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EFFECT OF COMPUTER SIMULATION LEARNING STRATEGY ON STUDENTS' INTEREST AND ACADEMIC ACHIEVEMENT IN NUCLEAR CHEMISTRY IN CALABAR EDUCATION ZONE OF CROSS RIVER STATE, NIGERIA.

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ABSTRACT

This study investigated the effect of Computer Simulation Learning Strategy on students' interest and academic achievement in Nuclear Chemistry in the Calabar Education Zone of Cross River State, Nigeria. Two research questions and two corresponding null hypotheses guided the study. The study adopted a quasi-experimental, non-equivalent pre-test–post-test control-group design with a 2 x 2 x 2 factorial matrix. The population comprised 3,196 SS III Chemistry students, while a sample of 139 students from four public secondary schools participated in the study. Two researcher-developed instruments, Nuclear Chemistry Achievement Test (NCAT) and Nuclear Chemistry Students' Interest Inventory (NCSII) with reliability coefficients of 0.734 and 0.766, respectively were used for data collection. Descriptive statistics were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at the .05 level of significance. The findings indicated that computer simulation learning strategy significantly improved students' interest and academic achievement in nuclear Chemistry compared with conventional teaching method. The study concluded that computer simulation learning strategy provides a more effective strategy to teaching Nuclear Chemistry. It was recommended that Chemistry teachers adopt computer simulations when teaching Nuclear Chemistry.

Keywords: Academic achievement; Computer simulation learning strategy; Nuclear Chemistry and Students' interest in Chemistry.

Introduction

Chemistry is one of the core science subjects offered at secondary school and concerned with the composition, properties and transformations of matter. As a core science subject alongside Biology and Physics, Chemistry contributes to scientific, technological and industrial development. Its effective teaching and learning are therefore essential for developing students' scientific knowledge and understanding. However, students' understanding of Chemistry concepts depends partly on the instructional strategies employed by teachers, particularly when teaching abstract scientific

phenomena (Fabeku & Enyeasi, 2024; Jere & Mpeta, 2024).

One area of Chemistry that presents considerable conceptual challenges is Nuclear Chemistry, which deals with atomic nuclei and nuclear processes, including radioactivity, half-life, nuclear fission and nuclear fusion. These concepts involve processes that are not directly observable under ordinary classroom conditions. Consequently, explaining them exclusively through verbal instruction and textbook illustrations may limit students' opportunities to develop meaningful conceptual understanding. The abstract nature of these concepts highlights the need for innovative instructional strategies that facilitate visualization, active participation and conceptual exploration (Fabeku & Enyeasi, 2024).

Two important outcomes for evaluating the effectiveness of innovative instructional strategies with respect to Nuclear Chemistry are students' interest and academic achievement. Students' interest refers to their curiosity, attention and positive disposition towards learning a subject. In Nuclear Chemistry, interest may be reflected in students' willingness to participate in lessons, explore nuclear processes and sustain engagement with learning activities. Interest is important because students who are engaged in learning activities may be more willing to explore challenging concepts. Conversely, limited interest may reduce participation and engagement. Examining students' interest is therefore important for determining whether an instructional strategy encourages positive engagement with Nuclear Chemistry (Igboanugo, 2023).

Academic achievement in Nuclear Chemistry refers to the knowledge and understanding students demonstrate through assessments of nuclear concepts and processes. Students' achievement may be influenced by the extent to which instructional approaches help them understand and apply concepts that are difficult to observe directly. Therefore, one instructional approach that may address the challenges associated with teaching abstract nuclear Chemistry concepts is the Computer Simulation Learning Strategy. This strategy involves the use of computer-generated models, animations and interactive representations to demonstrate scientific processes and relationships. In Nuclear Chemistry, computer simulations can illustrate radioactive decay, half-life, nuclear fission and nuclear fusion, enabling students to observe simulated nuclear processes and examine changes under different conditions. By providing visual and interactive learning experiences, computer simulations may promote students' interest with lesson content and facilitate conceptual understanding. These features suggest that the innovative instructional strategy may enhance both students' interest and academic achievement in Nuclear Chemistry (Fabeku & Enyeasi, 2024).

