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Fostering Senior Secondary School Students' Performance in Biology Using Computer Simulation and Instructional Scaffolding in Minna, Niger State

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Abstract

This study examined the effects of computer simulation and instructional scaffolding on the performance of senior secondary school students in Biology in Minna, Niger state. Quasi-experimental design employing pre-test, treatment and post-test was adopted. The sample consists of ninety (90) Senior Secondary (SSII) Biology students. Three secondary school were randomly assigned to experimental group 1 and 2 and control. Thirty (30) students consisting of fifteen (15) males and fifteen (15) females were randomly assigned to each group. Experimental group 1, 2 and control were treated with computer simulation, instructional scaffolding, and traditional method, respectively. Three research questions and three corresponding hypotheses were formulated to guide the study. Twenty-five (25) multiple-choice Biology Achievement Test (BAT) questions was used as instrument for data collection. The data collected were analyzed using Analysis of Variance (ANOVA), and t-test to test the formulated hypotheses at 0.05 level of significance. The finding shows that treatments used had significant effects on students' post-test achievement score. Students exposed to computer simulation and instructional scaffolding did better in performance than those taught with conventional teaching method. No significant difference was observed in the performance of the male and female students taught with both computer simulation and instructional scaffolding. It was concluded that meaningful learning can be enhanced using computer simulation and instructional scaffolding and that the approaches are gender friendly. It was recommended that secondary school Biology curriculum should be reviewed with an aim to integrate computer simulation packages and instructional scaffolding into the curriculum.

Keywords: biology achievement, computer simulation, scaffolding and secondary

The place of science in the development and fulfilment of the needs of any country is very pivotal. For instance, major advances in science and technology have helped nations to promote efficiency, self-reliance, and the overall wellbeing of humanity through inventions/innovations in Telecommunications, Transportation, Health and Agriculture. In Nigeria, the National Policy on Education FRN (2004) clearly spells out the objectives of science teaching from pre-primary to the tertiary level. Specifically, at the secondary level it entails equipping students to effectively live in this age of science and technology.

Science in its broadest sense denotes systematized knowledge in any field which is usually applied to the organization of objectively verified sense experience. Science can also be seen as the area of knowledge which gives theoretic explanations that are based on observations and experiments about the natural phenomena.

It spans a wide area of study and is basically divided into two major branches or field of discipline which are: Social sciences that deal with the study of human behaviour and societies and the Natural sciences which studies the natural world. Biology as one of the biggest branches of natural science is the science that studies Life; it studies both the life of creatures around us and the life within us, thus making it the most significant science area to human endeavour.Biology is of great importance because it helps us have knowledge of not only ourselves and the living things around us, but also to know those factors in the environment of living things that affects living things, how they affect them and their relationship with other living and non-living things around them.

In spite of the importance of Science and Technology in general and biology in particular, the teaching and learning of it has not been very successful over the last decade or more, there has been a steady depreciation in the quality of teaching and learning, this is characterized by poor performance of students in schools and public examinations.

In Nigerian Universities, candidates must have at least a credit grade in Biology external examination to gain admission to study Science oriented courses such as: Medicine, Biochemistry, Microbiology, Biology Education, Biological Sciences, Zoology, and Botany, among others. Despite the central role of Biology in studying science-oriented courses in Nigerian Universities, students' performance in external examination is unsatisfactory.

Investigations for students' low academic achievement shows that large class size, shortage of qualified teachers, instructional techniques of teachers and inability of students to understand lessons taught among others are the major reasons for dismal performance (Shirey,2018, Agboghoroma & Oyovwi, 2015). It was also highlighted that teachers teaching style/techniques could be a factor that affects students learning biology (Yaki*et al.,* 2019). They observed that the performance of students in any subject depends on the quality of instructional strategy used by the teacher.

Textbooks and lecture method can no longer be banked on as the main instructional medium for abstracts subjects such as biology, if it must be effectively taught to the learners (Galloway& Anderson, 2014). As a result of this there is need to adopt some instructional methods that are activity based and learner centered as they might improve the teaching and learning of Sciences and Biology in particular, examples of such are cooperative learning, peer tutoring, instructional scaffolding, and computer simulation.

Given the preceding this study is centered on computer simulation and instructional scaffolding methods of instruction. Computer simulation, which is a mode of Computer Assisted Instruction (CAI), is an interactive instructional strategy where computer using a software program is used to put forward an instructional material and monitor the learning that is taking place. It is a model of a real-life system or process represented in an abstracted or scaled-down form that can be powerful tools for analyzing, designing, and interacting with complex systems or processes (Lunce 2006).

