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Effectiveness of computer simulation software on students' learning and performance of scientific concepts in Sabon- Gari Educational Zones Kaduna state, Nigeria.

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Abstract

This study examined the effect of computer simulation as an instructional delivery system in determine students' understanding of scientific concepts and academic performance. The study used a quasi-experimental design, the population consist of Private and public senior secondary school students studying science in Sabon- Gari educational Zones Kaduna state. The sample for the study was derived from the selected secondary schools. Systemic sampling technique was embraced to smooth out the chosen zones. In each zone, two (2) schools were deliberately chosen, one (1) each from the urban and rural area respectively. A sample of 155 different students, comprising of 76 and the control group with 79 students, the participants taking a set of tests before and after receiving treatment. An innovative computer-simulated instructional system was used with the experimental group, while the traditional lecture method was used with the control group. Information was collected using a tool called the Science Concepts Performance Test (SCPT). The collected data was analyzed with descriptive and inferential statistics of means, percentages and standard deviation to provide insight into the research questions and the quantitative statistics employed the use of t-test to test the null hypothesis at a 0.05 level of significance. The data gathered from the pilot test of the SCPT were subjected to Kuder–Richardson 21 (KR-21) test which resulted as 0.712 reliability coefficient. The coefficient guaranteed the certainty of purpose of the instrument. The results indicated that Science concepts were easier to grasp through simulation software than through traditional lecture.

Keywords: Computer simulation Software; Innovative instruction; Performance and Scientific Concepts

1. Introduction

Effective teaching and learning in various schools have been a main issue for all education sectors lately. One of the reasons are the fall in the nature of the alumni of most public schools and the lack of the resources required for effective teaching and learning. The effectiveness in teaching is central particularly when we consider teaching and learning and as the securing of information and abilities to empower one become a more valuable individual from the general public. Teaching involves processes, intentional exercises equipped towards the improvement of the less inexperience individuals. Teaching and learning embraces types of cycle, conduct and exercises which could not be clarified by a solitary hypothesis (Hoerunnisa, et al., 2019). Teaching consequently, is a unique cycle in training. In the classroom circumstance, ICT has been noted as fundamental devices for successful teaching and learning. The utilization of ICT in classroom circumstance sees the educators as facilitator as opposed to dispenser of knowledge. It is necessary to embrace the utilization of ICT in teaching and learning in order to try not to be disposed from the world of intranet and global village. ICT can be seen as any gear or associated arrangement of hardware that is utilized in automatic acquisition, capacity, control, the board, control, show, exchanging and transmission of data. (El-Sofany and El-Haggar, 2020).

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To make progress in a educational system as far as great quality education system is concerned, it depends generally on the available of infrastructural resources in adequate amount and quality. The significance of innovation in accomplishing present day instructive interest must be gained on the off chance that secondary teachers' mentality and discernments is satisfactorily evolved toward the utilization of innovation for educating and growing experience (Jovalson and Gaudelia, 2021). knowledge is basic and the facts confirm that education is principal to the improvement of a powerful workforce fit for getting to and coordinating information into social and economy exercises and taking part in contemporary worldwide economy. With the development of information Communication Technology (ICT), the conveyance of instruction and preparing is evolving. Successively, ICTs is impacting the existence of each and every person in current ways of securing information. ICT should be visible as an interaction, which is a bunch of exercises worked with by electronic means: the input, processing, transmission, and giving out as results. While as a resource it covers the hardware and software, network, and a few different devices that convert data into information (Rachmawati, et al., 2023).