In contrast, conventional teaching relies primarily on teacher explanations, textbooks, classroom illustrations and other traditional methods of presenting lesson content. Although these approaches can communicate scientific information, their effectiveness in teaching abstract nuclear

processes may be limited when students have few opportunities to visualize or interact with the concepts being taught. Computer simulations may offer an advantage by allowing students to observe representations of otherwise inaccessible processes. Empirical studies have reported positive academic outcomes associated with computer simulation in Chemistry education, although the applicability of these findings to Nuclear Chemistry requires further investigation (Jere & Mpeta, 2024; Fabeku & Enyeasi, 2024). A direct examination of computer simulation in Nuclear Chemistry is therefore necessary to establish whether the potential benefits of simulation extend to students' interest and academic achievement in this specific area.

Also, previous empirical studies provide a basis for investigating this possibility. Nweze and Nnadi (2024) investigated the effects of different modes of computer simulation on students' achievement and interest in Chemistry in Enugu State, Nigeria. The study adopted a quasi-experimental research design involving 204 students from four intact classes. Computer simulation with on-screen text and narration was used in two schools, while computer simulation with on-screen text only was used in the other two schools. Data were collected using the Chemistry Achievement Test (CAT) and Chemistry Interest Inventory (CII), which had reliability coefficients of 0.96 and 0.84, respectively. Mean and standard deviation were used to answer the research questions while analysis of covariance (ANCOVA) was employed to test the null hypotheses. The findings revealed that students taught using computer simulation with on-screen text and narration achieved better results than those taught using on-screen text only. However, the two modes did not differ significantly in their effects on students' interest in Chemistry. This study demonstrates the relevance of examining both achievement and interest when evaluating computer simulation in Chemistry.

Similarly, Nkemakolam, Offiah and Madichie (2018) investigated the effect of computer simulations on secondary school students' academic achievement in Chemistry in Anambra State, Nigeria. The study adopted a quasi-experimental, non-equivalent control-group design. The population comprised 1,279 Senior Secondary II (SS II) Chemistry students from 18 public co-educational secondary schools in Awka South Local Government Area. A sample of 78 students was purposively selected from two schools, comprising 38 students in the experimental group and 40 in the control group. Data were collected using the Chemistry Achievement Test (CAT), which had a reliability coefficient of 0.78, determined using the Kuder–Richardson Formula 20 (KR-20). A pretest was administered before the intervention, followed by a posttest after four weeks of instruction. Mean gain was used to answer the research question while ANCOVA was employed to test the hypotheses. The findings revealed that students taught using computer simulations achieved significantly better results than those taught using the conventional method. This study provides evidence of the potential of computer simulations to improve

academic achievement in Chemistry, it did not examine students' interest and was not specifically concerned with Nuclear Chemistry. Thus, the extent to which computer simulation influences both interest and academic achievement in Nuclear Chemistry remains insufficiently established by the evidence presented in these two reviews.

Hence, the reviewed studies indicate that computer simulation may support students' academic achievement and, depending on its mode of presentation, may have different effects on students' interest. However, the studies considered different Chemistry content areas and did not directly establish the comparative effectiveness of computer simulation and conventional teaching for both outcomes in Nuclear Chemistry. Furthermore, the findings of studies conducted in other locations cannot automatically be generalized to students in the Calabar Education Zone of Cross River State, Nigeria. This creates a need for further empirical investigation of the instructional strategy within the specified geographical and subject context.

Therefore, the present study investigates the effect of Computer Simulation Learning Strategy on students' interest and academic achievement in Nuclear Chemistry in the Calabar Education Zone of Cross River State, Nigeria.

Research questions

The following two research questions guided the study:

1. What is the effect of teaching method (computer simulations and conventional teaching method) on students' interest in nuclear chemistry?
2. What is the effect of teaching method (computer simulations and conventional teaching method) on students' academic achievement in Nuclear Chemistry?

