

EFFECTS OF COMPUTER AIDED INSTRUCTIONAL PACKAGE ON PERFORMANCE AND RETENTION OF GENETIC CONCEPTS AMONGST SECONDARY SCHOOL STUDENTS IN NIGER STATE, NIGERIA

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Abstract

The study investigated the effects of computer aided instructional package (CAIP) on performance and retention of genetic concepts among secondary school students in Niger State. Quasi-experimental research design i.e. pre-test-post-test experimental and control groups was adopted for the study. The population of the study were all senior secondary school three (SS3) students' offering biology. A sample of 223 students was randomly drawn from six purposively selected secondary schools. The researchers' developed computer aided instructional package (CAIP) on genetic concepts was used as treatment instrument for the experimental group while the control group was exposed to the conventional lecture method (CLM). The instrument for data collection was a Genetic Performance Test (GEPET) that had 50 multiple-choice questions which were validated by science educators. A Reliability coefficient of 0.92 was obtained for GEPET using Pearson Product Moment Correlation (PPMC). The data collected were analyzed using IBM SPSS Version 20 package for computation of Means, Standard deviation, t-test, and analysis of covariance (ANCOVA). The ANOVA analysis ($F_{cal}(220) = 27.147, P < 0.05$) shows that students who received instruction with CAIP outperformed the students who received instruction with CLM and also had higher retention. The findings also revealed no significant difference in performance and retention between male and female students ($t_{cal}(103) = -1.429, P > 0.05$). It was recommended amongst others that teachers should use computer aided instructional package in teaching genetic concepts in order to improve students' performance and retention in biology subject.

Keywords: Computer aided Instructional Package, Performance, Retention and Genetic Concepts

Introduction

The global landscape is experiencing rapid changes in all spheres of life. Globalization is creating considerable new opportunities and new challenges as exemplified in the plethora of scientific breakthrough recorded in biotechnology, space research, energy development, telecommunications, and so on. It is obvious that if Nigeria with its cultural endowment is to successfully transform its economy and socio-cultural artifacts, it has to integrate computer technologies into its classroom for national development processes. Recent advances in pedagogy organization and presentation using technologies have changed the structure of education systems. These giant strides recorded by developed nations in technology have put additional responsibility on the educators of science (Kocakaya & Gonen, 2010). If the modern world is a product of science and technology, then a glance at the system of education in Nigeria reveals a poor state of infrastructure. The picture portrayed is that of a teacher that is limited to classroom environment with large groups of students without a subject textbook, desk and chalkboard. Teachers also complain of low performance while they are the custodian of this bedrock which is the foundation for higher knowledge (tertiary education). It is no gain saying therefore, that sound science education is pivotal to self-reliance and national development. According to John (2009), science is a way of knowing, a systematic method of learning about nature, based on observations and testing leading to the formulation of

hypotheses, laws, and theories. While education is an investment and instrument used in achieving rapid socio-economic, political, technological, scientific and cultural development.

Various individuals and groups have passed the blame of poor performance among secondary school students to parental factors, association with wrong peers, lack or unavailability of instructional materials, motivation and the likes (Asikhia, 2010). Morakinyo (2003) has also attributed the fallen level of academic achievement to teachers' non-use of verbal reinforcement (visual materials) and strategies in the course of instruction. Researchers have attempted to find out the causes of poor comprehension and performances in science subjects. Some of the problems identified include; Poor teaching methods (Mathew, 2002; Olorunkoba, 2007), abstract nature of sciences (Nsofor, 2006; & Shehu, 2006), the order of arrangement of biology scheme of work which placed abstracts concepts like genetics (Bajah, 2000), non-availability and utilization of instructional materials (Gambari & Gana, 2005; Yusuf, 2004).

