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IMPACT OF COMPUTER SIMULATION INSTRUCTION ON ACADEMIC PERFORMANCE IN MOLE CONCEPT AMONG SECONDARY SCHOOL CHEMISTRY STUDENTS IN OKENE METROPOLIS

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Abstract

This study examined the impact of Computer Simulation Instruction on academic performance in Mole Concept among Secondary School Chemistry Students in Okene Metropolis, Kogi State. The study was guided by two objectives, two research questions, and two null hypotheses. The study adopted a quasi-experimental research design involving pretest and posttest. The students in the experimental group were exposed to Computer Simulation Instruction while students in the control group were exposed to a conventional method. A total of 1850 SS II students constituted the target population out of which 164 students were randomly selected as samples for the study. The instrument used for data collection was Mole Concept Performance Test (MCPT). The MCPT was duly validated and pilot-tested and the reliability coefficient was found to be 0.85. The research questions were answered using descriptive statistics while the null hypotheses were tested at $p \leq 0.05$ level of significance using an independent t-test. The findings of the study showed that students in the experimental group performed significantly better than those in the control group. Based on the findings of this study it was recommended among others that Chemistry teachers in secondary schools should adopt Computer simulation instruction in teaching difficult concepts like Mole Concepts.

Keywords Computer simulation instruction, Academic Performance, Mole Concept.

Introduction

The importance of science and technology to national goals, aspirations, and the economy has led nations to commit significant support to their advancement. Science and technology have become global phenomena, permeating almost every aspect of human endeavor. Recognizing the relevance of science and technology in nation-building, the National Policy on Education (FRN, 2013) emphasizes the teaching of science and technology at all levels of education.

Chemistry, being an important subject, plays a crucial role in the scientific and technological development of any nation (Yakub, 2016).

Chemistry is a fundamental science subject taught in Nigerian secondary schools and tertiary institutions. Ababio (2016) defines Chemistry as a branch of science that deals with the study of the structure, composition, properties, and reactions of matter in different forms. Chemistry is highly significant in the technological development of a nation, and its importance cannot be underestimated (Babalola & Hafsatu, 2015). Asiyai (2015) observes that chemistry has contributed to the development of modern technology through the application of its principles in various inventions. Chemistry education also equips individuals with the necessary knowledge and skills to interact meaningfully with the environment and solve societal problems, thereby preparing professionals in fields such as medicine, pharmacy, teaching, chemical engineering, biology, and other technologically based courses.

Despite the central and crucial position of Chemistry among other science disciplines, studies by Abdullahi (2014), Yakub (2016), and Israel (2020) have consistently shown the poor academic performance of students in Chemistry at the Senior School Certificate Examination (SSCE). The West African Examination Council Chief Examiners Report (WAEC, 2021-2022) has also reported students' generally poor performance in Chemistry. Several factors have been identified as contributing to this poor performance, including inadequate laboratory infrastructure and equipment, the mathematical and abstract nature of Chemistry concepts and laws, and inappropriate teaching methods employed by teachers (Samba & Eriba, 2012). Poor teaching methods have been recognized as a major cause of students' underperformance in Chemistry. Previous research has focused on the use of different models of inquiry learning in science but often overlooked students' prior knowledge and the application of what they have learned. Therefore, this study employs Computer Simulation Instruction, which aligns with the constructivist instructional approach—an innovation in science education.

Computer simulations are computational models that replicate real or hypothetical situations or natural phenomena, enabling users to manipulate and modify parameters within them (Clark et al., 2009). According to Chen et al. (2013), computer simulations are computer-generated versions of real-world objects. They provide a near-authentic environment, context, and situations for task-based learning, allowing learners to observe events, processes, and activities that might otherwise be inaccessible. Computer simulations incorporate multimedia elements such as graphics, animation, static pictures, simulations, photos, videos, text, and narration on the computer screen (Elangovan & Ismail, 2014). They are software programs designed to facilitate the teaching and learning of abstract concepts by helping students visualize these concepts and create mental models of observed phenomena. Through the integration of new knowledge acquired in the simulation learning environment with previous knowledge, computer simulations assist in simplifying the presentation of abstract concepts (Ali & Zamzuri, 2016; Elangovan et al., 2014). Simulation mimics the behavior of an ideal system, presenting abstract concepts in a simplified manner to students (Hulya, Aslan, & Rifat, 2011; Chinenye, Abraham, & Willaims, 2019). Computer simulation instruction has been identified as an effective instructional medium for enhancing students' learning of difficult and abstract concepts (Cheung, Slavin, Kim, & Lake, 2016). Furthermore, it has been found to improve students' performance regardless of gender (Cheung et al., 2016).