Innovation in education, consider not only the latest technological advancements, but also how those advancements can be used to inspire students to become independent thinkers and dedicated learners. Since innovations are required in ways of thinking that could be implemented to better serve the needs of today's dynamic society. The creation and use of simulations to impart knowledge on students is one example of such progress. The process of running a model in real time or space is known as simulation. The role of technology in the modern classroom is growing, and it is being used in many different contexts. But among the many types of educational software, interactive computer simulations are especially popular in the field of science (Zaman et al., 2018). The goal of a computer simulation is to demonstrate how scientific principles can be applied to real-world phenomena through the medium of an animated, interactive, and game-like environment. This method streamlines the complex visual and conceptual models developed by experts and scientists into something that can be easily grasped by students (Adams et al., 2008). According to research that Hartel performed in the year 2000, “XYZET” is a Physics teaching simulation software, and this research will focus on it. Hartel concluded in his research that simulations should be regarded as fundamental methods for improving Physics education. The virtual nature of computer simulations does not prevent students from studying and observing physical, chemical, or biological phenomena in situations where actual research would be impossible due to time constraints, safety requirements, or a lack of appropriate equipment. They help close the gap between theory and practice (Sweeney and Geer, 2021).

The Nigerian government, in its National Policy on Education, emphasized the importance of making classroom instruction more hands-on and activity-based so that the country can reap the full benefits of education and achieve its stated goals. Innovative use of information and communication technologies (ICT) and experimentation. (FME, 2004). To build a technologically advanced nation, the foundation of science education begins in the secondary schools; this highlights the importance of creating simulations for the efficient teaching of abstract concepts in the sciences during the final years of high school. The use of simulations to better grasp abstract scientific concepts should be ingrained in students through science education. Important and central to the scientific method are concepts, which can be thought of as organized mental representations of the physical world (Landrum et al., 2021). However, ambiguity arises because of characteristics that are built into the very ideas themselves. While an abstract concept cannot be said to "be," The nature of mathematical objects is often thought to be abstract because it "emerges" from the logical "relations" of other concepts. A tangible idea is one that can be visualized in the mind's eye as an abstract concept. Human intelligence relies in large part on our innate capacity to recognize, comprehend, and articulate abstract ideas. Not all abstract ideas are imaginary; some can be proven through evidence. Time, events, and causes are all abstract concepts; so are elements of the scientific methods like hypothesis, experiments, and controls. Raising the bar for education in the STEM fields is a national priority and a goal shared by educators across the board (Udousoro, 2018).

Gender is categorized as part of human endeavor and has an import on all areas of life. ICT advancements allude to those new discoveries and better approaches for getting things done in a better perspective. Gender and ICT advances subsequently mean the gender connection between male and female as they respond to the presence or disclosures of new advancements of ICT in the improvement teaching and learning procedures (Sentongo et al., 2019). Elbanisa and Sueb (2022) indicated that gender as a social trait and opportunity related with being male and female. The shared relationship which is built and is learned through socialization cycle and innovation is changing nature to address their issues. Research over the years have proposed that there is technological and experience gap between male and female with female subject falling behind their male friends in the utilization of devices, computer system and other related ICT tools. This study thus correlated the academic success of high school seniors with the use of simulations designed to teach science concepts (Goossen, et al., 2020). Since the current educational system is showing signs of inequity, especially in the area of science, all hands must be on deck to rectify the situation. For example, work could be done to develop simulations that help science educators convey abstract concepts to their students.

1.1. Statement of the Problem

Middle school students, specifically the science school curriculum, the teaching methods employed, the accessibility of instruments, materials, teaching strategies, and the school atmosphere are only a few of the issues that plague science education in Nigeria schools, (Udousoro, 2018). Students do poorly in science classes overall and in physical science classes specifically at all educational levels. There are many obstacles to science education in South-East, including the students' dismal performance in the physical sciences. As a result, the processes that deal with the curriculum should be changed, particularly in the way that educational content and instructional techniques are presented. As well as the delivery of content in line with educational objectives, using computerized programs and cutting-edge teaching techniques including interactive computer simulations. In South -East Nigeria secondary schools, much has not been done in utilizing computer simulator software in enhancing teaching and learning. To the best information on the researchers, there are lack of concentration on how simulator software can be used for guidance and what it can mean for students learning initiative

Computer simulations and their effects on success has been the subject of some research studies, the studies did not show a sufficient amount of interest in studying computer simulation, its effect on academics' performance and techniques among third-year middle school students, particularly in South -east secondary schools, and their effects on academic success in rural areas. This study is aimed to examine how interactive computer simulations affect science students' academic performance. In order to better understand how simulation teaching strategies affect students' academics in science secondary school additionally, the study took the influence of gender into account (Hoerunnisa, et al., 2019). It is in the light of this, the research examines the effect and academics performance of students towards the utilization of versatile innovation called computer simulation software in South-East Nigeria.

