Effects of Computer Graphics and Animation Instructional Modes on Secondary School Students' Achievement and Retention in Genetics

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Abstract: *There is a perceived trend of poor academic achievement and retention of students in genetics in Nigerian Secondary schools today. This situation has been attributed to many factors one of which is poor method of teaching. Against this background that this study determined the effects of computer graphics and animation instructional modes on secondary school students' achievement in genetics. Four research questions were raised and two research hypotheses were formulated and tested at 0.05 level of significance. The research design was quasi – experimental. Three groups (two experimental and one control) made up of 135 senior secondary one (SS1) students were drawn from the population of 2, 608 SSI students. Purposive random sampling was used to select three public secondary schools from Aguata Education Zone of Anambra state. One instrument was used for data collection namely, Genetics Achievement Test (GAT). Three experts validated the instruments. The instrument was trial tested and the GAT gave a reliability coefficient of 0.89. Before treatment was given they were pretested with GAT. After five weeks of teaching they were post-tested GAT though the items positions juxtaposed to make it look different from the pretest. Three weeks after the post-test was given, the items position of GAT were rearranged again and administered as Genetics Retention Test (GRT) to the students. Mean and standard deviation were used to answer the research questions while Analysis of Co-variance (ANCOVA) was used to test the null hypotheses. The findings indicated that computer graphics and animation instructional modes had significant effects on the achievement and retention scores of students in genetics. Based on the findings, it was recommended among others that biology teachers should adopt the use of computer graphics and animation in the teaching of genetics in order to enhance the performance of students and retention of knowledge in genetics. Government and education authorities should sponsor biology teachers to workshops and seminars to learn how to improve their teaching skills using computer graphics and animation.*

Keywords: Computer, graphics, retention

1. Introduction

Biology is the study of life and evolution of organisms and their structures, processes and interactions with each other and their environment (Aloh & Afamah, 2013). It is taught at senior secondary school level in Nigeria and is introduced to students as a preparatory ground for human development where career abilities are groomed (Federal Republic of Nigeria, FRN, 2014). Biology is a prerequisite for pursuing a number of careers in science-based courses which include medicine, pharmacy, agriculture, biochemistry, botany, zoology among others. The importance of biology in the industrialization and other sector of the economy cannot be over emphasized.

The aims and objectives of secondary school biology education as contained in the National Policy on Education (FRN, 2014) include to: develop an awareness of the environment, understand certain key biological concepts necessary for successful living in scientific and technological advancement, inculcate the habit of critical observation and drawing conclusions only on available data, illuminate the problems of sex, reproduction, growth, pollution, health etc for the benefit of the society, acquire the ability to apply scientific knowledge to everyday life in

matters of personal and community health and agriculture as well as disperse superstitious beliefs in a technological method and also see one as an organism among a group whose processes influence and influenced by same.

Biology has many topics some of which are abstract and difficult for students to understand. Nzelum (2010) identified genetics, homeostasis, evolution, nervous co-ordination, ecology, cellular respiration among others as difficult topics in secondary school biology curriculum. In addition, Cimer (2012) noted that there are five topics in biology that are most difficult which are matter cycles, endocrine system and hormones, respiration, cell division, genetics and evolution.

Genetics is an important aspect of biology that deals with heredity and variation. Umeh (2010) defined genetics as the science that deals with questions and answers on inheritance. An understanding of genetics is necessary for the diagnosis, prevention and treatment of hereditary diseases, the breeding of plants and animals and the development of industrial process through the use of micro-organisms. Genetics could be called a science of potentials since it deals with the transfer of information from parents to offspring. Genetics gives answers to such problems as incompatibility of blood groups, hereditary diseases like sickle cell anaemia,

leukemia and others. Thus, the study of genetics gives the students the opportunity to explain most naturally occurring phenomenon like birth of twins, sex determination, crops and livestock failures which were hitherto explained through superstition.

Despite the importance of genetics to man, it is one aspect of biology that most teachers find difficult to teach and students find it difficult to learn because of its abstract nature (Cimer, 2012). This is because it deals with inheritance of traits that can be visibly seen but the explanation is always inadequate as to how the process takes place. This implies that those things that are responsible for the transfer of the genes cannot be seen by the students. Consequently, students perform poorly in such abstract concepts in senior school certificate examinations (WAEC, Chief Examiner's report, 2017; 2018; 2019; 2010).

