



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 Calabar Education Zone, Cross River State, Nigeria. One research question and one corresponding null hypothesis guided the study. The study adopted a quasi-experimental pre-test post-test non-equivalent control group design with a $2 \times 2 \times 2$ factorial matrix. The population comprised 3,196 SS III Chemistry students from 113 public co-educational secondary schools, while a sample of 139 students from 4 schools participated in the study. Three instruments were used for data collection: Nuclear Chemistry Achievement Test (NCAT), Nuclear Chemistry Students' Interest Inventory (NCSII) and Nuclear Chemistry Students' Achievement Motivation Questionnaire (NCSAMQ). Mean and descriptive statistics were used to answer the research questions and Analysis of Covariance (ANCOVA) was used to test null hypotheses at the 0.05 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 strategy. The study concluded that computer simulation learning strategy provides a more effective strategy to teaching Nuclear Chemistry. It was recommended that Chemistry teachers integrate computer simulations into the teaching of abstract and difficult Chemistry concepts and that educational authorities provide the necessary ICT facilities and teacher training to support its effective implementation.

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



Introduction

The teaching of science requires instructional strategies that enable students to understand abstract, complex and often unobservable phenomena. Nuclear Chemistry, which encompasses radioactivity, nuclear reactions, isotopes and nuclear transformations, may present considerable learning challenges when taught predominantly through conventional teacher-centred strategies. Recent evidence indicates that students may experience difficulty understanding abstract scientific concepts when instruction provides limited opportunities for visualization and active exploration (DeCaro, McClellan, Patrick, Powe, Franco, Chastain, Fuselier & Hieb, 2025). These challenges highlight the need for instructional strategies that promote interaction with scientific representations and active knowledge construction.

One strategy capable of addressing these challenges is the Computer Simulation Learning Strategy (CSLS). Computer simulations provide interactive representations that enable learners to manipulate variables, observe outcomes and explore phenomena that may not be directly observable in the classroom. This is particularly relevant to Nuclear Chemistry because many nuclear processes occur at microscopic levels and cannot easily be demonstrated through conventional experiments. Simulation-supported instruction can therefore enhance the visualization and exploration of abstract scientific phenomena while promoting active engagement (Langbeheim & Bielik, 2025). Computer simulation learning becomes more meaningful when learners can manipulate variables, observe changes and connect visual representations with scientific explanations. In Chemistry, where learners need to connect macroscopic, symbolic and submicroscopic representations, interactive simulations can provide useful links among these levels.

Evidence indicates that students perceive computer simulations as useful for visualizing and exploring difficult Chemistry concepts (Batamuliza, Habinshuti & Nkurunziza, 2024). Similarly, simulation-based learning can support conceptual understanding by allowing learners to explore scientific processes and develop explanations rather than relying mainly on memorization (Jere & Mpeti, 2024). The interactive nature of computer simulations also provides a logical connection between instructional strategy and students' interest in science. Interest involves attention, curiosity, willingness to participate and sustained engagement with learning activities. Manipulating representations, receiving visual feedback and exploring different outcomes can make learning more stimulating and meaningful. Such experiences may encourage curiosity and sustained interest, particularly when students encounter abstract scientific concepts (Kang & Kim, 2024).

Evidence from Chemistry education supports the relationship between simulation and students' affective engagement. Kekeba, Gure and Olkaba (2024) found that students exposed to computer simulation integrated with jigsaw learning demonstrated more favourable attitudes towards Chemistry than those taught conventionally. Similarly, interactive Chemistry approaches have been associated with enhanced learner motivation, suggesting that instructional experiences can influence affective engagement (Mohammed Naaim & Karpudewan, 2024). These findings suggest that computer simulation can provide an environment capable of stimulating students' interest in science learning.

Students' interest is also related to academic achievement because interested learners are more likely to attend to instruction, participate, persist with challenging tasks and invest cognitive



effort in learning. Research indicates that students' motivational orientations are associated with differences in science achievement, showing that affective engagement and cognitive outcomes are related (Liou, Jang & Myoung, 2024). Thus, increased interest resulting from computer simulation may create favourable conditions for improved academic achievement in Nuclear Chemistry. Academic achievement reflects the knowledge and understanding students acquire through instruction. Computer simulation may improve achievement by enabling learners to visualize processes, manipulate variables, test relationships, observe consequences and receive feedback. Repeated exploration may also help learners identify misconceptions and develop more accurate conceptual understanding. Evidence from Chemistry education indicates that technology-supported instructional resources can improve students' learning outcomes (Fabeku & Enyeasi, 2024).

