
COMPUTER SIMULATION PACKAGE AND GENDER AS PREDICTORS OF STUDENTS' ACHIEVEMENT IN BIOLOGY

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Abstract: The conventional method of teaching is the most common in Nigeria and researchers have shown that this method has led to poor performance of students in Biology but in other subjects. Researchers have been able to ascertain that students will learn best when they participate in teaching-learning process. This study was conducted to establish computer simulation package and gender as predictors in the teaching of Genetics on students' achievement in Biology. The pretest-posttest, control group, quasi-experimental design with 2x2x3 factorial matrix was adopted. Two hundred and forty (240) Senior Secondary School students from four (4) purposively selected schools in Ibadan metropolis of Oyo State were used for the study. The schools were randomly assigned to experimental and control groups and the study lasted twelve (12) weeks. Five (5) instruments used for data collection were: Teachers Instructional Guides for teachers using the treatments and control group; Students' Achievement in Biology Test ($r = 0.80$), Computer Simulation Package on Genetics in Biology and Assessment Sheet for the research assistants. Three null hypotheses were tested at 0.05 level of significance. Data collected were analyzed using Analysis of Covariance (ANCOVA) and Multiple Classification Analysis Treatment had a significant effect on students' Post-test achievement score. Students exposed to computer simulation performed better with higher adjusted posttest achievement mean score (mean = 72.215; dev. = 3.21) than their counterparts who were taught with the conventional teaching method (mean = 49.743; dev. = 3). There was a significant main effect of gender on student's achievement in Biology ($F(1,228) = 8.652, P < 0.005$). ICT-based instructions in the form of computer simulation or video-cd have been found to make learning real, permanent and provide experience in all field of learning and so it is recommended to avert the recurrent failure of students.

Keywords: Computer Simulation Package, Education, Students' Achievement, Biology.

INTRODUCTION

Education is the bedrock of development. It is all about knowledge and skill acquisition. Successful development entails more than investing in physical capital. It also entails acquiring and using knowledge as well as closing the gaps in knowledge. Fafunwa defines Education as "the aggregate of all the processes by which a child or adult develops the abilities, attitudes and other forms of behaviour which are of positive value to the society in which he lives, that is to say, it is a process of disseminating knowledge either to ensure social control or to guarantee rational direction of the society or both." (Odiat and Omofonmwan 2007).

Biology as a subject is so wide and important that it is offered in many departments in secondary schools including science, commercial and art departments but the students' performance in Senior School Certificate Examination (SSCE) which is controlled by two major bodies in Nigeria: The West African Examination Council (WAEC) and the National Examination Council (NECO) has been below average despite the input from concerned quarters. This is due to the technical nature of some of the major and complex topics like genetics, nervous system, circulatory system etc.

Table 1: Students' Performance From 2000-2010

Year	Number of Candidates	Number and Percentage Obtaining Grade		
		% Grade 1-6	% Grade 7-8	% Grade F9
2000	620291	19.30	29.76	50.93
2001	995345	23.25	29.70	47.04
2002	882119	31.52	30.64	37.82
2003	909101	43.14	27.80	27.70
2004	821996	30.83	33.68	35.47
2005	1051557	35.74	29.84	32.18
2006	1137131	49.23	25.70	23.52
2007	1238163	33.37	32.09	32.47
2008	1259965	33.94	26.18	38.41
2009	1340206	28.59	30.82	35.17
2010	1325408	49.65	24.49	22.86

Source: Research Library, West African Examination Council (WAEC) Head Quarters Office, Lagos.

Percentage failure was highest in the year 2000 in which it was greater than 50% and lowest in the year 2006 in which it was put at 23.52. Percentage grades 1-6 have been the highest in the same 2006. so between the year 2000 and 2009, percentage grades 1-6 has been found between 19.30 and 49.23, percentage grades 7-8 between 25.70 and 33.68 while percentage grades F9 was between 23.52 and 50.93.

Duyilemi (2005) advised that students should be given opportunity to be actively involved in the learning process. This has therefore; created room for further search for other instructional strategies that could appeal to the learners and that would help to achieve the objectives of science education.