The method used by teachers in teaching biology has been blamed for poor achievement and retention of knowledge by the students. Several research reports (Anyaegbunam, 2012; Nworgu, 2009; Obiekwe, 2008) indicate that many science teachers prefer the conventional method of teaching and shy away from innovative, activity-oriented, learner-centered methods or strategies. According to Ezeudu (2011), conventional method is a discourse delivery method of instruction. The use of conventional method entails a one way flow of communication from the teacher to the students and it is economical in terms of time and effort. Conventional method leads to easy coverage of curriculum and allows for easy teaching of larger classes. However, despite the advantages of conventional method, it is still identified to be ineffective in promoting learning because of the following: conventional method encourages rote learning and favours passive reception of knowledge by students; students easily become restless and it cannot meet the different needs of the students since the classes in our schools consist of mixed ability groups (Ezeudu, 2011). Thus, the need to adopt technology based packages to improve the teaching and learning of biology for effective performance of students is urgently required. The use of technology has made the process of teaching and learning more enjoyable through Information, Communication and Technology (ICT) tools. Computer graphics and animation instructional modes are some of such innovative teaching methods that have been found effective in teaching some school subjects like Fine arts, Religious knowledge, drama and literature. One wonders if computer graphics and animation will also enhance interest, achievement and retention of secondary school students in biology. Graphics, according to Heller and Chwast (2011) are visual images or designs on some surfaces such as a wall, carvas, screen, paper or stone to inform, illustrate or entertain. Computer graphics is the creation, storage and manipulation of drawing and picture with the aid of computer system (Adekoya & Adekoya, 2002). Animation is the use of cartoons and other graphic materials to create motion pictures. Computer animation is another presentation format that could be used to present biology concepts to secondary school students. Precisely computer animations are images in motion (Dwyer & Dwyer, 2003). It is the use of computer to create animation.

Achievement is the act or process of finishing something successfully.

Achievement is synonymous with success. According to Eze (2009) achievement could be referred to as something very good or difficult which was carried out successfully. This implies that achievement refers to the degree of success reached or attained by an individual. Academic achievement could be referred to as the degree of success reached or attained by an individual in some general or specific academic area which is measurable. In this study achievement is measured with an achievement test which is an instrument administered to an individual as a stimulus to elicit certain desired and expected responses, performance on which the individual is assigned a score representing his achievement.

Closely associated with achievement in learning is the students' retention of knowledge. The teacher is faced with the task of how to help students improve on their ability to assimilate and retain what they have learnt. Probably, if what has been learnt is retained over a long period of time, it may lead to higher achievement because retention is measured in collaboration with achievement (Iji, 2010). Sousa (2011) defines retention as the process whereby long term memory preserves learning in such a way that it can locate, identify and retrieve it accurately in future. This implies that retention is the capacity to remember something, skills, knowledge, habits, attitudes or other responses initially acquired. However, students' knowledge could be retained through the use of appropriate instructional strategies in teaching which could make learning more effective, lasting and enjoyable.

2. Purpose of the Study

The purpose of this study is to determine the effects of computer graphics and computer animation on students' achievement in genetics. Specifically, the study was designed to determine the:

1) Difference in the mean achievement scores of students taught genetics using computer graphics and those taught using conventional method.
2) Difference in the mean achievement scores of students taught genetics using computer animation and those taught using conventional method.
3) Difference in the mean achievement scores of students taught genetics using computer graphics and those taught using computer animation.
4) Difference in the mean retention scores of students taught genetics using computer graphics and those taught using computer animation.

3. Research Questions

The following research questions were raised:

1) What is the difference in the mean achievement rating scores of students taught genetics using computer graphics and those taught using conventional method?

2) What is the difference in the mean achievement rating scores of students taught genetics using computer animation and those taught using conventional method?
3) What is the difference in the mean achievement rating scores of students taught genetics using computer graphics and those taught using computer animation?
4) What is the difference in the mean retention scores of students taught genetics using computer graphics and those taught using computer animation?