The persistent poor performance in science subjects in Secondary School Certificate Examination has led to the assumption that most science teachers in secondary school in Nigeria do not make use of varied forms of teaching strategies to cope with difficulties associated with teaching and learning of science (Umoren & Ogong, 2007). Studies have also shown that most science teachers' do not possess the requisite knowledge to teach, as a result, the most prevalent method has been 'talk' and 'chalk' method. And the possible ineffectiveness of this approach may be strongly responsible for persistent poor performance of candidates in public examinations. There are so many possible reasons for the inability of science teachers in putting their lessons across to learners which may be because they are not abreast with the use computers as an innovative method of teaching. The use of computer aided instruction (CAI) has become the driving force in the delivery of instruction today. Computers have become an increasingly accessible innovative resource for educators to use in their teaching activities and improve teaching quality where quality is very expensive to reproduce or to substitute (Oguzor, 2011). Science educators must avail themselves of CAI, especially in teaching biology concepts that are considered difficult to comprehend since it is a compulsory requirement for admission into science related disciplines. The educational uses of computer that is considered to be Computer Aided Instruction (CAI) are those cases in which the instruction is presented through a computer program to a passive student or the computer is the platform for an interactive and personalized learning environment. Elizabeth (2011) averred that Computer Aided Instruction (CAI) could be in forms of drills and practice exercises, tutorials sequences to the student, animation and sometimes simulation which has the capacity of making the teaching and learning of science interactive thus improve students' performances.

Biology as a subject occupies a unique place in the secondary school curriculum and very relevant to science related fields, such as medicine, agriculture, biotechnology and genetic engineering (Kiboss, Ndirangu & Wekesa, 2004). Biology is important not only for the better life of individuals but also for preparing students for special fields such as agriculture, medicine, biotechnology, genetic engineering and so on (Sarajoni, 2001). Despite the importance of genetics to the future of students, the society and national development, students find most concepts difficult and teachers considers them abstract and difficult to understand as reflected in students' poor performance in Biology at Senior School Certificate Examinations (SSCE) in Niger State. Results of studies conducted with CAI on students' performance in biology has been mixed; the results of a study conducted in Ghana by Kofi, Appiah, Monney and Eric (2010) indicated that students that were instructed by the conventional approach performed better on the post-test than those instructed by the CAI. Finding of another study carried on pre-service Integrated Science teachers showed that CAIP enhanced their achievement at high, medium and low levels on scientific literacy when compared to the expository method of instruction

(Oludu, Ilabor & Isidi, 2014). This therefore prompted the investigation of the effects of computer aided instructional package on performance and retention of genetic concepts among secondary School Students in Niger State, Nigeria.

Statement of the Problem

Parents, teachers, government and the public generally are concerned about the state of education in Nigeria. Students' performances in examinations have continued to dwindle despite governments' investment in physical infrastructure, instructional materials and in training of teachers. This problem has necessitated researchers and science educators to step-up researches aimed at finding solutions to this problem and identifying newer strategies or approaches of teaching and learning science and biology in particular. The Chief Examiner's report on secondary school students' performance in Biology in senior secondary school examinations conducted by West African Examination Council (WAEC) in Nigeria from 2004-2011 showed continued decline in performances. The following represents the percentages of students with credits (A₁ - C₂) in WAEC (2004 – 2011) in Nigeria; 42.23% in 2004; 32.90% in 2005; 37.97% in 2006; 35.61% in 2007 and 35.39% in 2008, 28.59% in 2009, 49.65% in 2010 and 38.50 in 2011 respectively

Similarly, the performance of students in Biology is also reflected in the grades obtained (A₁ - C₂), Passes and failures recorded in WAEC in Niger State. The problem of poor performances can be appreciated from the percentages of failure (F9) obtained in the following years (see table 1.2), 2004 (62%); 2005 (59%); 2006 (59%); 2007 (78%) and in 2008 (72%) This result no doubt was worrisome to all stakeholders in the education sector. And part of the reasons responsible for this continued slide may be attributed to the type of or unsuitability of instructional methodology used by teachers in secondary schools.

On these bases therefore, this study will investigate the effects of computer aided instructional package on performance and retention of genetic concepts among secondary school students in Niger State.