A number of science educators believes that computer simulation offers great potential for enhancing the teaching and learning of science concept. Otero (2001) opined that computer simulations offer learners with conceptual assistance that leads to improved performance and retention of what is learnt. Akpan and Andre (2000) are also of the opinion that computer simulation may be superior to other learning media such as textbooks, lectures, and tutorial courseware because simulation simulates real-world experiences and may increase students' intrinsic motivation by engaging them in solving challenging problems and it provides students with opportunities to observe certain processes that happen either too quickly or otherwise too slowly in real life.

The second approach is instructional scaffolding; Oxford concise English dictionary, (2004) explains scaffolding as 'a temporary structure outside of a building which is made of wooden planks and metal poles, used in the process of building, repairing or cleaning' which is normally taken away after the work has been done.

According to Sawyer (2006) instructional scaffolding is the support given to students during the learning process which is tailored to the needs of the student with the aims of helping the student achieve his/her learning goals. This support can be provided in a various ways including modelling, the putting forward of questions for different subjects and at different stages, explanations, prompts, hand out, real objects etc.

Scaffolding instruction provides a supportive learning environment as it encourages students interaction with instructors and also among themselves. In scaffolding, the scaffolds which is the temporal assistance given by the instructor to the learners to help and guide their understanding of any concept is gradually removed or fades naturally as the learners gain a deep level of comprehension or assimilation of the concept. The scaffold serves as a link between what students already know and are familiar with and what they do not know and are expected to know.

Saye and Bush (2002), postulated that two levels of scaffold exist which are; soft and hard scaffold. In soft scaffolding the kind and measure of support needed depends on the needs of the students during the time of instruction. It is also known as "Contingent" scaffolding while hard scaffolding also known as 'Embedded' scaffolding is planned ahead of a lesson to help students with a learning task which is known in advance to be difficult. For the purpose of this research, the hard scaffolding will be employed.

A number of researchers believe that instructional scaffolding improves learning tremendously. Chang, Sung, & Chen, (2001), stated that "scaffolding has effectively promoted learning among different learners, for various learning goals, and in diverse learning environments". Ormrod (2004) opined that scaffolding plays a vital role in enhancing student learning.

Gender as a moderating variable was also investigated in this study. Gender is the range of biological, mental, physical, and behavioural characteristics related to masculinity and femininity which also differentiate between, masculinity and femininity (Wikipedia encyclopedia 2013). Research findings on gender has been inconclusive as researchers have different view on the influence of gender on academic performance, while some have the opinion that gender has no influence on academic performance, others believe that gender influences academic achievement.

For instance, Ogunleye (2002) and Raimi (2003) reported individually that males perform better than their female in science subjects, whereas Bada and Dokubo (2011) recorded that there is no significant difference in the academic achievement of male and female students in mathematics and science.

The aim of this paper is to report the result of the study carried out on the effect of computer simulation and instructional scaffolding on academic achievement of Senior Secondary School Students in Minna metropolis of Nigeria.

Research Questions

The following research questions were raised to guide the study:

How does the achievement of Senior Secondary School Students taught with computer simulation differ from those taught with instructional scaffolding and convectional teaching method?
In what way has gender influenced the performance of male and female students taught using computer simulated method of instruction?
In what way has gender influenced performance of male and female students taught using instructional scaffolding?

Research Hypotheses

The following research hypotheses were formulated to direct the study:

HO_1: There is no significant difference in the academic achievement of students taught with computer simulated instruction, instructional scaffolding, and convectional teaching method.
HO_2: There is no significant difference in the performance of male and female students taught using computer simulated method of instruction.
HO_3: There is no significant difference in the performance of male and female students taught using instructional scaffolding.

Methodology

Pretest-post-test experimental design was adopted, involving three independent variables; two treatment groups and one control group which are: experimental groups 1 & 2 and control group. They were given pre-test and post-test on Biology Achievement Test (BAT), treatment of computer simulation, instructional scaffolding, and convectional teaching method. Experimental group 1 was subjected to computer simulation, experimental group 2 was subjected to instructional scaffolding while the control group was subjected to convectional teaching method.

The performance of the two gender types; male and female was also investigated in the study. A three-stage sampling technique was adopted for the research. Purposeful non-random sampling was first adopted to obtain three co-educational secondary schools in Minna.Secondly, the three co-educational schools were randomly assigned to the two experimental groups (computer simulation and instructional scaffolding) and the control group (conventional teaching method). Thirdly, 90 students were selected as sample size which included experimental group 1; which is made up of

(30) students; 15males and 15 females, experimental group 2; which is made up of (30) students 15 males and 15 females and the control group made up of (30) students 15 males and 15 females. The representation of the subjects in terms of gender is of great importance in the study to examine gender differences in students' achievement in Biology.