Statement of hypotheses

The following two null hypotheses were formulated to guide the study:

1. There is no significant effect of teaching method (computer simulations and conventional teaching method) on students' interest in nuclear chemistry.
2. Teaching method (computer simulations and conventional teaching method) does not significantly affect students' academic achievement in nuclear chemistry.

Research Method

Design of the study

The study adopted a quasi-experimental, non-equivalent pre-test–post-test control-group design to determine the effect of computer simulation learning strategy on students' interest and academic achievement in Nuclear Chemistry. The population comprised 3,196 SS III Chemistry students, consisting of 1,549 males and 1,647 females' students, from 113 public secondary schools. The senior secondary three (SS3) students were used for the study because they had already been selected into specific discipline and the selected contents were found in SS3 Chemistry curriculum.

Sampling Technique

Purposive and random sampling techniques were used in selecting the sample for the study. Out of the seven LGAs in Calabar Education Zone, two were purposively sampled. From these two LGAs, four secondary schools were selected using random sampling technique. Purposive sampling was introduced in selecting schools who met the criteria for taking part in the study. Some of which are, the school must be co-educational, such school must have teachers with B.Sc., B.Ed. or B.Sc. (Ed.) and the school must possess computer facilities. More so, the selection was done to ensure that there was no room for the students to be test-wise. An intact class in each of these schools was used for the study. Four schools were used as control and experimental groups to have a total of four classes. All the sampled students were given equal chance to take part in the exercise. Only those with pretest scores and at least 70% attendance during treatment constituted the study sample.

The Sample

Sample size of the study comprised 139 SSIII Chemistry students in four intact classes from four public mixed secondary schools in Calabar Education Zone.

Instruments

Two researcher-developed instruments were used: Nuclear Chemistry Achievement Test (NCAT) and Nuclear Chemistry Students' Interest Inventory (NCSII). The NCAT contained 50 multiple-choice items while the NCSII contained 40 four-point Likert items. The supervisors, one expert in Chemistry Education, and one in Measurement and Evaluation all in University of Cross River State, Calabar validated the instruments. Their reliability coefficients were 0.734 for the NCAT, determined using the Kuder - Richardson 20 (KR-20) and 0.766 for the NCSII, determined using Cronbach's alpha. Reliability was established through a trial test involving 40 comparable SS III Chemistry students from Government Secondary School Ikom, Cross River State. NCAT responses were scored 1 for a correct response and 0 for an incorrect response, whereas responses to the 4-point Likert-scale instruments were scored from Strongly Agree (SA, 4), Agree (A, 3), Disagree (D, 2) and Strongly Disagree (SD, 1), with negatively worded items reverse-coded before analysis.

The treatment lasted six weeks and was implemented by four Chemistry teachers trained by the researcher. Experimental-group teachers received five days of training on computer simulation instruction while control-group teachers received standardized lesson plans for conventional instruction. Both groups completed pre-tests before treatment and post-tests after the intervention, with NCAT items reshuffled at post-test to minimize recall effects.

Data Analysis

Data were coded and analyzed using SPSS. Mean and standard deviation were used to describe students' scores while

Analysis of Covariance (ANCOVA) was used to determine the effect of teaching method on students' interest and academic achievement while controlling for pre-test differences. The hypothesis was tested at the 0.05 significance level, with the null hypothesis rejected when the p-value was less than .05.

Results and Discussion

Table 1: Demographic distribution of Study Sample

Treatment Group	Statistic	Male	Female	Total
Computer Simulation	Observed	33.0	31.0	64.0
	Expected	33.2	30.8	64.0
Conventional Method	Observe	39.0	36.0	75.0
	Expected	38.8	36.2	75.0
		72.0	67.0	139.0
Pearson Chi-Square (χ^2) = .003			P-value = .959	
Linear-by-linear Assoc. = .003			P- value = .959	

The results in Table 1 show that the sample comprised 72 (51.8%) males and 67 (48.2%) females. The computer simulation group consisted of 33 (51.6%) males and 31 (48.4%) female students, while the conventional group comprised 39 (52.0%) males and 36 (48.0%) female students. The Pearson chi-square result, χ^2 (1) = 0.003, p = .959, indicated no significant difference in distribution between the treatment groups.