Objectives of Study

The purpose of this study was to determine effects of computer aided instructional package on performance and retention of genetic concepts in biology among secondary school students in Niger State, Nigeria. Specifically, the study determined:

- (i) Whether there is any difference in performance of students taught genetic concepts using Computer-Aided Instructional Package (CAIP) and those taught with the Conventional Lecture Method (CLM).
- (ii) If there is gender difference in performance between students taught genetic concepts using Computer Aided Instructional Package (CAIP).
- (iii) If there is difference in retention of genetic concepts between students taught with Computer Aided Instructional Package (CAIP) and those taught using the Conventional Lecture Method (CLM).
- (iv) If there is difference in retention of genetic concepts between male and female students taught using Computer Aided Instructional Package (CAIP).

Research Questions:

To achieve the stated objectives, the following research questions were formulated:

- (i) Is there any difference in performance between students taught genetic concepts using Computer-Aided Instructional Package (CAIP) and those taught with the Conventional Lecture Method (CLM)?
- (ii) Is there any difference in performance between male and female students taught genetic concepts using Computer-Aided Instructional Package (CAIP)?

- (iii) Is there any difference in retention of genetic concepts between students taught using Computer-Aided Instructional Package (CAIP) and those taught with the Conventional Lecture Method (CLM)?
- (iv) Is there any difference in retention of genetic concepts between male and female students taught using Computer-Aided Instructional Package (CAIP)?

Null Hypotheses

Four null hypotheses were formulated and tested at 0.05 alpha levels:

- HO₁:** There is no significant difference in the performance of students taught genetic concepts using Computer-Aided Instructional Package (CAIP) and those taught with the Conventional Lecture Method (CLM)
- HO₂:** There is no significant difference in the performance of male and female students taught genetic concepts using Computer-Aided Instructional Package (CAIP)
- HO₃:** There is no significant difference in retention of genetic concepts between students taught using Computer-Aided Instructional Package (CAIP) and those taught with the Conventional Lecture Method (CLM)
- HO₄:** There is no significant difference in retention of genetic concepts between male and female students taught using Computer-Aided Instructional Package (CAIP).

Research Methodology

The research design adopted for the study was quasi-experimental research design i.e. a pre-test, post-test and randomized group design. The study is a randomized two groups design with subjects of the study divided into experimental and control groups by random sampling method. The experimental group received CAIP treatment while the control group did not but was however taught with the conventional lecture method. The population of this study was made up of 446 secondary schools in Niger State whose students offer Biology in 2013/2014 academic session. The population of students for the study was 46,714 including male and female students in SS3 who are between the ages of 16 and 20 years. Simple random sampling technique i.e. hat-draw method was used to select the subjects (students) for the study. The sample for this study consists of 223 students offering Biology. In all, only SS III students in six (6) senior secondary schools constituted the samples of the study. Three of the schools were purposively selected and assigned to the experimental group. This is because the three schools have computer laboratories, equipped with serviceable desktop and laptop computers which are basic requisite for the study. While the remaining three schools that were used as control group were randomly selected and used as intact classes. Computer Aided Instructional Package on Genetic Concepts (CAIP) was used as treatment instrument while a Genetics Performance Test (GEPET) used as pre-test and post-test for experimental and control groups. GEPET was reshuffled and renamed Genetic Concepts Retention Test (GECORET) which was used to measure retention among experimental and control groups. The instrument was validated by experts in science education and reliability coefficient of $r = 0.92$ using Pearson Moment Correlation Coefficient. GEPET was administered as pre-test and post-test and 2 weeks later GECORET was also given to measure retention. t-test and analysis of covariance (ANCOVA) were used to analyze the null hypotheses.

Results

Table 1 shows t-test analysis of pre-test result of experimental and control groups.