Gender is an important variable in educational research, and it has been a subject of concern for educators and researchers. Okolo (2018) asserts that gender issues in science have created aversion, as science-related subjects have been stereotypically associated with males due to their perceived abstract and difficult nature, which aligns with the attributes traditionally associated with boys. Lagoke (2011) notes that boys tend to outperform girls in activities that involve manipulation, and boys are generally seen as more mathematically and scientifically inclined. However, other researchers, such as Mari (2010), have observed that female students perform better than male students. Akhigbe and Ogufere (2016) found no significant difference in the performance of male and female students when exposed to computer simulation instruction. Therefore, this study aims to investigate the impact of Computer Simulation Instruction on performance and determine if there are significant differences in the performance of male and female Chemistry students in Okene Metropolis.

Methods

The study utilized a quasi-experimental control group design with pretest and posttest measurements. The target population consisted of all public senior secondary schools in Okene Metropolis, Kogi State. From this population, a sample of 164 students was randomly selected using a simple random sampling technique. The sample was divided into two groups: the Experimental Group (EG) and the Control Group (CG), with 80 students in the EG and 84 students in the CG.

Both groups were administered a pretest to assess their academic performance before the intervention. The experimental group received Computer Simulation Instruction (CSI), while the control group received conventional teaching methods. After a six-week treatment period, a posttest on academic performance was administered to both groups to measure their performance.

The data collection instrument used in this study was the Mole Concept Performance Test (MCPT), which was validated and pilot tested. The reliability coefficient of the MCPT was found to be 0.85. The collected data were then collated and analyzed using SPSS version 23. Descriptive statistics such as mean and standard deviation were used to answer the research questions, while an independent t-test was conducted to test the research hypotheses at a significance level of 0.05.

Findings and Discussions

Research Question One: What is the difference between the mean academic performance scores of students exposed to Computer Simulation Instruction (CSI) and those exposed to conventional methods?

To address research question one, the post-test scores of the experimental and control groups on the Mole Concept Performance Test (MCPT) were analyzed using descriptive statistics, specifically the mean and standard deviation. The summary of the analysis is presented in Table 1.

Table 1: Summary of Mean and Standard Deviation of Post-test Mean Performance Scores of the Experimental and Control Groups

Groups	N	Mean	Std. Deviation	Std. Error	Mean Difference
Experimental	80	45.23	3.81	0.65	
					18.36
Control	84	26.87	5.98	0.97	

Table 1 indicates that the experimental group had a mean academic performance score of 45.23, while the control group had a mean score of 26.87. The mean difference between the two groups is 18.36, favoring the experimental group. This suggests that students exposed to Computer Simulation Instruction (experimental group) performed better academically in the mole concept compared to students exposed to conventional methods (control group).
To determine if the difference in mean academic performance score between the experimental and control groups is statistically significant, an independent t-test was conducted.

Research Question Two: What is the difference in the mean academic performance scores of male and female students who are exposed to Computer Simulation Instruction (CSI)?
To address research question two, the post-test scores of male and female students in the experimental group on the Mole Concept Performance Test (MCPT) were analyzed using descriptive statistics, specifically the mean and standard deviation. The summary of the analysis is presented in Table 2.

Table 2: Summary of Mean and Standard Deviation of Mean Performance Scores of Male and Female Students in the Experimental Group

Groups	N	Mean	Std. Deviation	Std. Error Mean	Mean Diff.
Male	42	54.37	9.51	1.36	
					0.18
Female	38	54.19	14.49	3.42	

Table 2 presents the mean and standard deviation of the mean performance scores of male and female students in the experimental group who were exposed to computer simulation instruction. The male students had a mean performance score of 54.37, while the female students had a mean score of 54.19. The mean difference between the two groups is 0.18, indicating that there is a negligible difference in the mean performance scores of male and female students.
To determine if the difference in the mean performance scores between male and female chemistry students in the experimental group is statistically significant, an independent t-test was conducted.

Research Hypothesis One: There is no significant difference between the mean performance scores of students exposed to Computer Simulation Instruction (CSI) and those exposed to the conventional method.

To test research hypothesis one, the data collected from the responses of the students in the experimental and control groups on the Mole Concept Performance Test (MCPT) were analyzed using an independent t-test. The results of the analysis are summarized in Table 3.