Research question one: What is the effect of teaching method (computer simulation learning strategy and conventional teaching method) on students' interest in Nuclear Chemistry?

Table 2: Descriptive Statistics of Study Variables by Teaching method.

Variable name	Teaching method	N	Mean	Std. dev.	Std. error	Minimum	Maximum
Pre-test	Computer	64	30.576	5.720	.715	20	40
Interest	Conventional.	75	29.640	5.853	.676	20	40
	Total	139	30.072	5.791	.491	20	40
Post-test	Computer	64	54.547	11.486	1.436	34	78
Interest	Conventional.	75	38.553	10.490	1.211	21	56
	Total	139	45.971	13.507	1.146	21	78
Gained chem	Computer	64	23.969	7.024	.878	13	42
Interest	Conventional.	75	9.013	8.962	1.035	-7	31
	Total	139	15.899	11.025	.935	-7	42

The results in Table 2 show that pre-test interest means were similar for the computer simulation group (M = 30.576, SD = 5.720) and conventional group (M = 29.640, SD = 5.853). After treatment, the computer simulation group recorded a

higher interest mean (M = 54.547, SD = 11.486) than the conventional group (M = 38.553, SD = 10.490). Their respective gain scores were 23.969 and 9.013, indicating greater improvement in interest among students exposed to computer simulation.

Hypothesis one: There is no significant effect of teaching method (computer simulations and conventional teaching method) on students' interest in nuclear chemistry.

Table 3: **One-way ANCOVA of Nuclear Chemistry Interest by Teaching Method**

Study group (Teaching method)	N	Mean	Std. dev.	Std. error	Adjusted	
					Mean	Std. error
Computer simulation	64	54.546	11. 486	1.436	53.886	.997
Conventional	75	38.653	10.490	1.211	39.217	.921
Total	139	45.971	13.507	1.146	46.552	.678

Source of variation	Sum of squares	df	Mean square	F – value	P – value
Corrected model	16555.480	2	8277.740	130.564*	.000
Intercept	260.520	1	260.520	4.109*	.045
Pre-test interest	7832.442	1	7832.442	123.540*	.000
Teaching method	7381.847	1	7381.847	116.433*	.000
Error	8622.404	136	63.400		
Total	318934.000	139			
Corrected total	25177.885	138			
			R^2 = .658	Adj. R^2 = .653	

Significant at .05 level.

The results in Table 3 show that students taught using computer simulation recorded a higher mean interest score (M = 54.55, SD = 11.49) than those taught using the conventional method (M = 38.65, SD = 10.49). After adjusting for pre-test interest scores, the adjusted means were 53.89 and 39.22 for the computer simulation and conventional groups, respectively. The ANCOVA revealed a statistically significant effect of teaching method on students' interest in Nuclear Chemistry, F (1, 136) = 116.433, p < .001. The pre-test interest score also had a statistically significant effect on post-test interest, F (1, 136) = 123.540, p < .001. The model explained 65.8% of the variance in students' interest scores (R^2 = .658; adjusted R^2 = .653), indicating that computer simulation was associated with higher interest than conventional instruction.

Research question two: What is the effect of teaching method (computer simulations and conventional teaching method) on students' academic achievement in Nuclear Chemistry?

Table 4: Descriptive Statistics of Study Variables by Teaching method.

Variable name	Teaching method	N	Mean	Std. dev.	Std. error	Minimum	Maximum
Pre-test Chem.	Computer	64	19.031	7.848	.981	5	35
Achievement	Conventional.	75	17.333	8.380	.967	4	35
	Total	139	18.115	8.154	.692	4	35
Post-test Chem.	Computer	64	35.875	7.119	.890	5	46
Achievement	Conventional.	75	27.040	5.244	.606	17	38
	Total	139	31.108	7.577	.643	5	46
Gained chem	Computer	64	16.844	6.219	.778	-18	28
Achievement	Conventional.	75	9.707	9.610	1.110	-11	29
	Total	139	12.993	8.940	.758	-18	29

Table 4 shows that the computer simulation group recorded a higher pre-test academic achievement mean (M = 19.031) than the conventional group (M = 17.333). at post-test, the computer simulation group also recorded a higher mean (M= 35.875) than the conventional group (M= 27.040). The gain scores were 16.844 and 9.707 respectively, indicating greater improvement in academic achievement among students exposed to computer simulation.

