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IMPACT OF COMPUTER SIMULATION ON STUDENTS' PERFORMANCE AND RETENTION IN CHEMISTRY AMONG SECONDARY SCHOOL STUDENTS IN ZARIA METROPOLIS, KADUNA STATE, NIGERIA

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Abstract

This study investigated the impact of computer simulation on students' performance and retention in Chemistry among secondary school students in Zaria Metropolis, Kaduna State. The study was motivated by the persistent poor performance in chemistry, largely due to traditional teaching methods that limit student engagement and hinder long-term understanding. The population of the study comprised 96 SS2 chemistry students from eight public secondary school within the Zaria Metropolis of Kaduna State. The Study employed Quasi-Experimental Design, particularly the pretest, posttest, and postposttest quasi-experimental and control group design. A sample of 30 students from two randomly selected from 96 SSII students. The study involves two groups: an experimental and a control. The experimental group was taught Organic chemistry using computer simulation while the Control Group was exposed to the same concept using Conventional Method. Two instruments were used for data collection, namely, Chemistry Perfomance Test (CPT) and Chemistry Retention Test (CRT), The instruments were validated by experts and have reliability coefficients of 0.77 and 0.81 estimated using Pearson Product

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Moment Correlation (PPMC) and Cronbach's Alpha statistics respectively. Two research questions and two null hypotheses were formulated to guide the study. Research questions were answered using Mean, Standard Deviation statistics while null hypotheses were tested using Independent Sample t-test and at $p \leq 0.05$ level of significance. The result obtained revealed a significant difference between the mean scores of experimental and control groups in their academic performance, all in favour of the experimental group; Researcher concludes that the computer simulation enhanced academic performance and long-term retention of students. It is therefore recommended that Chemistry teachers should frequently employ computer simulation in teaching Chemistry.

Keywords: Computer simulation, Academic Performance, Retention and Chemistry, Secondary School students**.**

Introduction

Introduction Science education aims to develop students' understanding of the natural world through inquiry-based learning and practical engagement. Computer simulation provides interactive, visual, and engaging platforms where learners can manipulate variables, observe chemical reactions, and repeat experiments virtually. Chemistry is one of the branches of science which deals with the study of the composition of matter, the relevance of chemistry as a requirement for scientific and technological development of any nation cannot be underrated (Babalola & Hafsatu, 2015). Especially in the manufacturing sector. The chemistry curriculum is packaged with contents that lead to self-actualization by students, focuses on practical activities with emphasis on locally available materials. This will enable learners to develop the spirit of enquiry as well as achieve maximum potential in the subject of chemistry and its various applications. This implies that whether students proceed to tertiary institutions or not, the learning of chemistry ought to inculcate in them the scientific attitude which will be beneficial to them throughout life.

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Poor teaching would lead to poor learning and poor performance (Orasi 2007, Okeke 2008 & Okoli 2011). This demands a re-examination of instructional strategies used in teaching senior secondary school students' chemistry. There is need for chemistry teachers to shift from teacher-directed instruction such as conventional methods to a more active learning environment such as the use of computer simulations, where students can participate actively and make use of their creative minds rather than remain passive. Chemistry, as a core science subject, is often considered abstract and difficult by many students, resulting in poor academic performance and retention (Achor & Moses, 2019). Despite the importance of chemistry in scientific and technological development, students' performance and retention in the subject remain poor in Nigerian secondary schools. Studies have shown that the abstract nature of chemistry contributes to students' misconceptions and low achievement (Udo & Etukudo, 2021). Traditional teaching methods, which rely heavily on rote memorization and lack visual support, may not sufficiently address these challenges.

Traditional methods of teaching often fail to make chemistry concepts concrete and relatable. Effective teaching and learning of chemistry in secondary schools in Nigeria has become a problem and needs urgent attention Ogenyi (2014). This issue has been observed to be affecting students' performance adversely especially in external examinations such as West African Examination Council exams(WAEC), Nigerian National Examination Council exams(NECO), Joint Admission Matriculation Board (JAMB) exam among others. Teaching strategies in which learners are actively involved would likely lead to meaningful learning and not rote learning (Isah, 2018). Recent studies Therefore, there is a need to take a close look at ways chemistry could be taught in secondary schools in order to improve academic performance of students. Computer simulations is one of such instructional strategies that encourage active learning (Shihusa, 2009), this study demonstrated that Computer simulations significantly enhance students' performance and retention in chemistry compared to traditional methods. (Fabeku and Enyeasi, 2024) also it found that computer simulation instructional packages are more effective than the four mode Application techniques in teaching challenging chemistry concepts. (Omoniyi, 2021). Computer simulations also allow students to experiment virtually with chemical processes, which can improve both their academic performance and memory retention.

