grand Mean =20.44 Unadjusted Deviation	$\sum ta$	Adjusted for Independent + Covariance	Bcta
Experimental	300	5.43	-0.05	4.98	-0.02
Control	300	-5.42		-5.14	
Multiple R^2					0.000
Multiple R					0.022

Source: Authors' Computation

Table 5. 2 x 2 ANCOVA of students' gender on academic performance in computer simulation by treatment

Source	SS	Df	MS	F_{cal}	P
Corrected Model	17705.18	4	4426.30	239.10	0.00
Covariate (pre-test)	26.44	1	26.44	1.43	0.233
Sex	1.39	1	1.39	0.08	0.784
Group	17498.53	1	17498.53	945.24	0.000
Sex Group	18.99	1	18.99	1.03	0.312
Error	11014.78	595	18.51		
Corrected Total	28719.96	599			
Total	279437.00	600			

$P< 0.05$, $F_{cal} = 1.03$
Source: Authors' Computation

From Table 5, F_{cal} 1.03, P = 0.312 > 0.05. Hence, the null hypothesis is upheld. This implies that there is no significant difference in the performance of male and female students in experimental and control groups.

4. DISCUSSION

The results of the study revealed that the pre-test mean scores of experimental group and control group were the same. But, mean scores of 12.61 which was less than that of the control group with a mean score of 13.60 was very low. However, after the treatment the experimental group has a mean score of 25.87 and control group had a mean score of 15.02 indicating improvement in performance in the experimental group with mean gain (score difference) of 10.85. This means that CSP is superior to CM in enhancing performance.

This finding corroborates those of Okwuduba, Offiah & Madichie [10] and Adegboyega & Adeoluwa [2] that showed better academic achievement when students were exposed to animated and simulation package treatment as against the control group that used conventional method.

The results in Table 4 shows that there is a significant difference in the performance mean scores of students in experimental and control groups after the treatment. This result is in line with the findings of Cheung & Kan [18], Stern & Repa [19], West & Graham [20]. Also, the result is at variance with the findings of Lowe [21]. His findings showed that there were no significant differences between the treatment (experimental group) and control group on a measure of achievement.

Table 5 revealed no significant difference in the performance of male and female students in experimental and control groups. This shows that students' gender has no profound influence on the use of the treatment (CSP) and students' academic performances in science concepts. This is in agreement with the finding of Amaechi, Chinwe & Udogu [22].

5. CONCLUSION

The study vividly showed that development and usage of computer simulation package enhanced academic performance of students in science positively because significant differences existed between the mean performance of students in experimental and control groups after the usage of computer simulation package. Gender has no significant influence on students' performance in both experimental and control groups in the learning of science concepts in Ekiti State senior secondary school class two.

6. RECOMMENDATIONS

Based on the research findings of this study, the following recommendations are made by the researchers.

- Teachers of science subjects should be encouraged to adopt and improve on their usage of computer packages in the classroom to enhance the academic performance of science students.
- Experts in computer science should be involved in the training and retraining of teachers through seminars, workshops and conferences on the usage of computer simulation instructions for better students' performance.
- Students should be provided with computer systems and accessories and constant regular supply of electricity to schools in order to encourage personalized

learning resulting in meaningful learning and better academic performance.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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