1.2. Purpose of the Study

The purpose of the study was to determine the effectiveness of Simulation Software on Students' Learning and Performance in Scientific concepts related subjects in senior secondary schools in Sabon- Gari educational Zones, Kaduna state of Nigeria. Specifically, the study sought to determine the following objectives;

- To determine the effect of computer simulation software in teaching and learning concept of science
- To examine whether the gender of the students make a difference in performances in teaching and learning through computer simulation software

1.3. Research Questions

- How do computer simulations software affect students' ability to grasp difficult scientific concepts?
- Does the gender of a student make a difference in how well they perform in leaning through computer simulation software?

1.4. Research Hypotheses

- HO1 There is no significant difference between the usage of computer Simulations software in improving students' ability to learn complex scientific concepts.
- HO2 There is no significant difference between male and female students using computer simulations software as instruction.

2. Research Methodology

The whole data collection and analysis process was conducted using a quasi-experimental design. The population of the study comprises of all science secondary school students both Public and private sector in Sabon- Gari educational Zones Kaduna state, who were enrolled in a science course were included in the study. There were an approximated 101,150 students enrolled in science courses at the senior secondary level. Students from the designated secondary schools were the only ones included in the sample. The zone's member was narrowed down from four to two using a systematic sampling method. one (1) chosen at random from each of the metropolises and suburban enclaves, respectively.

In each of the zone, one (1) school was chosen in each category. One urban and one rural school were chosen for the experimental group, and the same was true for the control group. Within each of these schools, an entire SSS1 science class was randomly selected and divided into the experimental and control groups. There were total of 155 students in the study, with 76 in the experimental group and 79 in the control group. The typical an average of 16 years old.

In order to better explain science-oriented class ideas a package on simulation was developed for the fields of Biology, Chemistry and Physics, the following science concept courses were taken respectively; biology (Cell and Organs), chemistry (State of Matters), and physics (Concept of Energy) to the experimental group. The same science concept taught in control group was also taught with the conventional lecture method. Teachers in schools randomly selected for the experiment were first given training on how to use the simulation software, then asked to conduct a "micro-lesson" while the researchers observed and graded their performance.

The instrument was designed for data collection, the "control" group received the same information via more traditional methods, namely, a series of lectures, Science Concepts Achievement Test was developed as a data collection tool for the study (SCAT). There are a total of twenty (10) objective items with four possible answers (A-D). Along with their materials, the drafted instruments and the packages were given to three science teachers for physical observation and validity. What they observed, served as a notable guide for the further development of the tool. It was subsequently tried out on students from a different school in a different local government council. The SCAT reliability coefficient was calculated as 0.712 after analyzing data from the pilot test using the Richard Kuderson 21 method. For that reason, the instrument could be used with complete assurance.

Before the treatment began, the two groups were given the instrument's pre-test to determine how similarly they would respond to the intervention. Both groups were given the same post-test after eight weeks of interaction improved student comprehension of theoretical abstractions. All of the statistical analysis of the study's data was conducted using strictly qualitative and quantitative methods. Means and percentage calculations are part of the qualitative statistics used to answer the quantitative statistics used a t-test to examine the hypotheses and answer the research questions. instrument presented in a permutation format, with answers graded to obtain raw data subsequently subjected to statistical analysis to ascertain if advancement and utilization of simulation has an influence on

3. Result

3.1. Demographic

Table 1 Respondents and sex

Variable	Students (Sex)			
	Male		Female	
	Experimental	Control	Experimental	Control
Number	41	37	37	40
Percentage	26.90	23.42	24.33	25.35

Table 2 Sample for treatment

Variable	Treatment	
	Simulation	Control
Number	75	80
Percentage	48.02	51.98

Table 1 presents demographic characteristics of respondent. It revealed the variable sex comprises of male and female, each can as well be grouped to experimental and control. Male category was 41 experimental while control was 37 responded and their percentages were 26.90 and 23.42 respectively. Also, female category was 37 experimental while control was 40 responded and their percentages were 24.33 and 25.35 respectively.