Hypotheses

The following null hypotheses tested at 0.05 level of significance guided the study:

1) There is no significant difference between the mean achievement scores of students taught genetics using computer graphics and those taught using computer animation.
2) There is no significant difference between the mean retention scores of students taught genetics using computer graphics and those taught computer animations.

Research Design
The study adopted quasi–experimental design. Specifically, the study adopted a non-equivalent control group design.

Area of the Study: The area of this study is Aguata Education Zone of Anambra State. Aguata Education Zone consists of three Local Government Areas (L. G. A. s) namely: Aguata, Orumba South, and Orumba North. The people of the area are predominantly farmers and traders.

Population of the Study
The population of the study is all the Senior Secondary one (SS1) biology students in the 48 government owned secondary schools in Aguata Education Zone of Anambra State. The population size is 2, 608SSI students made up of 1, 184males and 1, 424 females. (Source: Aguata Education ZoneOffice)

Sample and Sampling Technique
The sample size comprised of135SS1 biology students, 69 males and 66 females. A purposive and simple sampling technique were used to drawthree co-educational government owned senior secondary schools in Aguata Education Zone. A purposive sampling is one that is selected based on characteristics of a population and the purpose of the study.

Genetic Achievement Test (GAT) is the instrument for data collection. The GAT consists of 50-item multiple choice test from genetics (mitosis and meiosis) with five items drawn from each of the concepts of cell, cell division, concept of mitosis, life examples and importance of mitosis; stages of mitosis; concept of meiosis, life examples and its importance; stages of first meiotic division and stages of second meiotic division; similarities and differences between mitosis and meiosis which were identified as difficult concepts in biology by the students. The GAT was used for the pre-test and the post-test. The selection of the items was

based on a well planned test-blue print to ensure even coverage of the content.

Research Question I: What is the difference in the mean achievement scores of students taught genetics using computer graphics and those taught using conventional method?

Table 1: Mean achievement and standard deviation scores of students taught genetics using computer graphics and those taught using conventional method

Group	N	Pre-test Mean	Post-test SD	Pre-test Mean	Post-test SD	Mean Gain Score
Computer Graphics	50	25.48	5.81	62.20	6.54	36.72
Conventional method	38	22.16	8.38	31.00	8.21	8.84

Mean differences b/w groups3.32 31.2 27.88
Table 1revealed the pre-test, post-test and the mean gain scores25.48, 62.20 and 36.72respectively for students taught using computer graphics. On the other hand, those taught using conventional method had 22.16, 31.00 and 8.84 as pre-test, post-test and mean gain scores. The pre-test, post-test standard deviation scores of computer graphics group were 5.81 and 6.54 respectively while the pre-test, post-test standard deviation scores of conventional group were8.38 and 8.21 respectively. The mean differences between the two groups in the pre-test, post-test and mean gain scores were 3.32, 31.2 and 27.88 respectively. The high mean differences in the achievement scores of the two groups showed that the computer graphics group gained mastery of the concepts of genetics than those of the conventional group. This suggested that computer graphics instructional mode was more effective in enhancing students' achievement in genetics than the conventional method. The lower SD in computer graphics group showed that the students' scores in computer graphics group was clustered around the mean score than in conventional method.

Research Question II: What is the difference in the mean achievement scores of students taught genetics using computer animation and those taught using conventional method?

Table 2: Mean achievement and the standard deviation scores of students taught genetics using computer animation and those taught using conventional method

Group	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Gain Score
Computer Animation	47	24.17	6.33	69.36	5.80	45.19
Conventional method	38	22.16	8.84	31.00	8.21	8.84

Mean differences b/w groups2.01 38.36 36.35

The analysis in Table 2 showed that the mean post-test score 69.36 and the mean gain score 45.19 of students taught genetics using computer animation were higher than that of those taught using conventional method which had 31.00 and 8.38 as post-test mean score and mean gain score respectively. The pre-test, and post-test standard deviation scores were 6.33and 5.80 respectively for computer animation group while those of conventional group were 8.84 and 8.21 respectively. The mean pre-test, post-test and mean gain score differences between the two groups were

2.01, 38.36 and 36.35 respectively. The differences in the mean between the two groups and the higher mean gain score in computer animation suggested that computer animation was more effective in enhancing students' achievement in genetics than conventional method. The lower post-test SD in computer animation also suggested that students' scores clustered around the mean score than those in the conventional group.