Computers are sometimes used in biological investigations for collecting data, searching literature, planning experiments and analysing data, these functions are very common in many science and biology laboratories. However, simulations are important for formulating and improving the conceptual models that scientist and science teacher's use in their practice and teaching if these important but numerous objectives must be achieved in order to have improvement in the performance of students in external examinations. In lieu of this, there is a need for a boost on the previous methods of teaching especially in the supposed difficult topics, genetics particularly.

So, it is obvious that there is an urgent need, most especially in Nigeria, to provide education that goes beyond teaching basic literacy and numeracy skills. Education must help to build

higher-order cognitive abilities, strengthen processes of inquiry, enable collaborative problem solving and prepare people to compete in global markets and become productive members of societies. New approaches and strategies for change are needed, and computers, mediated communications and related educational technologies are an important part of this approaches and strategies.

The rapid increase in educational computer use has led to changes in the teaching/learning process, curricula and teachers' and administrators' approaches to instruction (Loveless and Ellis, 2002). These changes in instructional techniques are shaped by the fact that computer-assisted learning increases student motivation and creates better learning environments in which rote learning is minimised and meaningful learning can occur (Renshaw and Taylor, 2000). One way of enhancing learning is to help students create models of dynamic systems by combining words with pictures (Schnotz and Bannert, 2003). This approach has assisted in the development of a special type of interactive animation: computer simulations (Nerdel and Prechtel, 2004).

Computer simulations give students the opportunity to take initiative when learning about a given topic. Simulations are important for formulating and, improving the conceptual models that scientist and science teachers use in their practice and teaching. Also, there are several reasons to use computer simulation in science and biology classrooms as Hilbish and Goodwin (1994). State:

"Computer simulations, unlike artificial examples, are not limited to real time but may be used to simulate selection over hundreds or thousands of generations.... The advantage of teaching with artificial examples is that they illustrate the basic concept of natural selection and are often inexpensive. Computer simulations are valuable because they allow students to explore the factors affecting natural selection. Neither of them, however, is a real example of natural selection. Both show what could happen, not what is happening in the world simulation used in dissections can be used by students several times and give an immediate feedback to student."

Using conventional teaching approaches in which the teacher dominates all the class activities right from introduction to conclusion, teachers usually find large, natural, mathematical, economic, or social systems difficult to clearly explain or demonstrate. Similarly, the time and difficulty of performing complex mathematical equations and graphical functions often prevents teachers and students from fully exploring and understanding complex principles Wood and Gentile (2003), Blair, Schwartz, Biswas and Lewlawong (2007), express the opinion that the conventional method of teaching science is inadequate for effective learning in science. Furthermore, Mohanan (2000) opined that using lecture strategy prevents possible mental development by doing for the learner what the learner could have done for him/her.

Computer simulations, a sophisticated form of CAL, make it possible for students to experience and experiment with a variety of biological, scientific, weather, mechanical, business, mathematical, social, and political phenomena with less risk, cost, and time than has ever been possible. More important, however, computer simulations make it possible for students to quickly grasp complex concepts and apply their understanding. In the absence of computer simulations, students usually learn the behavior of complex systems passively through

general descriptions and definitions of system elements and primary governing rules. However, because most complex systems involve several levels of positive and negative feedback and intricate interrelationships, general descriptions and basic rules are incapable of conveying much understanding.

The effect of gender on learning outcomes in sciences is still on issues of debate among educators as a result of conflicting results from studies that focus on gender and achievement. Researchers have come up with different findings on the effect of gender on learning outcomes. While some found no significant differences based on gender Morribend (2004), Chukwuka (2005), Ogunleye (2002) and Raimi (2003) individually reported that males perform better than their female counterparts in science subjects. Okeke (2001) and Aremu (2005) also reported significant effect of gender on learning outcomes in favour of the male students.

Some researchers reported significant difference in performance in favour of males while other did not (Ivowi, 2003, Duyilemi, 2004). Hence, the need for further studies on the effect of gender on leaning outcomes of pre-service teachers especially in the area of science learning; such findings will provide information on appropriate strategies for both sexes. Solomon (2004) in his study of gender differences and students achievement in secondary school Biology, found out that boys performed better than girls in all schools taken as a group and a single sex school as shown by their mean score (52.2 for boys and 49.8 for girls).