Table 1: t-test Comparison of Experimental and Control Groups on Pre-test

Group	N	df	Mean(\bar{X})	SD	t_{cal}	P-value	Remarks
Experimental Group	105	33.39		10.78			
		221			3.869	.001	Significant
Control Group	118		28.03	9.78			

Significant at 0.05 level

The t-test result of pre-test of the experimental and control groups in Table 1 shows that, the calculated t-value ($t_{cal} (221) = 3.869, P < 0.05$) is significant. This meant that there was statistically significant difference between the mean scores of the experimental group (33.39) and the mean score of the control group (28.03) at the 0.05 significant levels. Therefore, the students in the two groups were not equivalent with respect to their prior knowledge on genetic concepts in biology before receiving instruction with CAIP.

Null Hypothesis One (H_{01})

H_{01} : There is no significant difference in the performance of students taught genetic concepts using computer aided instructional package (CAIP) and those taught with the conventional lecture method (CLM).

Table 2: Analysis of Covariance (ANCOVA) on Experimental and Control Groups at Post test

Variables	SS	df	MS	F_{cal}	P-value	Remarks
Corrected Model	6169.567	2	3084.783	33.428	.001	
Pre-test (Covariate)	2505.109	1	34504.667	373.909	.001	Sig.
Group	2105.595	1	2505.109	27.147	.001	Sig.
Error	20301.823	220	2.281			
Corrected Total	26471.390	222				

Sig: Significant at 0.05 level

Table 4.8 shows the post-test analysis of ANCOVA between experimental and control groups which showed a significant difference $F_{cal} = 27.147, P < 0.05$. This means that at P-value less than 0.05 the mean difference of performance between the experimental and control groups of students taught genetic concepts with CAIP was significant hence, the null hypothesis was rejected. This implies that, there is significant difference between the performance scores of students taught genetic concepts with CAIP and those taught using the conventional lecture method. Schiff's Post-hoc (Least Significant Difference) analysis was used to determine which of the 2 groups was responsible for the observed differences in performance.

Table 3: Schiff's Post-hoc Analysis (LSD) on Performance between Experimental and Control Groups

Variable (i)	Variable (j)	Mean Difference	P-value
Experimental (1)	Control (2)	13.641	0.001
Control (2)	Experimental (1)	-13.641	0.001

Furthermore, mean gains statistic was carried out to compare the experimental and control groups scores at pre-test and post-test to determine which of the groups gained more.

Table 4: Mean Gains Comparison between Experimental and Control Groups

Groups	Pre test	Post test	Mean Gains
Experimental	33.39	53.56	20.17
Control	28.03	45.44	17.41

Table 4 also shows the mean gains comparison between experimental and control groups. The experimental group had a pre-test mean of 33.39 and post-test mean of 53.56 with a mean gain of 20.17. While the control group had a pre-test mean of 28.03 and post-test mean of 45.44 and a mean gain of 17.41 which is lower than that of experimental group. Thus, from the mean gain comparison, the experimental group taught genetic concepts with CAIP recorded a higher mean gain statistically greater than the mean gain of the control group taught using the conventional lecture method. Thus, the ANCOVA ($F_{cal} = 27.147, P < 0.05$) favoured the experimental group taught genetic concepts with CAIP.

Null Hypothesis Two

There is no significant difference in performance between male and female students taught genetic concepts using Computer Aided Instructional Package (CAIP).

Table 5: t-test Analysis of Male and Female Students Performance within the

Group	N	df	Means	SD	t_{cal}	P-value	Remark
Male	65	103	52.65	7.95	-1.43	0.156	NS
Female	40		55.05	9.02			

Experimental Group

NS: Not Significant at 0.05 level

Table 5 presents the t-test result of male and female students of the experimental group. The t_{cal} value of -1.429 obtained at .156 alpha level was found to be not significant ($t_{cal} (103) = -1.429, P > 0.05$). This meant that, there is no significant difference in the performance of male and female students exposed to CAIP on genetic concepts within the experimental group. The hypothesis was retained.

Null Hypothesis Three

There is no significant difference in retention between students taught genetic concepts using Computer Aided Instructional Package (CAIP) and those taught with Conventional Lecture Method (CLM).

To test differences in retention of genetic concepts between the groups that received instruction with CAIP and CLM, the data collected was subjected to analysis of covariance as presented in Table 6.