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Research confirms that students who learn with computer simulations often perform better and remember more than those taught with traditional methods (Okwuduba et al., 2018; Yusuf & Afolabi, 2020). To improve the situation, researchers and educators are exploring the use of computer simulations in teaching chemistry. These simulations make learning more interactive, visual, and engaging, which helps students better understand complex chemical concepts (Fabeku & Enyeasi, 2024). Recent studies have shown that this approach does not promote deep understanding or long-term retention, especially for female students, who may already face challenges in STEM-related subjects (Igboanugo, 2024). The result shows a gender gap on performance and participation in science classes.

However, most researchers credit the model to Bergmann and Sams (2012), two school teachers from Colorado, USA, who used digital media to deliver lecture materials online to students, so that they could learn at home, but complete their traditional homework assignments in the classroom (Bergmann & Sams, 2012; Tucker, 2012). This approach supplements and enhances students' learning opportunities (Tucker, 2012). Therefore, it is referred to as an inverted or reversed approach, where the learning is inverted, and the teaching is reversed: students engage in class preparation and also learning the fundamentals at home (view videos or review presentations and lecture materials); and participating in meaningful learning activities with the lecturer and their peers in class.

Statement of the Problem

Chemistry is an important subject for students interested in science and technology careers. However, many secondary school students in Nigeria and other developing countries find chemistry difficult to understand, which often leads to poor performance and low interest in the subject. One of the major reasons for this challenge is the traditional method of teaching, where teachers mostly conventional and students passively listen. This teacher-cantered approach makes chemistry seem abstract and disconnected from students' everyday experiences (Omoniyi, 2021).

Objectives of the Study

The following objectives were set for this study to;

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i. To find out effect of computer simulation on the academic performance of students taught chemistry concept.

ii. Determine the effect of the computer simulation on the retention levels of students taught chemistry concepts.

Research Questions

The following research questions were asked to guide the study:

i. What is the difference between the mean academic performance score of students taught chemistry concept using computer simulations and those taught using lecture method?

ii. What is the difference in the retention levels of students taught chemistry using computer simulation and those taught using conventional methods?

Hypotheses

The following null hypotheses were formulated and tested at $p \leq 0.05$ level of significance.

H_{01}. There is no significant difference between the mean academic performance score of students taught chemistry concept using computer simulations and those taught using lecture method.

H_{02}. There is no significant difference in the retention levels of students taught chemistry using computer simulation and those taught using conventional methods.

Methodology

The pretest - posttest and postposttest Quasi Experimental Control group design was employed for the study. The design was used because intact classes were involved. The targeted population comprised all 96 Chemistry students from 8 public Senior Secondary Schools in Zaria Education Zone, Kaduna State. A sample of 30 students from two randomly selected co-educational schools where involved in the study. The schools were assigned to experimental group and control group using balloting system. The two groups consist of 15 and 15 respectively.

Two (2) instruments (CPT & CRT) with reliability coefficient of 0.77 and 0.81 respectively were used to collect data for the study. The two research questions and the two null hypotheses stated were answered and tested respectively. The data collected were subjected to statistical

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analysis at 0.05 level of significance. Mean, standard deviation, were used to answer research questions, independent sample t-test was used to test the null hypotheses.

Results

The results of the study were presented in the following tables:

Research Questions One:

i. What is the difference between the mean performance score of students taught chemistry concept using computer simulations and those taught using lecture method?

Table 1: Mean, Standard Deviation Statistics of Post-test OCPT Scores for Students in Experimental and Control Groups

Group	n	Pretest Mean	Mean diff.	STD	Posttest mean	STD	Mean gain	Mean diff
EXP (Flipped-chart Advanced-Organizers)	15	31.40	1.2	6.25	78.60	7.11	47.2	20.47
Control (Conventional method)	15	30.20		5.92	58.13	6.47	27.93	

Table 1 showed that difference exist between the mean academic performance scores of Chemistry students taught Chemistry using Computer Simulations and their counterparts taught using Conventional method. Their computed mean performances are 78.60 and 5813 of SSII Chemistry students taught Organic Chemistry using Computer Simulations and their counterparts taught using Conventional method respectively, with a mean performance difference of 20.47 in favour of students taught Chemistry using Computer simulations.

Research Questions Two:

What is the difference in the retention levels of students taught chemistry using computer simulation and those taught using conventional methods?

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Table 2: Retention analysis Mean and Standard deviation

GROUP	n	Mean	Mean diff	SD
EXP (Computer simulations)	15	75.80		6.55
Control (Conventional method)	15	53.60	22.20	7.23
Total	**30**			

From Table 2, the retention test revealed that difference exist between mean of students taught Chemistry using Computer Simulations and their counterpart taught using conventional method. Their computed Means are 75.80 and 53.60 students taught Chemistry using Computer Simulations and their counterpart taught using Lecture method respectively indicating a Mean difference of 22.20 in favour of students taught Computer Simulations. This implies that the use of Computer Simulations aid long-term retention than conventional method.