The potential contribution of computer simulation is particularly relevant to scientific concepts that are difficult or unsafe to demonstrate physically. Nuclear Chemistry involves radioactive processes, nuclear transformations, isotopes and nuclear stability that cannot easily be observed or reproduced in conventional secondary-school laboratories. Simulations provide controlled environments for representing these phenomena without the physical and safety constraints of radioactive materials. Evidence from chemical kinetics shows that simulation-supported instruction can improve learning outcomes, although its effectiveness depends on appropriate teacher guidance and meaningful integration with learning activities (Jere & Mpeti, 2024). Similarly, research combining virtual and real experiments indicates that the organization of technology-supported learning experiences influences conceptual learning (Flegr, Kuhn & Scheiter, 2023).

Empirical studies provide further support for the relationship between computer simulation, students' interest and academic achievement. Olugbade, Oyelere and Agbo (2024), in their study titled Enhancing junior secondary students' learning outcomes in basic science and technology through PhET: A study in Nigeria, investigated the effects of PhET-based computer simulation on students' academic performance, motivation and attitudes towards Basic Science and Technology in Oluyole Local Government Area of Oyo State, Nigeria. The population comprised Junior Secondary II students in 26 public and private schools offering Basic Science and Technology, while 162 students from four randomly selected schools participated in the study, with 79 assigned to the experimental group and 83 to the control group. A pre-test–post-test non-equivalent control-group quasi-experimental design was employed. Data were collected using the Basic Science and Technology Achievement Test (BTAT), Students' Attitude towards Basic Science and Technology Questionnaire (SABST), and Students' Intrinsic Motivation Inventory towards Basic Science and Technology (SIMIBST). Experts in science curriculum, special education, and measurement and evaluation examined the instruments for validity. Reliability coefficients were 0.871 for BTAT, 0.867 for SABST, and 0.908 for SIMIBST. The findings showed that students taught using PhET achieved significantly higher post-test performance than those taught conventionally, $t(160) = 36.28$, $p < .05$. PhET also significantly improved motivation, including the interest/enjoyment component, with the experimental group recording a mean of 15.19 compared with 9.11 for the control group, $t(160) = 13.77$, $p < .001$. The study therefore provides evidence that computer simulation can positively influence both affective engagement and academic achievement in science.



Tuyizere and Yadav (2023), in their study titled Effect of interactive computer simulations on academic performance and learning motivation of Rwandan students in Atomic Physics, examined the effects of PhET simulations on academic performance and learning motivation among Senior Five Physics students in the Eastern Province of Rwanda. The study involved 163 students selected through multistage sampling from Rwamagana, Kayonza, Ngoma and Kirehe districts, with 83 students in the experimental group and 80 in the control group. A quasi-experimental non-equivalent-group design was employed. Data were collected using the Atomic Physics Conceptual Understanding Test (APCUT) and the Revised Instructional Materials Motivation Survey (RIMMS), which measured Attention, Relevance, Confidence and Satisfaction (ARCS). Content, face and construct validity were established through curriculum alignment, a table of specifications, assessment procedures and reviews by Physics lecturers and secondary-school Physics teachers. Reliability coefficients were $\alpha = 0.797$ for the pre-test, $\alpha = 0.752$ for the post-test and $\alpha = 0.881$ for the ARCS questionnaire. The findings indicated that the experimental group performed significantly better academically and recorded significantly higher learning motivation than the control group. The study is particularly relevant to the present investigation because Atomic Physics involves concepts closely related to Nuclear Chemistry and demonstrates the potential of interactive computer simulations to influence both cognitive and affective learning outcomes.

Jere and Mpeti (2024), in their study titled Effects of Computer Simulations, Attitudes Towards Chemistry and Prior Knowledge on Students' Academic Achievement in Chemistry, investigated whether computer simulation instruction, students' attitudes and prior knowledge predicted achievement in chemical kinetics in two secondary schools in Limpopo Province, South Africa. The study involved 118 Grade 12 Chemistry students, comprising 53 students in the experimental group and 65 in the control group, with one outlier subsequently removed for the regression analysis. A mixed-method approach incorporating a quasi-experimental non-equivalent control-group design was adopted. The instruments were the Chemical Kinetics Achievement Test (CKAT) and Attitude Towards Chemistry Lessons Scale (ATCLS), supported by semi-structured interviews. Four experienced Chemistry teachers validated the CKAT through content review, while its test-retest reliability was $r = 0.81$, $p < .01$. Construct validity of the ATCLS was established through confirmatory factor analysis, with reliability coefficients of 0.77, 0.85, 0.75 and 0.79 for its respective dimensions. Students taught with computer simulations supported by Predict–Observe–Explain recorded significantly more positive attitudes than those taught conventionally, $t = 5.682$, $p < .05$, with a large effect size ($d = 1.052$). Instructional method significantly predicted academic achievement ($\beta = 0.40$, $p < .001$), while attitude also significantly predicted achievement ($\beta = 0.18$, $p = .027$). Together with prior knowledge, the predictors explained 41.3% of the variance in achievement. The study therefore demonstrates a relationship between simulation-supported instruction, students' affective responses and academic achievement.