Research Question III: What is the difference in the mean achievement scores of students taught genetics using computer graphics and those taught using computer animation?

Table 3: Mean achievement scores and standard deviation scores of students taught genetics using computer graphics and those taught using computer animation

Group	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Gain Score
Computer Graphics	50	25.48	5.81	62.20	6.54	36.72
Computer Animation	47	24.17	6.33	69.36	5.80	45.19

Mean difference b/w groups 1.31 7.16 8.47

Table 3 showed the pre-test mean achievement score, post-test mean achievement score and the mean gain score of 25.48, 62.20 and 36.72 for students taught genetics using computer graphics respectively. The pre-test and post-test standard deviation scores were 5.81 and 6.54. Their counterparts taught using computer animation had 24.17, 69.36 and 45.19 as the pre-test, post-test and mean gain scores respectively. Their pre-test and post-test standard deviation scores were 6.33 and 5.80 respectively. The mean differences between the two groups for pre-test, post-test and mean gain were 1.31, 7.16 and 8.47 respectively. The differences in mean and the higher mean gain scores of the computer animation group suggested that computer animation method was more effective in enhancing students' achievement in genetics than computer graphics instructional mode. The lower post-test SD also suggested that the students' scores clustered around the mean in computer animation group than in computer graphics group.

Research Question IV: What is the difference in the mean retention scores of students taught genetics using computer graphics and that of those taught using conventional method?

Table 4: Mean retention and standard deviation scores of students taught genetics using computer graphics and those taught using computer animation

Group	N Score	Post-test Mean	Post-test SD	Retention Loss Mean	Retention SD	Mean Score
Computer Graphics	50	62.20	6.54	59.56	9.00	2.64
Computer Animation	47	69.36	5.80	67.11	7.74	2.25

Mean differences b/w the gps 7.16 7.55 0.39

Table 4 showed the achievement post-test and retention scores of students taught genetics using computer graphics and computer animation. Students taught using computer graphics had post-test mean score and retention mean score of 62.20 and 59.56 respectively with loss mean of 2.64 while their counterparts taught using computer animation had 69.36 and 67.11 and 2.25 as post-test mean score, retention mean score and loss mean respectively. The post-test, retention standard deviation scores for computer graphics were 6.54 and 9.00 while those of computer animation were 5.80 and 7.74 respectively. The mean differences between the two groups in post-test, retention and mean loss scores were 7.16, 7.55 and 0.39 respectively. The mean differences between the two groups and the lower mean loss indicated that computer animation was more effective in enhancing students' retention in genetics than computer graphics group. The lower SD by the computer animation suggested that the students 'scores in computer animation group were clustered more around the mean score than in computer graphics group

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught genetics using computer graphics and those taught using computer animation**.**

Table 4: Summary of ANCOVA Test of Difference between the Mean Achievement Scores of Students' Taught Genetics Using Computer Graphics and Those Taught Using Computer Animation

Source	SS	Df	MS	F	P-value	Decision
Corrected Model	2027.502[a]	2	1013.751	33.343	.000	
Intercept	15632.612	1	15632.612	514.169	.000	
Pretest_Achievement	784.909	1	784.909	25.816	.000	
Method	1450.071	1	1450.071	47.694	.000	S
Error	2857.942	94	30.404			
Total	**423204.000**	97				
Corrected Total	**4885.443**	96				

In Table 4, the data showed that there was a significant difference in the mean achievement scores of students taught genetics using computer graphics and those taught using computer animation, F (1, 94) = 47.694, *P*<0.05. The null

hypothesis which stated that there is no significant difference between the two groups was therefore rejected.

