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Investigating impact of computer simulation on secondary education of biology students

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Abstract
The study investigated the possible effect of the use of computer simulation on secondary school Biology students' Academic performance and retention in Port Harcourt city local government area, Rivers state. The quasi-experimental design was adopted. A total of 180 SS1 students was drawn from an intact class formed the sample size. The population of the study was 1,243 students in the three selected schools who are offering Biology. Two instruments namely; senior secondary Biology performance test (SSBPT) and senior secondary Biology retention test (SSBRT) were used for the data collection. Two research questions and two hypotheses were used for the study. Mean and standard deviation was used to answer research questions while the research hypotheses were analyzed using ANCOVA at.05 level of significance. The findings established that students taught with computer simulation performed and retained better than students taught using demonstration method. It was recommended that biology teachers should make use of computer simulation in teaching since it enhances students understanding and retention of biology course. Biology teachers should improve themselves innovatively by attending workshops, and learn how to use computer simulation in teaching biology.

Keywords: interactivity, scaffolding, interface driven, simulation

Introduction
Biology is a science of life, it is taught at the senior secondary school (S.S.S) and tertiary level of education. It helps students understand the rudiments or root of life and creation. It is concerned with the study of life rather than objects; it involves the study of living and non-living organism. A biologist studies the structure, function, growth, origin, evolution and distribution of a living organism. Biology is divided into many specialized fields that take care of their physiology, morphology, anatomy, origin and distribution. Biology course helps students to respect and appreciate the great diversity of life at all its levels of organization and to understand the impact of progress in Biology on our lifestyle. To ensure quality in the teaching and learning of Biology, the teacher has to consider some important factors such as the nature and quality of instructional materials, the presentation of content, the pedagogical skills of the teacher, the learning environment and students' motivation. However, in this digital age, education has experienced innovations and changes in the teaching and learning process. The emergence of digital tools and proper integration and utilization by teachers can improve performance on the part of teachers and facilitating learning on the part of students (Williams, 2016) [13]. Technological advancement has created a paradigm shift in education from being teacher-centered to learner-centered. This technological advancement has made the 21st-century learner be conversant with all kinds of digital tools like computers, laptops, smartphones and so on. A teacher happens to be the implementer of curriculum, (Nwafor & Umoke 2014) [9]. They are faced with the responsibility of exploring ways to enhance teaching and learning in order to improve the academic achievement of students. They adopt the technological tools of which the students are used to by incorporating computer simulations as learning tools in the classroom. The students, who are referred to as the 21st-century learners (digital natives) as a result of their exposure to digital tools, have been made to reason and analyze information critically and differently from their predecessors. Computer simulation is a program that replicates or imitates an object making it look real, hence providing students an avenue to appreciate uncertainty and acquire responsibility in learning which results in their performing well in Biology. Computer simulation has become a useful part of modelling many natural systems in the sciences like Physics, Chemistry, Biology, etc. in order to gain insight into the operation of the system.

Literature Review
Computer simulation is a computer program and a teaching strategy that imitates an object or a system making it look real. According to Encyclopedia Britannica, Computer simulation is the use of a computer to study the dynamic behaviour of a system in response to conditions that cannot be safely or easily applied in the real world. It is an approach used by teachers to arouse the interest of students in the classroom. The computer can be seen as an electronic device that stores and manipulates information while simulation means imitating exactly. Computer simulation happens to be the visualization of objects and skills that are difficult or too touchy to be viewed in the real world to enhance learning. According to Adebayo and Oladele (2016) [1] stated that computer simulation is a profound instructional strategy that is effective for teaching and learning of complex concepts. The idea is that this technology has been designed in a way that those topics that seem difficult are been simplified. Ndioho and Mumuni (2016) [8] computer simulation present engaging lesson concepts to students which are designed to help them conceive and retain the different concepts in science

courses. This implies that science teachers can use computer simulation to get the attention of the learners and also simplify the concept for better understanding. The researcher defines computer simulation as using a computer in a lesson to imitate the behaviour of a system. Meanwhile, the real behaviour of a system is visualized for the lesson to be well understood by the learner. Computer simulations are primarily used to facilitate and enhance learning; hence it simplifies different concepts, aids and promotes learning. Hulya and Rifat (2011) [6] describe computer simulation as a strategy that helps students to visualize processes that seem abstract and complex such as cell topics. This provides an avenue for students to observe how oxygen, food and water penetrate the cell membrane and waste products are expelled. Four Important Features of Educational Computer Simulations that are related to this work would include**:**

Model-Based: Simulations are model-based, meaning that rules and calculations in operating simulation are programmed by the instructor which is collectively called the "model." This model determines the act of the simulation which is dependent on the users' actions.

Interactive: Simulation models are programmed in a way that it will encourage learners to interact with them, by imputing information and then observing how the variables in the simulation change, based on the output.

Interface-Driven: This means that it must be as simple as possible for the learners to use. The value changes to influence variables and the observed value changes in the output must be found in the simulation interface.