Kekeba, Gure and Olkaba (2024), in their study titled Effect of Computer Simulation Integrated with Jigsaw Learning Strategy on Students' Attitudes towards Learning Chemistry, investigated the effect of integrating computer simulation with the jigsaw learning strategy on students' attitudes towards Chemistry in Jimma, Ethiopia. The study involved 144 Chemistry students assigned to three intact groups: computer-simulation-integrated jigsaw learning, jigsaw



learning alone and conventional method. Data were collected using the Chemistry Attitude Likert Scale Test (CALST). Chemistry college teachers examined the instrument for content validity, while English teachers assessed its linguistic validity, and a pilot test was conducted with 36 Grade 11 students outside the study school. The CALST demonstrated strong internal consistency, with a Cronbach's alpha coefficient of 0.928. The findings showed a significant difference among the three groups, $F(2, 141) = 93.90$, $p < .001$, with the computer-simulation-integrated jigsaw group recording the highest post-test attitude mean ($M = 3.84$), compared with the jigsaw group ($M = 2.96$) and conventional group ($M = 2.45$). The finding indicates that integrating computer simulation with active learning can produce more favourable affective responses than conventional instruction.

Kekeba (2025), in the study titled Effects of Jigsaw Learning Strategy Integrated with Computer Simulations on Gender Differences in Students' Achievement and Attitude in Learning Chemistry, examined the effect of computer-simulation-integrated jigsaw learning on students' Chemistry achievement and attitudes in Ethiopia. The study adopted a quasi-experimental pre-test-post-test non-equivalent-group design involving 144 Chemistry students in three intact classes comprising a computer-simulation-integrated jigsaw group, jigsaw-only group and conventional-method group. Data were collected using the Chemistry Achievement Test (CAT) and Chemistry Attitude Likert Scale Test (CALST). The CAT consisted of 30 multiple-choice items and had a Kuder-Richardson 20 reliability coefficient of 0.78, while the CALST had a Cronbach's alpha coefficient of 0.928. Content validity was established through reviews by Chemistry college teachers, while English teachers examined the clarity of the items. The findings indicated that computer-simulation-integrated jigsaw instruction was significantly more effective than jigsaw learning alone and conventional instruction in improving students' academic achievement and attitudes towards Chemistry. Gender did not significantly moderate the effects of the intervention. The study consequently strengthens the evidence that computer simulation can support both affective and cognitive outcomes in Chemistry.

Batamuliza, Habinshuti and Nkurunziza (2024), in their study titled Integration of Interactive Computer Simulations in Teaching and Learning Chemical Reaction: Students' Performance and Concept Retention, investigated the effect of interactive computer simulations on Grade 8 students' performance and retention in chemical reactions in Kayonza District, Rwanda. Four schools were purposively selected, producing a sample of 320 Grade 8 students, with 160 students in the experimental group and 160 in the control group. An experimental comparative design was adopted, and data were collected using the Chemical Reactions Achievement Test (CRAT). The achievement test underwent expert validation and reliability checking, although the published study did not report a separate numerical reliability coefficient. Students exposed to interactive computer simulations obtained a significantly higher post-test mean ($M = 8.67$) than students in the control group ($M = 6.69$), $t(318) = 6.34$, $p < .001$. The simulation group also recorded significantly higher delayed retention ($M = 8.08$) than the control group ($M = 5.58$), $t(318) = 7.28$, $p < .001$. Although the study did not measure interest directly, its findings provide further evidence that interactive simulations can improve science learning outcomes, particularly where scientific processes require dynamic visualization.



Taken together, the reviewed studies indicate that computer simulation-based instruction generally produces more favourable learning outcomes than conventional teaching. Evidence from Nigeria, Rwanda, South Africa and Ethiopia shows improvements in academic achievement, interest and related affective outcomes. These benefits appear to arise from opportunities for visualization, manipulation, exploration, feedback and active participation, providing a basis for expecting computer simulation to enhance students' interest and academic achievement in Nuclear Chemistry.