Computer simulated packages for Senior Secondary Biology II that was adopted from Mexus Education Ptv. Ltd and modified by the researcher and a computer programmer, and a second and third one that was developed by the researcher and the programmer was used for the study.

The instructional content for this study consists of three topics; (i) reproductive system in flowering plants which includes;structures and functions of reproductive organs in plant (ii) types of flower and position of ovary and (iii) placentation in flowering plants and kinds of placentation. The topics were selected from the senior secondary school two (SSII) Biology syllabus and scheme of work and it agreed with what the students should be taught in their school at the time the study was carried out.

The simulated package was administered to experimental group 1; it was installed on a computer and was administered using a projector, the computer presented the animation as well as information of the lessons simultaneously, at the end of the lesson there was a summary of the lesson and the students were given opportunity to ask questions, areas that were not clear to the students was re-played. During the administration, the researcher alongside a Biology teacher helped monitor the process. Instructional scaffolding was administered to experimental group 2. Scaffolds used consisted of relevant materials that helped students to understand the concepts being taught. The scaffold includesexplanations, handouts, visual scaffolds, and prompts. Real objects of flowers of different colours and species, different fruit showing the different kinds of placentation were administered and explained appropriately. Visual Scaffolds in the form of illustrative diagrams was also employed, promptings when necessary was also given to the students. Every student had the real objects of flower and fruits while the illustrative diagram was pinned to the board. Explanations and prompts were given when necessary.

Students could ask questions as the lesson progresses, where the Biology teacher of the class helped timed and monitor the progress of the lesson. The scaffolds were removed after the students understood the concepts being taught, their understanding of the concept was measured by the responses they gave when asked questions. Conventional teaching method was used for the control group using the same topics as that of the experimental groups. Lessons for the control group were abstractly driven.

The test instrument used in data collection in the study was researcher adopted Reproductive System in Flowering Plant Achievement Test (RSFPAT). The Reproductive System in Flowering Plant Achievement Test (RSFPAT) consisted of 25 multiple choice objective questions consisting of four options (A-D) adopted from past examination of West African Examination Council (WAEC, May/June). The chosen topics were selection from Biology syllabus of Senior Secondary (SSII). The

test instrument was administered to the Experimental and Control groups as pre-test and was reshuffled and used for post-test. The instrument was scored over hundred.

RSFPAT was validated by experts in biology, and evaluation experts and its reliability coefficient determined as 0.82 using Kuder Richardson (KR-21) and test-retest method. The computer simulation package was validated by 5 experts in educational technology and the validation results yielded 70% consensus. The data obtained was analyzed based on the stated hypothesis using t-test and Analysis of Variance (ANOVA). The level of significance adapted for the analysis was p = 0.05 and it was the basics for which the stated hypotheses were either accepted or rejected.

Results and Discussion

The results are presented in correspondence with the hypotheses formulated:

HO_1: There is no significant difference in the academic achievement of students taught with Computer simulated instruction, instructional scaffolding, and convectional teaching method. To test this hypothesis, ANOVA was used to analyze the data and the results is shown on table 3.

Table 3: ANOVA Analysis of the Mean Achievement Scores of Experimental 1 Experimental 2 and Control.

Groups	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	19316.267	2	9658.133	94.177*	.000
Within Groups	8922.133	87	102.553		
Total	28238.400	89			

* Significant at P < 0.05

Table 3,presents the post-test ANOVA results of experimental 1, experimental 2 and control groups. It yielded an F- ratio of 94.177 and a significance value of 0.00. The result is significant at P<0.05. This denotes that there is statistically significant difference in the performance of Experimental 1, Experimental 2 & Control groups. Hence null hypothesis one was rejected. To determine the direction of the difference, the data were subjected to scheffe's post hoc test or multiple comparison as shown in table 3b.

Table 3b: Scheffe's Post-hoc Test for Experimental 1, Experimental 2 & Control

(I) 1, 2 & 3	(J) 1, 2 & 3	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-6.267	2.615	.062	-12.78	.25
	3	27.467*	2.615	.000	20.95	33.98
2	1	6.267	2.615	.062	-.25	12.78
	3	33.733*	2.615	.000	27.22	40.25
3	1	-27.467*	2.615	.000	-33.98	-20.95
	2	-33.733*	2.615	.000	-40.25	-27.22

*. The mean difference is significant at the 0.05 level.