STATEMENT OF THE PROBLEM

This study is conducted to establish the effect of computer simulation package in the teaching of Genetics on students' achievement in biology. This study also aims to find out the influence of students' gender on students' achievement in biology

HYPOTHESES

The following null hypotheses were tested in the study;

- H₀: There is no significant main effect of treatment on students' achievement in Biology.
- H₀₂: There is no significant main effect of gender on students' achievement in Biology.
- H₀₃: There is no significant interaction effect of gender and treatment on student's achievement in Biology.

METHODOLOGY

Four public secondary schools, two from Egbeda local government and two from Ibadan North local government were randomly selected for this study. One public school, Urban Day Secondary School and Abadina Secondary School were used as the experimental group while Holy Trinity Grammar School and Emmanuel College Agbowo were used as control group. The criteria used for selecting the schools used are;

1. The schools used as experimental group should have electricity facilities.
2. Availability of experienced biology teacher.
3. An evidence that the topic Genetics has not been taught.

RESEARCH INSTRUMENTS

The following instruments were used in the study;

1. Students Achievement in Biology Test (SABT)
2. Computer Simulation Package on Genetics in Biology (CSPGB)
3. Operational Guide for Computer Simulation Package on Genetics in Biology (OGCSPGB)
4. Operational Guide for Conventional Based Instruction on Genetics in Biology (OGCBIGB)
5. Evaluation Sheet for Assessing Teachers' Performance during Training (ESAPT)

Students Achievement in Biology Test (SABT)

The instrument was constructed to measure cognitive achievement of students in Biology. SABT consisted of twenty (20) multiple choice items with 4 options labeled A-D. The instrument was subjected to facial and content validity by exposing it to examiners, experienced biology teachers and research experts. Items were replaced, modified and removed as advised. 40 items were assessed and 38 survived the scrutiny.

For reliability and item difficulty Kuder-Richardson formular-20 was used. The KR-20 value for reliability obtained is 0.80 which shows that the test is reliable.

Table 2: Specification for Students Achievement in Biology Test (SABT)

Topic	Level of Cognitive Development			Total
	Knowledge	Understanding	Application	
Gregor Mendel's work	6, 24, 17	11, 12, 34	30	7
Terminologies used in Genetics	1, 4, 8, 9, 14, 23, 26, 28, 29			9
Basic laws of genetics	31, 32, 33, 35	16		5
Transmittable character	5, 2,3, 13, 15	20, 27	10, 22	9
Transmission and separation of character in organisms	7, 18	19, 25	21	5
Total	23	8	4	35

Computer Simulation Package on Genetics in Biology (CSPGB)

CSPGB, a programmed instruction, was developed by the researcher and its mode of instruction is self-learning; it involved the trained teachers as a facilitator to operate during its use. CSPGB was prepared according to behavioural objectives of the topic genetics in the biology curriculum for senior secondary school.

Conventional Based Instruction on Genetics in Biology (CBIGB)

The mode of instruction of CBIGB is not learning package but the normal traditional way of teaching-learning process in classroom and the instruction is in form of lesson plan. The instrument was prepared according to the behavioural objectives of the topic- genetics in the biology curriculum for senior secondary school.

Operational Guide for Computer Simulation Package on Genetics in Biology (OGCSPGB)

This instrument was developed by the researcher to guide and ensure uniformity in the use of computer simulation package instruction for a period of Eight weeks (One period per week); it also ensures easy operation for all users.

Operational Guide for Conventional Based Instruction on Genetics in Biology (OGCBIGB)

The instrument was developed by the researcher to guide and ensure uniformity in the conventional based instruction especially the steps, teacher activities and students' activities in the school used as control group for a period of Eight weeks (One lesson per week).

The following;

- Computer Simulation Package on Genetics in Biology (CSPGB),
- Conventional Based Instruction on Genetics in Biology (CBIGB)
- Operational Guide for Computer Simulation Package on Genetics in Biology (OGCSPGB),
- Operational Guide for Conventional Based Instruction on Genetics in Biology (OGCBIGB).