Table 6: Analysis of Covariance (ANCOVA) of Experimental and Control Groups on Retention.

Variable	SS	df	MS	F_{cal}	P-value	Remarks
Corrected Model	10221.621	2	5110.810	42.685	.001	
Pre-test (Covariate)	5.310	1	5.310	0.044	.833	NS
Post-Post test	9675.605	1	9675.605	80.809	.001	
Significant						
Error	26341.500	220	119.743			
Corrected Total	36563.121	222				

NS: Not Significant.

Table 6 presents the result of ANCOVA on the post-post-test mean score (retention) of the experimental and control groups. The F-value was found to be 80.809 at 0.05 alpha levels at P-value 0.001 ($F_{cal}(222) = 80.808, P < 0.05$) indicating that the difference between the mean retention scores of the experimental group and control groups is statistically significant. Hence, the null hypothesis was rejected. Therefore, there is a significant difference in retention between the experimental group students' taught genetic concepts with computer aided instructional package and those taught using conventional lecture method. Mean gains comparison was carried out to determine the group that recorded a higher retention rate between the experimental and control groups.

Null Hypothesis Four

There is no significant difference in retention between male and female students taught genetic concepts using Computer Aided Instructional Package (CAIP).

To calculate retention between male and female students taught genetic concepts with CAIP within the experimental group, t-test statistic was carried out to determine if there is a difference between and male and female students.

Table 8: t-test Comparison of Retention between Male and Female Students in the Experimental Group

Group	N	df	Means	SD	t_{cal}	P-value	Remarks
Male	65	103	54.12	11.313	0.281	0.779	NS
Female	40		53.50	10.590			

NS: Not significant at 0.05 level

Table 8 presents the t-test comparison between of male and female students' retention of genetic concepts taught using computer aided instructional package. The $t_{cal} = 0.281, P > 0.05$ revealed that there was no significant difference between male and female students taught genetic concepts using the CAIP. The post-post result on gender ($t_{cal(103)} = 0.281, P > 0.05$) indicates that, there is no significant difference between the groups. The result has indicated that, there was no significant difference in retention between male and female students on retention of genetic concepts. Therefore, the hypothesis that there is no significant difference in retention between male and female students taught genetic concepts using computer aided instructional package is retained.

Discussion of Results

The findings of this study that showed that there is a significant difference in performance of students taught genetic concepts with CAIP and those taught using the CLM which agrees with the earlier findings of Fajola (2000), Yusuf and Afolabi (2010) and Yaki (2011) in Biology. Similarly, the finding is in line with the findings of Udousoro (2000), Spence (2004), Yusuf (2006) and Olusi (2008) in Mathematics which found CAI to have enhanced students' performance. Also the finding corroborates the findings of Kadayifci (1998) and Okoro and Etukudo (2001) in Chemistry using CAI. The finding agrees with the earlier findings of Bayrak (2008) and Gambari (2010) in Physics which found that the use of CAI in teaching Physics concepts significantly improved the performance of the experimental group.

Furthermore, this study revealed that CAIP has significantly influenced students' performance on genetic concepts. This may be true because present day students seem to appreciate the use of computer technologies and thus found learning using computer aided instruction more

rewarding. This may not be different from the opinion expressed by Yusuf and Afolabi (2010) that CAI interactive approach significantly influence learning when compared with conventional instruction alone. And that CAI appears to be more cost effective than other instructional methods, such as teacher-directed instruction and tutoring. According to Yusuf and Afolabi (2010), the use of CAI produces higher performance than the conventional instruction alone and students learn computer instructional contents faster.