Scheffe's analysis on Table 3b indicated that the observed significant difference was between Experimental 1 and Control as well as Experimental 2 and Control. Between Experimental 1 and control the mean difference is 27.46 and P-value of .000 which is significant at 0.05 level, between Experimental 2 and Control the mean difference is 33.733 and P-value of .000 which also is significant at 0.05 levels. Therefore, Experimental Groups 1&2 did better than Control group,

HO_2: There is no significant difference in the performance of male and female students taught using computer simulated method of instruction. To test this hypothesis, t-test statistics was used to analyze the mean scores.

Table 4: t-test Analysis on Achievement Scores of Male and Female Students taught with Computer Simulation

Variable	N	df	$\bar{x}$	SD	t-value	Sig(2 tailed)
Male	15	28	72.27	13.73	1.28^{ns}	0.22
Female	15		77.60	6.38		

Not Significant at $P < 0.05$

Table 4, shows the t-test post-test result of male and female students of experimental group 1, the mean scores of the male students was 72.27 and 77.60 for the females. The calculated t-value of 1.28 was not significant at 0.05 levels. Therefore, there is no statistically significant difference between the male and female students taught with computer simulated method of instruction. Hence, the null hypothesis was accepted.

HO_3: There is no significant difference in the performance of male and female students taught using instructional scaffolding.To test this hypothesis, t-test statistics was used to analyze the mean scores.

Table 5: t-test Analysis on Achievement Scores of Male and Female Students taught with Instructional Scaffolding

Group	N	Df	$\bar{x}$	SD	t-value	Sig(2 tailed)
Male	15	28	80.27	10.53	0.55^{ns}	0.59
Female	15		82.13	8.67		

Ns =Not Significant at $P > 0.05$

Table 5,presents the t-test post-test result of male and female students taught with instructional scaffolding, the mean scores of the male students was 80.27 and 82.13 for the females. The calculated t-value of 0.55 was not significant at 0.05 level. This points out that there is no statistically significant difference between the male and female students taught with instructional scaffolding. Hence, null hypothesis three was accepted.

Discussion

Results of hypothesis one revealed that there is significant difference in the academic achievement of students taught with computer simulation. This agrees with the finding of Chen (2007) who found that computer simulation is more effective in teaching and that it has a more notable effect on students learning than conventional teaching method. It also confirms the finding of Huppert, Lomask and Lazarowitz (2002) that discovered that treatment group that completed the simulation activities in

"the growth curve of microorganisms" obtained notable higher academic achievement than those in the control group. Tsegaye and Damtie (2007) found out that students who used computer simulation in learning scored better and had better mastery of concept than those taught with conventional teaching method.

Students taught with instructional scaffolding did better than those taught with conventional teaching method. This corresponds with the findings of Alake and Ogunseemi (2007) who reported that students exposed to instructional scaffolding strategy performed much better than those who were exposed to traditional method.

Our findings also agrees with Remalyn and Alicia (2013), who said that instructional scaffolding is a better instructional method than traditional teaching method. This is also true as seen in the work of Azih and Nwosu (2011) who revealed that instructional scaffolding method is superior to the conventional teaching method in improving the achievement of students. Simons and Klein (2006) in their findings suggested that instructional scaffolding enhances inquiry and performance especially when students are required to access and use them.

The results of hypotheses two and three shows that gender had no effect on the achievement of male and female students taught with computer simulation and instructional scaffolding. This is in agreement with the finding of Ezeudu and Okeke (2013) who discovered that there was no significant effect in the performance of male and female students taught Chemistry with Computer simulation. It also in line with the discovery of Azih& Nwosu (2011) who revealed that gender had no significant interaction with instructional scaffolding teaching approach.

Conclusion and Recommendation

This study examined the problems associated with poor performance of students in Biology and Science subject, among which poor instructional method is responsible for this. It can be deduced from this study that meaningful learning can be enhanced using computer simulation and instruction scaffolding and that the approaches are gender friendly as both male and female student were affected positively by the approaches.

It was recommended that secondary school Biology curriculum should be reviewed with an aim to integrate computer simulation packages and instructional scaffolding, students should be sensitized and made aware that computer system and internet should not only be used for social surfing purposes only but should be seen and utilized for academic purposes.

References

Agboghoroma, T. E. & Oyovwi, E. O. (2015). Evaluating effect of students' academic achievement on identified difficult concepts in senior secondary school biology in Delta State. Journal of Education and Practice, **6** (30): 117-125.

Akpan, J. P. & Andre, T. (2000). Using a computer simulation before dissection to help student learn anatomy. *Journal of Computers in Mathematics and Science Teaching,* **19** (3): 297-313.