Hypothesis two: Teaching method (computer simulations and conventional teaching method) does not significantly affect students' academic achievement in nuclear chemistry.

Table 5: One-way ANCOVA of Students' Nuclear Chemistry Achievement by Teaching method

Study group (Teaching method)	N	Mean	Std. dev.	Std. error	Adjusted	
					Mean	Std. error
Computer simulation	64	35.875	7. 119	.890	35.621	.724
Conventional	75	27.040	5.244	.606	27.257	.668
Total	139	31.108	7.577	.643	31.439	.491

Source of variation	Sum of squares	Df	Mean square	F – value	p – value
Corrected model	3393.620	2	1696.810	50.944*	.000
Intercept	15980.531	1	15980.531	479.794*	.000
Pre-test interest	698.119	1	698.119	20.960*	.000
Teaching method	2389.618	1	2389.618	71.745*	.000
Error	14529.761	136	33.307		
Total	14243.000	139			
Corrected total	7923.381	138			
			R^2 = .428	Adj. R^2 = .420	

Significant at .05 level

The results in Table 5 indicate that students taught using computer simulation achieved a higher mean score (M = 35.88, SD = 7.12) than those taught using the conventional method (M = 27.04, SD = 5.24). After adjusting for pre-test scores, the adjusted mean achievement scores were 35.62 and 27.26 for the computer simulation and conventional groups, respectively. The ANCOVA revealed a statistically significant effect of teaching method on students' Nuclear Chemistry achievement, F (1, 136) = 71.745, p < .001. The teaching method accounted for a significant difference in achievement, indicating that students taught using computer simulation performed better than those taught conventionally. The model explained 42.8% of the variance in achievement (R^2 = .428; adjusted R^2 = .420).

Discussion of Findings

The findings indicated that the Computer Simulation Learning Strategy significantly influenced students' interest and academic achievement in Nuclear Chemistry. For interest, the simulation group recorded a higher post-test mean (M = 54.547) than the conventional group (M = 38.553), with mean gains of 23.969 and 9.013, respectively. ANCOVA confirmed a significant effect of teaching method, F (1, 136) = 116.433, p < .001. This suggests that interactive visual representations of nuclear processes may enhance students' interest. The finding extends Nweze and Nnadi (2024), who found no significant difference in interest between simulation modes, by demonstrating a significant difference between simulation and conventional instruction.

Similarly, the simulation group recorded a higher achievement post-test mean (M = 35.875) than the conventional group (M = 27.040), with mean gains of 16.844 and 9.707, respectively. ANCOVA revealed a significant teaching method effect, F (1, 136) = 71.745, p < .001. This supports Nkemakolam, Offiah and Madichie (2018), and Nweze and Nnadi (2024), who reported improved Chemistry achievement through computer simulation. The present study extends these findings to Nuclear Chemistry, demonstrating improvements in both interest and achievement among SS III Chemistry students in the Calabar Education Zone of Cross River State, Nigeria.

Conclusion

The study concluded that the Computer Simulation Learning Strategy significantly improved students' interest and academic achievement in Nuclear Chemistry compared with the conventional teaching method. Students exposed to computer simulation recorded higher post-test mean scores and greater mean gains in both interest and academic achievement than their counterparts taught conventionally. The findings demonstrate that computer simulation is a more effective instructional strategy than conventional teaching for enhancing students' interest and academic achievement in Nuclear Chemistry in the Calabar Education Zone of Cross River State, Nigeria.

Recommendations

Based on the findings and conclusions of the study, the following recommendations were made:

1. Chemistry teachers should adopt computer simulation to enhance students' interest in Nuclear Chemistry.
2. Governments should provide adequate ICT facilities to improve students' academic achievement through computer simulation.
3. Curriculum planners should integrate simulation-based activities into Nuclear Chemistry to promote students' interest and academic achievement.

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