All these stimulus instruments were validated by using the comments of my supervisor, experienced biology teachers, and ICT experts.

PROCEDURE FOR DATA COLLECTION

Work Schedule

Table 3: Work Schedule for Data Collection

2 weeks	Training of teachers
1 week	Pre-test (using SACSS and SABT)
8 weeks	Treatment (using CSPGB,OGCSPGB,CBIGB)
1 week	Post test (using SACSS and SABT)

Training of Teachers

The researcher trains teachers in selected schools on how to adhere strictly to the instruments and experimental procedure. Briefing session was also organized for the students participating in the study in their various schools. Two teachers were trained as research assistants for the experimental group while the teachers for the control group were asked to adhere strictly to the instructional guide

Pre-test

The researcher and research assistants administered the pretest using Students Achievement in Biology Test (SABT) on the subjects of study. The two instruments were administered in such a way that individual's SABT were collected together in other to ensure easy analysis of individual's cognitive and attitudinal stat

Treatment

The researcher used a period of 8 weeks as treatment period in the 4 schools for the study. It involved the use of Computer Simulation Package on Genetics in Biology (CSPGB), Operational Guide for Computer Simulation Package on Genetics in Biology (OGCSPGB), in two experimental Schools and Conventional Based Instruction on Genetics in Biology

(CBIGB), Operational Guide for Conventional Based Instruction on Genetics in Biology (OGCBIGB) in two control schools.

Experimental Group

This group includes the two schools that were treated using Computer Simulation Package on Genetics in Biology (CSPGB). After the first week of administering the pretest, Students were grouped and allowed to receive learning instructions according to the Operational Guide for Computer Simulation Package on Genetics in Biology (OGCSPGB). The CSPGB introduced the topic, taught, and at the end of the instruction, the computer Simulation package evaluated the students' knowledge so far.

The researcher made sure the process of teaching according to the OGCSPGB is followed throughout the treatment period in the two schools used as experimental schools
The steps involved in CSPGB are:

Step I: Teacher tells and emphasizes on students adherence to instructions on how to use the simulation.

Step II: Teacher monitors the students as they use the simulation

Step III: Teacher asks pupils to ask questions based on the topic taught by the simulation package.

Conclusion: Teacher helps the students to close the program.

The 10th week was used for posttest. The researcher with the research assistant administered the posttest on the students in the same order of the pretest.

Control Group

This group includes the two schools that were treated with the conventional classroom practices using Conventional Based Instruction on Genetics in Biology (CBIGB). After the first week of administering the pretest, students were prevented from consulting internet on the topic genetics.

Students were treated according to the Operational Guide for Conventional Based Instruction on Genetics in Biology (OGCBIGB) for a period of 8 weeks (2nd – 9th week) and the 10th week was used for posttest. The researcher with the research assistance administered the posttest on the students in the same order of the pretest.

Post Test

The researcher and the research assistance administered the posttest just like the pretest.

Procedure for Data Analysis

The data obtained was analyzed using 2 x 2 x 3 Analysis of Covariance (ANCOVA), the pretest scores as covariates. The analyzed data is used to test the research hypothesis. The Multiple Classification Analysis (MCA) was used to show the magnitude of the posttest mean score. Bar chart was used for possible explanation of observed significant differences.

RESULTS

Table 4: ANCOVA of Posttest Students Achievement by Treatment, Gender and Parental Education

Hierarchical Method					
Source of Variation	Sum of Squares	Df	Mean Square	F	Sig.
Model	924594.030	12	77049.503	546.536	.000
Gender	1219.735	1	1219.735	8.652	.004
TM	8749.948	1	8749.948	62.066	.000
PEDU	207.890	2	103.945	.737	.480
Gender * TM	145.797	1	145.797	1.034	.310
Gender * PEDU	343.245	2	171.623	1.217	.298
TM * PEDU	109.903	2	54.951	.390	.678
Gender * TM * PEDU	423.859	2	211.929	1.503	.225
Residual	32142.970	228	140.978		
Total	956737.000	240			