Null Hypothesis One: There is no significant difference between the mean performance score of students taught chemistry concept using computer simulations and those taught using lecture method.

Table 3: Summary of Independent Sample t-test of Mean Posttest CPT Scores for Experimental and Control Groups.

Group	n	Mean	SD	t	Df	p	Decision
Experimental	15	78.60	7.11				
				6.92	28	0.000	Rejected
Control	15	58.13	6.47				

Significant at $p \leq 0.05$

From Table 3, result of the independent t-test statistics showed significant difference between the mean performance scores of Chemistry students taught Chemistry using Computer Simulations and their counterparts taught using lecture method. Reasons being that the calculated p-value of 0.00 is lower than the 0.05 alpha level of significance at df 28. Their computed mean performances are 78.60 and 58.13 of SSII Chemistry students taught Chemistry using Computer

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Simulations and their counterparts taught using conventional method respectively, with a mean performance difference of 20.47 in favour of students taught Chemistry using Computer Simulations. Therefore, the null hypothesis which states that there is no significant difference between the mean performance scores Chemistry students taught chemistry using Computer Simulations and their counterparts taught using lecture method, is hereby rejected.

Hypothesis Two: There is no significant difference in the retention levels of students taught chemistry using computer simulation and those taught using conventional methods.

Table 4: Summary of t-test Analysis of Retention Test

GROUP	n	Mean	SD	T	df	P	Decision
Experimental	15	75.80	7.11				Rejected
				6.29	28	0.000	
Control	15	53.60	6.47				
Total	**30**						

Significant at p ≤0.05

From Table 4, the outcome of Parametric test revealed that significant difference exists between means of students taught Chemistry using computer simulations and their counterpart taught using Lecture method. This is because the calculated p value of 0.000 is lower than the 0.05 alpha level of significance. Their computed Means are 75.80 and 53.60 by students taught Chemistry using computer simulations and their counterpart taught using Conventional method respectively indicating a Mean difference of 22.2 in favour of students taught computer simulations. This implies that the use of computer simulations has high positive effect and enhances memory retention towards learning Chemistry.

Therefore, the null hypothesis which state that there is no significant difference between mean interest level of SSII students taught computer simulations and their counterpart taught using Conventional method is hereby rejected

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Summary of Findings

The summary of findings from the study is as follows: -

1. Significant difference exists between the mean academic performance scores of Chemistry students taught Chemistry using computer simulations and their counterparts taught using Conventional method in favour of the experimental group.
2. Significant difference exists between computed Mean in the retention analysis of students taught Chemistry using computer simulations and their counterpart taught using Conventional method in favour of the experimental group.

Discussion of Findings

The results from Table 1 show that students in the experimental group had a higher mean performance score than those in the control group. The difference was significant as indicated by the t-test analysis in Table 3. This signifies that students taught Organic Chemistry concepts using Flipped-chart as Advanced-Organizer had a significantly higher mean performance score than those taught using Conventional Method. By implication, the computer simulation was able to foster a significantly higher performance than the Conventional Method; this finding aligns with the results of Fabeku and Enyeasi (2024), who reported that computer simulations significantly enhance students' understanding and achievement in chemistry. Similarly, Yusuf and Afolabi (2020) found that using simulation tools to teach chemical bonding improved students' performance more than the traditional chalk-and-talk approach. Okwuduba et al. (2018) also observed that computer simulations help students grasp abstract chemical concepts more easily, leading to better academic outcomes. By implication, the use of computer simulations fosters meaningful learning and enhances performance when compared to the conventional method. The significant difference implies rejection of null hypothesis and retaining alternate hypothesis. Therefore, null hypothesis that states that there is no significant difference in the mean performance score of SSII students taught Organic Chemistry using computer simulations and their counterparts taught using Conventional method is rejected. The significant difference indicates that students in experimental group recorded the highest mean score than those in the Conventional Method. This research revealed that students exhibited significant improvements in

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performance and promotes Interests as a result of treatment with computer simulations compared to the conventional method.

The results in Table 2 showed that students in the experimental group had a higher mean than those in the control group. The difference is significant as indicated by the retention t-test analysis in Table 4. This signifies that students taught Chemistry concepts using computer simulations had a significantly higher mean than those taught using Conventional Method; this finding is consistent with Omoniyi (2021), who reported that students taught with computer-based instructional packages demonstrated better long-term memory retention. Furthermore, Oludipe (2021) confirmed that multimedia simulations not only improve performance but also enhance students' retention and engagement.

By implication, the computer simulation was able to foster a significantly higher interest than the Conventional Method. The significant difference implies rejection of null hypothesis. Therefore, null hypothesis is rejected. The significant difference indicates that students in experimental group recorded the highest mean than those in the Conventional Method. This finding revealed that computer simulations aid long term memory retention and understandings.

Conclusion

The result of the study showed that Academic performance in Chemistry students was enhanced significantly by the use of computer simulations and promotes memory retention.

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