Despite these findings, an important gap remains. Recent studies have mainly examined computer simulation in general science, Physics, chemical kinetics, chemical reactions and other Chemistry topics, with limited attention to Nuclear Chemistry at the secondary-school level in Nigeria. Moreover, several studies have measured motivation, attitude, engagement or satisfaction rather than interest as a distinct outcome. Evidence is therefore insufficient regarding the effect of computer simulation on students' specific interest and academic achievement in Nuclear Chemistry within the Nigerian context. The geographical context presents an additional gap because findings from other Countries not Nigerian states may not reflect the instructional conditions, technological resources and learning experiences of students in Cross River State. The effect of computer simulation learning strategy on students' interest and academic achievement in Nuclear Chemistry therefore remains insufficiently established in the Calabar Education Zone, Nigeria. The present study addresses this gap by examining whether computer simulation learning strategy, compared with conventional teaching, influences students' interest and academic achievement in Nuclear Chemistry.

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

Statement of null hypothesis: There is no significant effect of teaching method (computer simulation learning strategy and conventional teaching method) on students' interest in Nuclear Chemistry.

Methodology

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, from 113 public co-educational secondary schools. Four schools were selected from two purposively selected Local Government Areas using purposive and random sampling based on their public, co-educational status and availability of computer facilities. One intact class was selected from each school, yielding 139 students who participated in the pre-test and met the 70% minimum attendance requirement.

Three researcher-developed instruments were used: Nuclear Chemistry Achievement Test (NCAT), Nuclear Chemistry Students' Interest Inventory (NCSII), and Nuclear Chemistry Students' Achievement Motivation Questionnaire (NCSAMQ). The NCAT contained 50 multiple-choice items, while the NCSII and NCSAMQ each contained 40 four-point Likert items. The



supervisors, experts in Chemistry Education, and Measurement and Evaluation validated the instruments. Their reliability coefficients were 0.734 for the NCAT, determined using the Kuder - Richardson 20 (KR-20), 0.766 for the NCSII, determined using Cronbach's alpha, and 0.865 for the NCSAQ, also 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 design was represented as $O_1 X_1 O_2$ for the experimental group and $O_3 X_2 O_4$ for the control group, where O represents pre-test and post-test observations and X represents the respective instructional treatment. 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 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

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	Observed	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%) females, while the conventional group comprised 39 (52.0%) males and 36 (48.0%) females. The Pearson chi-square result, $\chi^2 (1) = 0.003$, $p = .959$, indicated no significant difference in distribution between the treatment groups.

Research question: 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 Interest	Computer	64	30.576	5.720	.715	20	40
	Conven.	75	29.640	5.853	.676	20	40
	Total	139	30.072	5.791	.491	20	40
Pre-test Chem. Achievement	Computer	64	19.031	7.848	.981	5	35
	Conven.	75	17.333	8.380	.967	4	35
	Total	139	18.115	8.154	.692	4	35
Post-test Interest	Computer	64	54.547	11.486	1.436	34	78
	Conven.	75	38.553	10.490	1.211	21	56
	Total	139	45.971	13.507	1.146	21	78
Post-test Chem. Achievement	Computer	64	35.875	7.119	.890	5	46
	Conven.	75	27.040	5.244	.606	17	38
	Total	139	31.108	7.577	.643	5	46
Gained chem Interest	Computer	64	23.969	7.024	.878	13	42
	Conven.	75	9.013	8.962	1.035	-7	31
	Total	139	15.899	11.025	.935	-7	42
Gained chem Achievement	Computer	64	16.844	6.219	.778	-18	28
	Conven.	75	9.707	9.610	1.110	-11	29
	Total	139	12.993	8.940	.758	-18	29

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. Academic achievement followed a similar pattern.

The computer simulation group recorded a pre-test mean of 19.031 ($SD = 7.848$), compared with 17.333 ($SD = 8.380$) for the conventional group. At post-test, the corresponding means were 35.875 ($SD = 7.119$) and 27.040 ($SD = 5.244$), with gain scores of 16.844 and 9.707, respectively. Thus, students exposed to computer simulation demonstrated greater descriptive improvement in academic achievement. Overall, the descriptive results indicate greater improvement in interest and academic achievement among students exposed to computer simulation.

Testing Of Hypothesis

Hypothesis: There is no significant effect of teaching method (computer simulation learning strategy and conventional teaching method) on students' interest in Nuclear Chemistry.