According to table 4, treatment has significant effect on student's achievement in Biology ($P < 0.05$). This means that the application of computer simulation package in teaching Genetics in Biology is more effective than the conventional teaching method, as there was significant difference between mean post test scores of students exposed to computer simulation package and that of those taught using the conventional teaching method. So, the null hypothesis 1 is rejected. To find out the magnitude of the mean scores of the group's performance, Table 5 is presented

Table 5: Multiple Classification Analysis of Post Achievement Score According to Treatment, Gender and Parental Education

Grand Mean = 60.98

Variable + Category	N	Unadjusted Predicted Mean	Adjusted Predicted Mean for Factors and Covariates	Unadjusted Deviation	Adjusted Deviation for Factors and Covariates	Eta
[Gender=1.00]	107	66.3271	66.427	2.023	3.51	0.879
[Gender=2.00]	133	56.6767	56.576	-2.09	-2.91	0.864
[TM=1.00]	120	72.1250	72.215	0.014	3.21	0.054
[TM=2.00]	120	49.8333	49.743	0.22	-3	.
[PEDU=1.00]	51	52.0784	51.988	0.574	-6.806	0.012
[PEDU=2.00]	43	53.5116	53.421	-0.88	-1.306	0.0104
[PEDU=3.00]	146	66.2877	66.397	-0.447	9.194	0.013

R Squared = 0.966, R = 0.965

The table 5 shows that students exposed to computer simulation performed better with higher adjusted posttest achievement mean score (mean=72.215; dev.=3.21) than their counterparts who were taught with the conventional teaching method (mean=49.743; dev.=3)

H0: There is no Significant Main Effect of Gender on Student's Achievements in Biology

According to table 4. there was a significant main effect of gender on student's achievement in Biology ($F(1,228) = 8.652, P < 0.005$). This means that there is a significant difference between the mean post test scores of males and that of females, although Multiple Classification Analysis in Table 4.2 shows that males performed better (mean = 66.3271; Std. dev = 2.023) than females (mean = 56.576; Std. dev = 2.09). So, the null hypothesis was rejected.

H0: There is no Significant Interaction Effect of Gender and Treatment on Student's Achievement in Biology

Table 4 shows that gender and treatment has no significant effect on student's achievement in Biology. ($F(1,228) = 1.034, P > 0.05$). So the null hypothesis is not rejected.

DISCUSSION, IMPLICATIONS, CONCLUSION AND RECOMMENDATION

The findings of this study in table 4 revealed significant differences in the post-achievement scores of students in the computer simulation group. This implies that the treatment produced an outstanding performance on students' academic achievement in Biology. The higher adjusted post test score might be because computer-based instruction makes teaching techniques more effective than conventional teaching strategy. This is because it is used for presenting information, testing and evaluation and also to provide feedback. It motivates students and gets them to take an active part in the learning process. It helps to develop creativity and problem solving skills, identity and self-reliance in learners. It makes a contribution to the individualization of education. Computer simulation provides drawings, graphics, animation and music and plenty materials for the students to proceed at their own pace and in line with their individual differences. It serves to control lots of variables having an impact on learning, which cannot be controlled by means of traditional educational techniques (Serpell 2002; Kacar and Dogan 2007; Aydogdu 2006; Gonen *et al.*, 2006; Akgun 2005; Nerdel and Precchl 2004; Demircioghi and Geban 1996). Efe and Efe 2010 also states that computer simulation to teach cell topics helps students to visualise the ways in which cell parts function. Slack and Stewart 1989, Johnson and Stewart 1990, Collins and Monisons 1992 reported that by using genetics construction kits as part of a strategy computer simulation, high school students learned to solve genetics programs and to build accurate and rich mental models of genetic knowledge. On the other hand, the findings of this research contradict the result of the studies carried out by Bayraktar 2001, Orvler and Saglam 2002; Hopkins 2001, Parker 1995, Tylinski 1994 even reported an opposite finding; the significantly greater effectiveness of traditional instruction.