Table 2 shows sample for treatment, the treatment consists of simulation and control. The simulation was 75 and control was 80. The percentages of simulation and control were 48.02 and 51.98 respectively.

- **Research Question** 1: How do computer simulations software affect students' ability to grasp difficult scientific concepts?

Table 3 Student Mean test scores based on Treatment

Treatment	Numbers	Mean		Std. Dev. (σ)	Mean gain score
		Pre-test	Post-test		
Simulation	75	8.40	14.32	2.774	5.82
Control	80	9.36	11.15	3.350	2.31

Table 3 shows that, the control group's post-test mean score of 11.15 with Standard deviation of 3.350; mean gain of 2.31. Also, the sample exposed to simulation had a post-test mean score of 14.32 Standard deviation of 2.774 and mean gain of 5.82. This proves that unlike the traditional lecture method, students have significant improvement while learning using simulation in teaching of scientific concepts.

- **Research Question 2:** Does the gender of a student make a difference in how well they perform in leaning through computer simulation software?

Table 4 Post-test mean scores based on gender

Gender	Number (N)	Mean($\bar{x}$)	Std. Dev. (σ)	Difference in Means
Male	39	11.84	3.071	0.42
Female	37	12.26	3.832	

Table 4 presents the average mean male score on the post-test is 11.84, with a standard deviation of 3.071, while the average mean female score is 12.26, with a standard deviation of 3.832, for a total difference of 0.42. As a result of this, it can be concluded that gender does not plays impact on students using computer simulations in the classroom on the learning outcomes of students.

3.2. Research Hypotheses

HO1: There is no significant difference between the usage of computer Simulations software in improving students' ability to learn complex scientific concepts.

Table 5 t-test of students' post-test scores according to treatment groups

Treatment	Number (N)	Mean ($\bar{x}$)	Std. Dev. (σ)	df.	t	Sig (2-tailed)
Simulation	75	14.32	2.774	153	3.758	.000
Control	80	11.15	3.350			

Significant at $p < 0.05$

The result showed in Table 5 presents that there was a significant difference between the usage of computer Simulations software in improving students' ability to learn complex scientific concepts. It is revealed that mean score of simulation was 14.32 and that of control was 11.15 t(153) equal to 3.758 at p<0.055. The hypothesis that stated that, there is no significant difference between the usage of computer Simulations software in improving students' ability to learn complex scientific concepts was therefore rejected. The Results showed that the mean score for those who participated in the simulations was higher than that of the control group. There is a clear correlation between the use of cutting-edge computer simulations in the classroom and increased student performance in the areas of science concept courses.

- HO2: There is no statistically significant difference in learning outcomes between male and female students who were instructed using computer simulations.

Table 6 t-test of students post test scores based on gender

Sex	Number (N)	Mean ($\bar{x}$)	Std. Dev. (σ)	df.	t	Sig(2-tailed)
Male	39	11.80	3.071			
Female	37	12.16	3.632	74	.374	708

No significant at $p < 0.05$

Table 6 shows that when teaching abstract concepts through simulations, there was no statistically significant difference between the mean scores of male students which is equal to 11.80 and that of female students of mean score which is equal to 12.16. In this case, the null hypothesis of no significant difference was accepted. This suggests that there is no major difference distinction between male and female students when it comes to the use of simulations to enhance learning of abstract concepts in science. Students' performance does not differ by gender when using a computer simulation as a teaching tool.