However, this finding contradicts the findings of Armstrong (1998), Mills (2001) and Onasanya, Daramola and Asuquo (2006) in *Introductory Technology* that the use of computer assisted instruction did not result in significant difference in performance compared to those taught with conventional lecture method. It was also observed that, because the computer aided instructional package appeals to both visual and auditory organs (multisensory) it contributed significantly in enhancing students' performance in genetic concepts learnt. This is because they are able to control the learning process; thus the CAI ensured greater comprehension and understanding. Dimerel (2004) painted this picture in a less cloudy perspective by saying that "learning resulting from seeing 83%, hearing 11%, smelling 3.5%, touching 1.5% and tasting 1%. Therefore, one could infer that, the use of CAIP produces higher effect on learning genetics. The use of CAIP can help achieve better students' performance in science subjects than the conventional lecture method. From the result of this study, it is observed that students taught genetic concepts with CAIP have higher achievement than those taught using conventional lecture method.

When the effect of CAIP on male and female students taught genetic concepts was analyzed using t-test statistic, there was no significant difference between them. The finding on this null hypothesis showed that, there is no significant difference between male and female students performance on genetic concepts when CAIP was used for instruction. This finding corroborates earlier findings of Bello (1990), Yusuf and Afolabi (2010) and Achuonye (2011) in *Biology* which showed that gender have no significant influence on performance. This finding also agrees with the findings of Anagbogu and Ezeliora (2007) which examined gender differences in scientific skills where predominantly visual material related to practical was used to determine students' performance. In other words, performance in genetics was not influenced by either being male or female. The possible reasons for the lack of discrimination in performance by male and female students could be attributed to the fact that computer aided instructional package appealed to both sexes without discrimination, balanced simulations and animation graphics, music, text and sound; short step-principle of arranging facts and immediate feedback system used in the package which made learning more interesting and permanent. However, the finding of this study refuted earlier findings on gender conducted by Chanlin and Lihjuan (2001) that there is significant difference in performance between male and female students taught with CAI. We could therefore infer that, the use of computer aided instructional package positively influenced both male and female students' performances in genetics.

The finding of this study corroborates the findings of Clark and Craik (1992), Fletcher-Flinn and Gravatt (1995), Oluwatoyo and Fatoba (2010) and Gultekin (2011) found that the use of CAI in instruction helped students' retention capacities much more than the conventional instructional method. And in order to determine the direction of significant difference after rejection of the hypothesis, the pre-test and post-post-test mean scores of students' retention was compared to determine the group with higher mean gains. The result was in favour of the experimental group that received instruction using computer aided instructional package.

There was actually no difference between male and female students retention on genetic

concepts. This finding is not surprising because female students that were hitherto seen to be less friendly to computer technologies (techno-phobic) are now changing and taking up carries and specialization believed to be exclusive reserve of the male sex. Earlier findings on attitude towards computer aided instruction have shown that it is appealing, enjoyable and supports individual students learning pace. Furthermore, students are at liberty to repeat a learning task as many times as possible which is essentially different with the conventional lecture method. Therefore, computer aided instructional package enhances meaningful knowledge construction which also encourages easy retrieval of knowledge over relatively long period of time. Bello (1986) in Wasagu (1997) rightly sums it up that, "people construct meanings of what they hear and see by generating links between their existing knowledge and new phenomena". Bloom (1990) also puts it that, "individuals construct their own knowledge in ways that are personally meaningful" to them.

Conclusion

Form the findings of the study it is concluded that the performance of secondary school students on genetic concepts can be significantly improved with the usage of computer aided instructional package (CAIP) better than the conventional lecture method (CLM) and that CAIP did not discriminate between male and female students performance on genetic concepts. CAIP also enhances greater retention of genetic concepts than the CLM of instruction and there is no differences in retention between male and female taught genetic concepts.

Recommendations

In the light of the findings in the study, the following recommendations are made:

- (i) Science Educators should begin to utilize computer aided instructional package in our secondary schools in order to improve on students' performance in biology to enable students pursue professional courses in tertiary institutions of learning.
- (ii) Computer aided instructional package has proven to be gender friendly since it does not discriminate between male and female student. It is therefore recommended that biology teachers should adopt its usage in order to further reduce the gap between male and female students performance.
- (iii) The Nigerian Educational Research and Development Council (NERDC) should begin to look at the possibility of developing computer aided instructional packages or software programmes on science subjects to supplement the conventional lecture method in teaching biology.

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