Hypothesis 2: There is no significant difference in the mean retention scores of students taught genetics using computer graphics and that of those taught using computer animation

Table 5: Summary of ANCOVA Test of difference between the Mean Retention Scores of Students' Taught Genetics Using Computer Graphics and Computer Animation

Source	SS	DF	MS	F	P-value	Decision
Corrected Model	4186.421[a]	2	2093.210	50.168	.000	
Intercept	26.105	1	26.105	.626	.431	
Pretest_Achievement	2806.755	1	2806.755	67.270	.000	
Method	28.682	1	28.682	.687	.409	NS
Error	3922.033	94	41.724			
Total	**395752.000**	97				
Corrected Total	**8108.454**	96				

Table 5 shows that there no was significant difference in the mean retention scores of students taught genetics using computer graphics and those taught using computer animation, $F_{(1, 94)} = .687$, $P > 0.05$. The null hypothesis of no significant difference between the two groups was therefore upheld.

4. Summary of the Findings

1) There is a significant difference in the mean achievement scores of students taught genetics using computer graphics and those taught using conventional method.
2) There is a significant difference in the mean achievement scores of students taught genetics using computer animation and those taught using conventional method.
3) There is a significant difference in the mean achievement scores of students taught genetics using computer graphics and those taught using computer animation.
4) There is no significant difference in mean retention scores of students taught genetics using computer graphics and those taught using animation.

Effects of computer graphics and Computer Animation on students' achievement in genetics
The result in Table 1 indicated that the overall gained mean achievement scores of students taught genetics using computer graphics is greater than those taught with conventional method. This implies that computer graphics instructional mode enhances students' academic achievement in genetics than conventional method. This finding is in line with the study of Sangodoyin (2011) who found out that the adoption of computer graphics as an instructional mode greatly improves students' academic achievement.

The result in Table 2 indicated that the overall gained mean achievement scores of students taught genetics using computer animation was greater than those taught with conventional method. This implies that computer animation instructional mode had a significant factor on students' achievement in genetics than conventional method. This finding is in line with the studies of Bamidele & Yoade (2017); Falode et al (2016); Adegbija & Falode (2014) who in their separate studies found that the adoption of computer animation as an instructional mode greatly improve students' academic achievement.

Table 3 showed that the performance of those taught genetics using computer animation was better than those taught genetics using computer graphics. The ANCOVA result presented in Table 5 further confirmed that there was a significant difference between the mean achievement scores of students taught genetics using computer graphics and those taught using computer animation instructional modes in favour of computer animation group. This finding is in line with the studies of Bamidele & Yoade (2017); Ariffin et al (2017) who in their separate studies found that the adoption of computer animation as an instructional mode greatly improve students' academic achievement. However, the study is contrary to the findings of Sushma Jolly (2003) who discovered that there was no significant difference between the mean achievement scores of animation with text group and graphic with text group.

Also table 4 showed that the loss mean of computer animation was lower than that of the computer graphics. However, Table 6 revealed that there was no significant difference in mean retention scores of students taught genetics using computer graphics and those taught using computer animation. This study is in line with the findings of Bamidele & Yoade (2017) who found that computer animation enhanced students' retention.

5. Conclusion

On the basis of the findings, the instructional modes adopted by the teachers greatly affect the students' learning of the concepts. This is usually reflected in their achievement and retention of knowledge in genetics. Computer graphics and animation instructional modes enhanced students' achievement and retention in genetics when used together with conventional method.

6. Recommendations

Based on the findings of this study, the following recommendations have been proffered:

1) Teacher education programmes should include computer graphics and animation instructional modes in biology method course content. This will ensure that the biology teachers are adequately trained on how to use computer graphics and animation instructional modes in the teaching and learning of genetics
2) Ministries of Education, both state and Federal should organize workshops and seminars and sponsor teachers to attend in service courses on how to use computer graphics and animation instructional modes to improve their teaching skills which are found by this study to be effective in promoting students' achievement.

3) Students should be encouraged to be serious to embrace this activity-oriented and student-centred approach which will enable them carry out independent or group work, such as assignment and project given to them by the biology teachers and also make their instructions authentic by relating what they have learnt to their personal experiences or real world situation.

4) From the findings of this study, it is recommended that examination bodies should be able to develop appropriate assessment instruments that will enable them to assess students' performance or abilities using CAI (computer graphics and animation).

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