4. Discussion

The findings of this study suggest that, compared to the more traditional lecture method, students comprehend more on scientific concepts through computer simulation. A statistically significant difference in usage patterns was found in the data used to test the null hypothesis, it was affirmed from the finding that using simulation is better option teaching of scientific concepts. This was as a result of simulations helped students to make connections between the concrete and the theoretical, leading to a more complete grasp of the latter. These results seemed to back up the claims made by Rachmawati, et al., (2023), who found that students learning wave in physics through computer simulation performed better than their colleagues taught with mode of lecture methods. The results of the current study are consistent with those of Sweeney & Geer (2021), who presented that students who were exposed to computer simulations increased in performance than those who were not.

The results of this study were corroborated by the findings of Sentongo, et al., (2019) reported that Students learn and improve in performance more from learning through computer simulations than learning through traditional lectures. Zaman et al., (2018), who found that using a technique involving simulation games to teach students significantly improved their performance while class. Elbanisa & Sueb (2022), gave scenario in their findings that when comparing the effectiveness of different teaching methods, especially teacher-centered ones, the simulation games technique yielded the best results of students' academic performance. El-Sofany & El-Haggar (2020), who also found that students learning through computer simulation outperformed those who learned through traditional lecture. Contrary to the findings of Sentongo et al. (2019), that reported on "The Influence of Simulation Performance on Student Interest," simulation performance does not significantly affect students' perceptions of their knowledge acquisition or their interest in the subject matter. Additionally, the findings of this study contradict those of Zaman et al., (2018), who discovered that students who learn Physics practical through the traditional method develop superior practical skills to those who learn the subject via simulation. This discrepancy may be explained by the fact that this study focused on the cognitive domain of Bloom's taxonomy of educational goals, while the aforementioned studies focused on the affective and psychomotor domains. As a result, it seems reasonable to conclude that incorporating computer simulation into teaching strategies is beneficial for raising students' performance academically.

Moreover, the results demonstrated that neither male nor female students benefited more from using simulations to learn scientific concepts. This study found that the mean scores of male and female students taught science concept with computer simulation subject were at the same level of achievement in academics performance. It implies there was an equivalent level of success in simulating scientific concepts. Furthermore, this result suggests that gender did not play a significant role in determining students' success in science. These results corroborated the findings of previous studies by Sweeney & Geer (2021), who found no significant difference in scholastic performance between males and females in chemistry. Other research, such as Udousoro, (2018), contradicts this result as stated in their own findings that female students outperform male students in science, while Landrum, et al., (2021) research showed a significant gender difference on students' achievement in favor of males. Gender stereotypes, which encourage men and women to behave differently, are likely to blame for the disparity in performance. Students to demonstrate an aptitude for and enthusiasm for subjects that are directly related to the societal roles to which they aspire. Our research indicates that students' basic psychological needs were met, and furthermore, that simulation can be used to boost students' intrinsic motivation. One possible explanation is that using a simulation package in the classroom encourages students to become more engaged and proactive in their learning of scientific concepts.

5. Conclusion

The study showed that there was no significant difference in their academic performance based on gender. Questions were posed and hypotheses were tested in an effort to advance simulation as an innovation in the teaching and learning of concepts in science in senior secondary school students. A study found that students' grades went up when they used simulations. It is worthwhile to know that secondary school science classes could benefit from more creative uses of simulation. It is important to provide a workshop for secondary school science teachers on how to gain access to, and create, novel computer simulations on science concepts. Both sexes should be given an equal shot at learning science in secondary schools. It can be simply concluded that, science concepts were easier to grasp through computer simulation than through the more traditional lecture method. The results also showed that when students were taught scientific concepts using a computer simulation, there was no significant difference in their academic performance based on gender. Consequently, the study concludes that, in order to effectively teach scientific concepts, science educators should make use of cutting-edge simulation in their classrooms. Science educators should have access to ongoing professional development that focuses on curriculum design and the use of relevant digital resources (such as simulations) in the classroom. Both genders should be encouraged to study science without regard to the stereotype that men are more naturally gifted in this area. It is also suggested that Sabon- Gari educational Zones Kaduna state secondary school teachers and students should endeavor to promote the use of computer simulation in teaching and learning.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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