From table 4 it was also revealed that; gender has a significant effect on students' achievement in Biology across the computer simulation and conventional teaching groups. This may be due to the fact that males spend more time using the computer to play games making them more familiar with a system. This result is against the earlier findings of Akinbobola and Afolabi (2006), Olagunju and Ojo 2006, Fadipe 2011; this is because according to MA (2007), the gender gap between males and females is reducing. She stated that if both sexes are exposed to some conditions and opportunities, this result will be the same for all Biology and all science. One can conclude based on the above result that gender difference in students' academic

achievement and attitude being observed among secondary school Biology students is diminishing at a speedy rate. The input of various educational stakeholders to bridge the gender gap is producing results. The findings of this study revealed that computer simulation-based instructions were more effective than the conventional-based instruction in Genetics in Biology. The findings of this study have some implications for Biology teaching in secondary schools.

The study revealed that exposure of students to computer simulation enhanced students' achievement in Biology. This strategy is learner-centered and embraces active participation by the students as advocated by the cognitive learner-centered theory. The students were enthusiastic at the innovation. The study emphasized the active intellectual involvement of learners by providing opportunities for students to meaningfully talk, listen, write, read and reflect on the contents ideas, issues and concerns of an academic subject (Olagunju and Ojo, 2006). This indicates that active involvement of students as adopted in this study can be used in other subjects.

The findings of this study also revealed that the use of computer simulation-based instruction is potentially powerful in improving students' achievement to Biology especially in concepts relating to Genetics. The computer simulation package was programmed in such a way that the concepts were presented in frames and chunks for easier and better mastery by students. Students were in groups due to availability of space and computer systems. Discussion which is one of the common strategies promoting active learning was allowed after each lesson. The finding of this study therefore shows the importance of group work and discussion among students.

It was revealed that gender has a significant effect on students' achievement in Biology across the computer simulation and conventional teaching groups. This may be due to the fact that males spend more time using the computer to play games making them more familiar with a system. This result is against the earlier findings of Akinbobola and Afolabi (2006), Olagunju and Ojo 2006, Fadipe 2011; this is because according to MA (2007), the gender gap between males and females is reducing. She stated that if both sexes are exposed to some conditions and opportunities, this result will be the same for all Biology and all science. One can conclude based on the above result that gender difference in students' academic achievement and attitude being observed among secondary school Biology students is diminishing at a speedy rate.

IMPLICATION OF THE FINDINGS

Based on the above, it's the responsibility of science educators, educational practitioners and the practicing science teachers, especially Biology teachers to embrace computer simulation-based instructions. The Biology teacher who is faced with the problem of handling large classes can embrace computer simulation-based instructions to supplement his or her teaching and also increase the level of concentration of the students thereby aiding class control. This would promote the enhancement of educational objectives. Teachers are to be trained on how to develop instructional packages with the use of computer simulation. Also, curriculum developers and designers should provide instructional designs that are based on computer simulation. This would enhance valid achievement of education objectives. Instructional

designs that are learner-centered should be provided so as to foster motivation, participation and creativity among students.

RECOMMENDATIONS

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

1. The secondary school Biology curriculum should be reviewed with a view to integrate computer simulation packages into the curriculum.
2. Secondary schools students in Nigeria should be encouraged and motivated to learn through electronic means.
3. The Nigerian government at the state and local levels should provide and support computer systems, video players, projectors. The use of these products of ICT should be enforced by the government.
4. Students should be sensitized and enlightened that computer system and internet access is not only for social pleasures alone but should be seen and used for academic purpose.
5. School principals, administrators and other stakeholders in both public and private sectors should be trained and updated periodically on the use of computer systems in the teaching and learning process.

CONCLUSION

The focus of this study was to develop ICT-based instructions (in form of computer simulation) and to expose the students involved in the study to electronic learning. The study also determined the effect of gender and parental education on students' academic achievement in Biology. From the finding of this study, it could be deduced that Biology learning can be enhanced through the use of the products aspects of Internet and Communication technology (ICT). The study revealed that a learner-centered and active participation approach by students should be highly encouraged by Biology teachers. The study revealed that the computer simulation-based instruction was more effective than conventional-based instruction. This implies that students' academic achievement can be improved and enhanced through ICT-based instructions. Learning can be made more interactive and interesting through inclusion of ICT-based instructions as a supplement to other teaching strategies.

Finally, use of computer simulation-based instructions is effective as a supplementary teaching strategy in an educational process.

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