Scaffolding: Scaffolding is a support to assist students in learning. This means that simulation designed for educational purposes must have scaffold to direct students systematically in the learning process, thereby making learning experience effective. Tavasuria and Zurida (2014) [10] was the opinion that computer simulation has a positive impact on students in teaching and learning biology. David (2003) [5] further explains that those learners' senses are primed to receive information; the attention and motivation of the learners are easily gained through the learning experience. The more students are motivated to learn the more they are active in the learning process. Therefore, faster learners are not bored and slower learners maintain control of their own rate of knowledge acquisition. Having discussed the features of educational computer simulation, it is vital to look at the benefits of computer simulation in learning. The advent of technology has increasingly changed the conventional roles and activities in the Biology classroom. Technology can be used to create an enabling environment for learners, which facilitates the acquisition and learning of Biology (Ango, 2002) [3]. Teachers are in a position to utilize these technologies in the classroom, such as computers, laptops, interactive whiteboards, projectors, etc. to enhance learning. In the process of finding out how these resources are used, you are invariably using computer simulation since scientists usually make use of these tools in their daily work. Uche, Abdulli, Asogwa and Ofoegbu (2016) [12] they were of the opinion that when teachers use this strategy especially in the teaching of genetic concept that significant effect on improving students' retention is made. Researchers have been working on classroom simulation for over a decade. The use of simulation in the classroom has been reported by many researchers with positive findings. Tayo (2012) [11] found out that students performed better when they are exposed to animated simulation. It shows that computer simulation helps students to build their understanding of topics in Biology. For instance, in a simulation of evolution, a student may see rabbits on a computer screen, by tweaking the simulation, he/she can observe what happens to the rabbit overtime, what happens when it is hot, cold, when there is a lot of food or a little food and also witness which rabbit survives and which rabbit fails under those various circumstances. In this way, there will be a huge improvement in students' understanding, performance and achievement. Utilization of computer simulation in the Biology classroom is determined by the instructor. Teachers can use a computer simulation to make a model that can reproduce some results in research literature involving feedback. Computer simulation can offer three dimensional (3D) manipulations that bring the concept to life. 3D multimedia simulation consists of multimedia elements such as graphics, animation, static pictures, simulation, photos or video texts on the computer screen and narration (Akpan, 2001) [2]. Students' motivation levels tend to increase when they receive lesson content in a realistic learning environment.

Methodology

Objectives

The purpose of the study is to determine the impact of computer simulation on senior secondary school students' academic performance and retention in Biology.

Specifically, the study has two objectives which are:

1. Compare the post-test mean scores of Biology students taught with computer simulation and those taught with demonstration method,
2. Ascertain the difference in the retention level of students taught with computer simulation and those taught with demonstration method,

Research questions

The following research questions will guild the study:

1. What are the post-test mean scores of students taught Biology using computer simulation and those taught with demonstration method?
2. What differences exist between the retention level of students taught with computer simulation and those taught with demonstration method?

Hypotheses

HO: 1 There is no significant difference between the post-test mean scores of students taught using computer simulation strategy and those taught using the demonstration method.

HO: 2 No significant difference exists between the retentions level of students taught with computer simulation and those taught with demonstration, method.

The study investigated the possible effect of the use of computer simulation and biology students' performance and retention. The researcher used two groups for the study, experimental and control group. Two lesson plans were used for the study, one for the demonstration learning group and the other for the computer simulation learning group. this was an intact class. The experimental (Treatment) group was taught with computer simulation while the control

groups were taught with Demonstration method.
The study lasted for three (3) weeks using two periods in a week. After teaching both groups, they were given the same post-test to respond to, and two weeks later, the retention test was administered to both experimental and control group and their scores were collected. Mean and standard deviation was used to answer research questions while the research hypotheses were analyzed using analysis of covariance.

Results

Research Question 1: What are the post-test mean scores of students taught Biology using computer simulation and those taught with demonstration method?

Research Question 2: What differences exist between the retention level of students taught with computer simulation and those taught with demonstration method?

Table 1: Mean, standard deviation and Mean difference of the students taught Biology using computer simulation and those taught with demonstration method. Post-test

Method	$\bar{x}$	SD
Computer Simulation	13.40	2.09
Demonstration Method	12.89	2.52

Table 1 revealed that students taught with computer simulation had a mean and standard deviation ($\bar{x}$ = 13.40 and SD = 2.09) while those taught using demonstration method had a mean score and standard deviation ($\bar{x}$ = 12.89 and SD = 2.52) on the post-test. This follows that students taught with computer simulation at the post-test performed better than the students taught with demonstration method.

Hypothesis 1: There is no significant difference between the post-test mean scores of students taught using computer simulation strategy and those taught using the demonstration method. In order to answer this research hypothesis, data were derived from responses to test items. The result is presented in table 2 below:

Table 2: summary of ANCOVA of student's post-test scores taught Biology using computer simulation and those taught Biology using demonstration method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	49.388[a]	2	24.694	4.767	.010
Intercept	2767.274	1	2767.274	534.225	.000
Post-test	37.632	1	37.632	7.265	.008
Method	12.286	1	12.286	2.372	.125
Error	916.856	177	5.180		
Total	32066.000	180			
Corrected Total	966.244	179			

Table 2 indicated an ANCOVA [between-subjects factor: method (use of computer simulation, Demonstration method); covariate: Pre-test] which revealed main effects of methods, (F (1, 177) = 2.372, p>0.05). This shows that H_0 was not rejected. This means that there is no significant difference between the outcome of students taught Biology using computer simulation and those taught Biology using demonstration method.