A one-way ANCOVA was performed with teaching method as the independent variable, post-test Nuclear Chemistry interest as the dependent variable and pre-test interest as the covariate. The analysis determined whether the difference in post-test interest remained significant after controlling for students' initial interest levels.



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 post-test interest mean ($M = 54.546$, $SD = 11.486$) than those taught conventionally ($M = 38.653$, $SD = 10.490$). After adjustment for pre-test interest, the estimated marginal means were 53.886 ($SE = .997$) for the computer simulation group and 39.217 ($SE = .921$) for the conventional group. The ANCOVA results showed that the corrected model was significant, $F(2, 136) = 130.564$, $p < .001$. Pre-test interest also had a significant effect, $F(1, 136) = 123.540$, $p < .001$. Most importantly, teaching method significantly affected students' post-test interest, $F(1, 136) = 116.433$, $p < .001$. The null hypothesis was therefore rejected.

The finding indicates that teaching method significantly influenced students' interest in Nuclear Chemistry in favour of the computer simulation learning strategy. The higher adjusted mean for the computer simulation group shows that the difference remained after controlling for initial interest levels. The ANCOVA model produced $R^2 = .658$, indicating that the variables included in the model collectively explained 65.8% of the variance in post-test interest. This value should not, however, be attributed to teaching method alone because the model also included pre-test interest as a covariate. The result provides evidence that computer simulation learning strategy was more effective than conventional teaching in enhancing students' interest in Nuclear Chemistry. The finding is consistent with evidence that simulation-supported learning can promote affective engagement through visualization, exploration, manipulation and feedback. The result therefore supports the rejection of the null hypothesis and confirms a significant effect of teaching method on students' interest in Nuclear Chemistry.



Discussion of Findings

The finding showed that teaching method significantly affected students' interest in Nuclear Chemistry, $F(1, 136) = 116.433$, $p < .001$, after controlling for pre-test interest. Students taught using computer simulation recorded a higher post-test interest mean ($M = 54.546$) than those taught conventionally ($M = 38.653$), with adjusted means similarly favouring simulation ($M = 53.886$ vs. 39.217). This suggests that the difference was associated with the instructional treatment rather than initial interest levels. The finding agrees with Kekeba, Gure, and Olkaba (2024) and Jere and Mpeta (2024), who reported more favourable Chemistry attitudes following simulation-supported instruction. The present study extends this evidence to interest in Nuclear Chemistry.

The observed effect may be attributed to the interactive and representational features of computer simulations, which enable learners to visualize abstract processes, manipulate representations, observe changes and receive feedback. These affordances can promote active participation and sustained attention, particularly when teaching phenomena that are difficult to observe directly. Batamuliza, Habinshuti and Nkurunziza (2024) similarly found that interactive simulations improved Chemistry performance and concept retention, while Jere and Mpeta (2024) reported positive attitudinal outcomes from simulation-supported Chemistry instruction. Thus, the present finding strengthens existing evidence that simulation-based instruction can enhance affective engagement in Chemistry. The higher adjusted interest mean supports rejection of the null hypothesis and favours computer simulation over conventional teaching.

Conclusion

The study concluded that teaching method significantly influenced students' interest and academic achievement in Nuclear Chemistry. Students exposed to the computer simulation learning strategy demonstrated greater improvement in interest and academic achievement than those taught using the conventional teaching method. The findings suggest that the interactive and visual nature of computer simulations provides learners with opportunities to engage actively with abstract Nuclear Chemistry concepts, explore scientific processes and develop a better understanding of the subject matter. The observed improvement in both affective and cognitive outcomes indicates that computer simulation learning strategy can provide a more effective learning environment than predominantly teacher-centred conventional instruction. The study therefore concludes that integrating computer simulation into the teaching of Nuclear Chemistry can enhance students' interest and support improved academic achievement. Consequently, Chemistry instruction at the secondary-school level should give greater consideration to computer simulation learning strategy, particularly for topics involving abstract, microscopic and difficult-to-observe scientific phenomena such as those encountered in Nuclear Chemistry.

Recommendations

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

1. Chemistry teachers should adopt computer simulation learning strategy for teaching abstract Nuclear Chemistry concepts.



2. Education ministries should provide adequate ICT facilities, including computers, projectors, simulation software and reliable digital infrastructure.
3. Teacher education institutions should integrate computer simulation into pre-service Chemistry teacher education.
4. School administrators should provide regular training to improve teachers' competence in using computer simulations.
5. Curriculum planners should include simulation-based activities in difficult and abstract areas of Nuclear Chemistry.

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