Alake, E. M. & Ogunseemi O. E. (2007). effects of scaffolding strategy on learners' academic achievement in integrated science at the junior secondary school level. Department of Integrated Science, College of Education, Ikere – Ekiti, Ekiti State, Nigeria. *European Scientific Journal July 2013 edition vol. 919.*

Azih, N. & Nwosu, B. O (2011). Effects of Instructional Scaffolding on the Achievement of Male and Female Students in Financial Accounting in Secondary Schools in Abakaliki Urban of Ebonyi State, Nigeria. Department of Business Education, Ebonyi State University, Abakaliki, Nigeria. *Current Research Journal of Social Sciences*, **3** (2): 66-70.

Bada, R. A. & Dokubo, O. O. Age and gender as predictors of academic achievement of College mathematics and science students. Department of Mathematics, Federal College of Education (Technical), Omoku, Rivers State, Nigeria. Proceedings of the 2011 International Conference on Teaching, Learning and Change.*International Association for Teaching and Learning (IATEL)*

Chang, K. E. Sung, Y. T. & Chen, S. F. (2001). Learning through computer-based concept mapping with scaffolding aid. *Journal of Computer Assisted Learning*, **17** (1): 21-33.

Chen, Y. (2007). The Effect of Computer Simulation Instruction on Student Learning: A Meta-analysis of Studies in Taiwan. *Journal of Information Technology and Applications*, **2** (2): 69-79.

Çimer, A. (2004). A study of Turkish biology teachers' and students' views of effective Teaching in schools and teacher education. EdD Dissertation, The University of Nottingham, nottingham, U.K.

Ezedu, F. O. & Okeke, P. E. (2013). Effect of Simulation on Students' Achievement in Senior Secondary School Chemistry in Enugu East Local Government Area of Enugu State, Nigeria. department of Science EducationUniversity of Nigeria, University of Nigeria, Nsukka Enugu state,Nigeria.*Journal of Education and Practice*, **4** (19).

Federal Republic of Nigeria, (2004). *National policy on Education.* Lagos: Federal Government press.

Galloway, K., & Anderson, N. (2014). Cootie genetics: Simulating model's experiments to understand the laws of inheritance. The American Biology Teacher, **76** (3): 189-193.

Hupper, J. Lomask, S. M. &Lazarowitz, R. (2002) Computer simulations in the high school: students' cognitive stages, science process skills and academic achievement in microbiology. *International Journal of Science Education*, **24** (Issue 8).

Imhanlahimi, E. O. & Aguele, L. I. (2006). Comparing three instruments for assessing biology teachers'effectiveness in the instructional process in Edo State, Nigeria. *Journal of Social Sciences,* **13** (1): 67-70.

Lunce, L. M. (2006). Simulations: Bringing the benefits of situated learning to the traditional classroom. Department of Technology & Cognition, College of Education University of North Texas. *Journal of Applied Educational Technology*, **3** (1).

Ogunleye, B. O. (2002). *Evaluation of the Environmental Aspect of the Senior Secondary School Chemistry Curriculum in Ibadan, Nigeria.* Unpublished Ph.D Thesis. University of Ibadan, Ibadan.

Ormrod, J. E. (2004). Human learning (4th ed.). Upper Saddle River, NJ: Person Prentice hall.

Otero, V. (2001). The role of computer simulators in students' construction of explanatory models of static electricity. A paper presented at NARST conference at St Louis, Missouri.

Oyediji, (2010). Effective teaching of mathematics and science in junior secondary schools in Bayelsa State. Organized by U.I. consultancy services in collaboration with Bayelsa State Universal Basic Education Board.

Raimi, S. M. (2003). *Gender Differences in Acquisition of Practical Skills,* Unpublished Paper Presented at the 1st National Conference on Science, Technology and Mathematics Education. School of Science, St. Andrew's College of Education, 17th – 20th, July.

Sawyer, R. K. (2006). The Cambridge Handbook of the Learning Sciences. New York: Cambridge University Press. Science 28 April 2006 312: 532-533.

Shirey, K. (2018). Breaking the silos of discipline for integrated student learning: A global STEM course's curriculum development, engineering. Engineering, **4** (2): 12-26.

Simons, D. K. & Klein, J. D. (2006). The Impact of Scaffolding and Student Achievement Levels in a Problem-based Learning Environment. Purdue University, USA & Arizona State University, College of Education, USA. Instructional Science (2007).

Yaki, A. A., Saat, R. M., Sathasivam, R. V. & Zulnaidi, H. (2019). Enhancing science achievement utilising an integrated STEM approach. Malaysian Journal of Learning and Instruction, **16** (1): 181-2.