Table 3: Mean, standard deviation and mean difference of students' retention taught Biology using computer simulation and those taught using the demonstration method.

Retention test			
Method	$\bar{x}$	SD	
Computer	16.10	2.78	
Simulation	13.07	4.91	

Table 3 indicated that students taught Biology with computer simulation had a mean retention score and standard deviation ($\bar{x}$ = 16.10 and SD = 2.78). While those taught Biology with demonstration method had a mean retention score and standard deviation of ($\bar{x}$ = 13.07 SD = 0.17). This indicated that students who were taught with computer simulation retained better than students taught with demonstration method.

Hypothesis 2: There is no significant difference exists between the retentions level of students taught with computer simulation and those taught with demonstration method. in order to answer this research hypothesis, data were derived from responses to test items. The result is presented in table 4.2 below

Table 4: Summary of ANCOVA of students' retention scores taught Biology using computer simulation and those taught Biology using demonstration method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	466.650[a]	2	233.325	14.839	.000
Intercept	708.561	1	708.561	45.063	.000
Post-test	52.600	1	52.600	3.345	.069
Method	377.296	1	377.296	23.995	.000
Error	2783.100	177	15.724		
Total	41531.000	180			
Corrected Total	3249.750	179			

Table 4 indicated an ANCOVA [between-subjects factor: method (use of computer simulation, Demonstration method); covariate: Pre-test] which revealed main effects of methods, ($F(1, 177) = 23.995$, $p<0.05$). This shows that H_0 was rejected. This means that there is a significant difference between the outcome of students taught Biology using computer simulation and those taught Biology using demonstration method, showing that students who were taught with computer simulation retained significantly higher than students who were taught Biology using demonstration method.

Discussion

The findings in table 4 showed that the students taught Biology using computer simulation performed better with a mean difference of 7.10. While students taught Biology using with demonstration method had a mean gain of 6.53. This is further confirmed in table 4. which indicate that there is no significant difference on the academic performance of the students taught using computer simulation compared to those using the demonstration $F(1,177) = 2.372$, $p>0.05$. The null hypothesis one was not rejected at 0.05 alpha levels. This means that students taught with computer simulation achieved better scores than those taught with the demonstration method. This outcome is similar to what Hulya and Rifat (2011) [6] suggest that when students are taught with computer simulations, it made statistically significant improvements in their test scores. This may lead to visualizing concepts that seem abstract and complex therefore enhances their ability to learn the complex process. The findings of the current study support the findings of Adebayo and Oladele (2016) [1] which suggests that when students are exposed to computer simulation strategy in learning, it enhances students' achievement, indicating that they understood the concept more than those taught with lecture method.

Research question 2 indicates that students that were taught with computer simulation had a mean retention score of 16.10 while students that were taught Biology using demonstration method had a mean retention score of 13.07. This indicated that students who were taught with computer simulation retained higher than students taught with demonstration method. This was tested in hypothesis 2, Table 4 shows that there is no significant difference on the students' retention when taught using computer simulation $F(1,177) = 23.995$, $p<0.05$ and student taught with demonstration method. The null hypothesis was rejected at 0.05. This finding is in accordance with that of Uche, Abdulli, Asogwa, Ofoegbu (2016) [12] they found out that interactive computer simulation package has a significant effect on improving student's achievement and retention in genetic concept. In their study, Tavasuria and Zurida (2014) [10] assessed the effect of 3D computer simulation on biology students' achievement and memory retention and they discovered that those students who learnt cell division topic using 3D computer simulation had high memory level compared to the students who learnt with the conventional method. If this is the case, then, it is obvious that there is no significant difference in academic achievement of those taught biology with computer simulation and those taught with demonstration method. Also, Tayo, (2012) [11] findings reveal that students exposed to developed animated agricultural package performed significantly better than those exposed to the conventional lecture method, there was also a significant difference in the retention ability of the two groups. This is because motion leads to long term memory; therefore, students exposed to computer simulation retained more knowledge than those taught with the conventional method.

Conclusion

The integration of computer simulation in Biology teaching and learning have positive impacts on students. However, the findings of the study showed that computer simulation is more effective in learning biology than demonstration method in cell and its environment topic which help the students to visualize and understand the difficult concept such as diffusion and osmosis through the simulation.

Recommendations

1. The use of computer simulation seems to enhance performance and retention in a biology course, the biology teachers should employ this strategy in the classroom
2. The use of computer simulation should be encouraged and made compulsory among biology teachers in our secondary school since; it has the capacity of stimulating the three senses of vision, hearing and touching.
3. Biology teachers should develop themselves innovatively by attending workshops, and learn how to use computer simulation in teaching biology, especially cell and its environment.

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