Table 3: Summary of Independent T-test Analysis of Mean Performance Scores of Experimental and Control Groups

Group	N	Mean	Std. Deviation	Df	t-Cal	p-value	Remark
Experimental	80	45.23	3.81				
				162	10.83	0.01	Significant
Control	84	26.87	5.98				

Significant at p≤0.05 level

The independent t-test results indicate that there is a significant difference between the mean performance scores of students in the experimental group (exposed to Computer Simulation Instruction) and the control group (exposed to the conventional method). The t-value is 19.74, with a corresponding p-value of 0.01 ($p < 0.05$). Therefore, the research hypothesis is hereby rejected, suggesting that there is a significant difference in the mean performance scores between the two groups.

Research Hypothesis Two: There is no significant difference between the mean academic performance scores of male and female students exposed to Computer Simulation Instruction (CSI).

To test research hypothesis two, the data obtained from the posttest scores of male and female students in the experimental group on the Mole Concept Performance Test (MCPT) were analyzed using an independent t-test. The results of the analysis are summarized in Table 4.

Table 4: Summary of t-test Analysis of Male and Female students in Experimental Group

Group	N	Mean	Std. Deviation	Df	t-Cal	p-value	Remark
Male	42	54.37	9.51				
				78	0.48	0.85	Not Sig
Female	38	54.19	14.49				

Significant at p≤0.05 level

The independent t-test result indicates that there is no significant difference between the mean performance scores of male and female students in the experimental group (exposed to Computer Simulation Instruction). The t-value is 0.48, with a corresponding p-value of 0.85 ($p > 0.05$). Therefore, the research hypothesis is hereby accepted, suggesting that there is no significant difference in the mean performance scores between male and female students exposed to computer simulation instruction.

Findings

The results of the data analysis presented in Tables 1 and 3 indicate several significant findings. Firstly, there was a significant difference in the performance of students exposed to Computer Simulation Instruction (CSI) compared to those exposed to the conventional teaching method. This suggests that the use of computer simulation instruction in teaching Chemistry had a positive impact on student's academic performance. This finding aligns with previous studies by Adebayo and Oladele (2016) and Ayodeji (2020), which also reported that Computer Simulation Instruction promotes students' understanding of concepts, critical thinking skills, and problem-solving abilities.

Secondly, the analysis in Tables 2 and 4 revealed that there was no significant difference in the performance of male and female students exposed to Computer Simulation Instruction. This indicates that gender does not influence learning outcomes when using computer simulation instruction. This finding is consistent with the findings of Akhigbe and Ogufere, who also reported no significant gender difference in performance when students were exposed to computer simulation instruction.

Discussions

The results of the data analysis presented in Tables 1 and 3 indicate several significant findings. Firstly, there was a significant difference in the performance of students exposed to Computer Simulation Instruction (CSI) compared to those exposed to the conventional teaching method. This suggests that the use of computer simulation instruction in teaching Chemistry had a positive impact on students' academic performance. This finding aligns with previous studies by Adebayo and Oladele (2016) and Ayodeji (2020), which also reported that Computer Simulation Instruction promotes students' understanding of concepts, critical thinking skills, and problem-solving abilities.
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Conclusion

In conclusion, the study establishes that computer simulation instruction has a significant positive impact on the performance of Chemistry students in Senior Secondary Schools. It also highlights that computer simulation instruction is a gender-friendly approach, as it does not discriminate between male and female students in terms of academic performance. Therefore, computer simulations can be effectively used as a pedagogical tool to enhance the understanding of complex and abstract concepts in Chemistry, facilitating a shift from abstract to concrete learning experiences.

Overall, the findings emphasize the potential of computer simulation instruction in improving students' academic performance and promoting a more engaging and effective learning environment in Chemistry education.

Based on the findings of this study, the following recommendations are proposed:

1. Professional development programs, such as workshops, seminars, and conferences, should be organized by professional associations like the Science Teachers Association of Nigeria (STAN) and the Nigeria Educational Research and Development Council (NERDC). These programs should focus on training Chemistry teachers in the effective use of Computer Simulation Instruction (CSI) in secondary schools. By enhancing teachers' knowledge and skills in utilizing computer simulation instruction, students' participation and performance can be improved.

2. The curriculum planners responsible for developing syllabi should take into consideration the results of this study. The empirical evidence provided in this research supports the inclusion of Computer Simulation Instruction (CSI) as an alternative teaching strategy in the senior secondary school curriculum for Chemistry. By incorporating computer simulation instruction into the curriculum, students' academic performance in Chemistry can be enhanced. This recommendation highlights the need for an evidence-based approach to curriculum development.

By implementing these recommendations, stakeholders in education, including teachers, curriculum planners, and professional associations, can contribute to the improvement of Chemistry education in secondary schools. The use of Computer Simulation Instruction (CSI) as a teaching strategy can lead to more engaging and effective learning experiences, ultimately resulting in improved academic performance for students.

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