Effect of Computer-Assisted Instruction on Secondary School Students' Achievement in Ecological Concepts

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Abstract
This study investigated the effects of computer-assisted instruction (CAI) on students' achievement in ecological concepts. Quasi-experimental design, specifically the pre-test post test non-equivalent control group design was adopted. The sample consisted of sixty-six (66) senior secondary year two (SS II) biology students, drawn from two randomly selected co-educational secondary schools in Aguata education zone of Anambra State, Nigeria. Two research questions and two hypotheses guided the study. Treatment consisted of teaching ecological concepts to the experimental group using CAI while the control group was taught using modified lecture method (MLM). Biology Achievement Test on Ecology (BATEC) was the instrument used for data collection. Mean and standard deviation were used to answer the research questions while ANCOVA was used to test the null hypothesis at 50% confidence level. Results revealed that: students' taught using CAI performed significantly better than those taught using MLM; though there was a difference in the mean achievement of male and female in both the experimental and control groups which was in favor of the males, the difference was not significant. Based on the findings of this study the use of CAI was recommended for enhancement of secondary school students' achievement in ecological concepts and other abstract concepts in science.

Keywords: Computer-assisted instruction, students' achievement, ecological concepts

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Introduction

Ecology is one of the branches of biology that deals with the study of plants and animals in relation to their environment. Ige (2001) conceptualized it as a subject that provides knowledge and understanding of the mechanism of change brought about by the interaction of the living things and its effects on their external environment. Ecology also gives us the basis for predicting, preventing and remedying pollution. It helps us to understand the likely consequences of massive environmental intervention, like in the construction of dams or diversion of rivers and difficulties arising from the stress of modern day life.

Despite the importance of ecology in national development available records from the West African Examination Council (WAEC, 2003 & 2007) on senior secondary school students' achievement in biology was very poor because of poor grasp of ecological concepts. According to WAEC Chief Examiners reports, in 2003, students were asked in ecology to state five important uses of water to organism in the rainforest. In stating the uses, most candidates wrote on the uses of water to man example cooking, drinking etc. Rather than necessary for photosynthesis, essential for plant turgidity ,maintaining body temperature. Also in 2007 WAEC question, biology students were asked to describe three ways each by which animals in Arid habitat are adapted to drought and high temperature. The Chief Examiner report shows that students wrote wrong answers.

The National Policy of Education (FRN, 2004) states that no educational system can rise above the quality of its teachers. Inline with the above, Besong and Obo (2003) observed that the method adopted by the teacher may promote or hinder learning. Some authors including Ali (1998) had stressed that the main cause of poor achievement in science in Nigeria results from the application of ineffective methods in science teaching, among other factors. Shymanasky (1992) also observed that one problem long recognized with traditional science teaching is the lack of integration of content and pedagogical components, as teachers too easily get caught up in "covering" material and degenerate to lecturing or to getting ideas "across". According to Esomonu (1998) there should be continuous interaction between the teacher and the pupils during lecture method so as minimize boredom. In line with the above, the researchers used modified lecture method (MLM) in teaching the control group during this study. MLM involved the use of examples, instructional materials, illustrations, demonstration and clarification of concepts. To address the unhealthy situation of poor achievement in science, research is constantly providing new methods for educators to use, and technology has developed many kinds of tools ideally suited for instructional needs. Examples include: the use of inquiry, process-based approaches, analogy and cooperative learning (Egbunonu, 2012). All these methods mentioned above have been found in the past to improve students' achievement in sciences, yet students continue to record poor performance in ecology. This poor achievement rate calls for better methods of teaching and learning. However, in this age of ICT research attention has turned to ways of bringing computers into teaching and learning in science classrooms. According to Egbunonu the introduction of computer has brought less waste and new applications in almost every field. Currently its greatest use in education is computer-Assisted Instruction (CAI) which according to Umaru (2003), Ojeme and Umendu (2004) is "a program of instructional materials presented by means of a computer or computer system. Similarly, Onyemechara (2007) and Onuba (2001) described CAI as the use of computer to store a vest amount of materials and to present them in various audio-visual modes to students. In computer-assisted instruction, the material to be learned is programmed into computer software. The teacher inserts the software into the computer for individualized study or divides students into groups for instruction (Olibie, 2002). The computer then presents the materials to the students in a variety of formats including sound, text and video with ample grammatical rules and exercises. As the students tackle such exercise the computer points out their errors to them and offers suggestions for help. It is the type of teaching in which the computer acts as tutor to the students. In line with the above statement, Onyemechara (2007) said that computer programs are interactive and can illustrate a concept through attractive animation, sound and demonstration. They allow students to progress at their own pace and work individually or solve problems in group. Computers provide immediate feedback. The computer

"talk" to the students by displaying messages on the screen and the students "talks" to the computer by typing his/her message through the keyboard. If the answer is not correct, the program shows the student how to correctly answer the question. This is only possible, according to Akuneme (2004) if the student has a prior knowledge of how to operate a computer so that it can display a particular subject matter and offers his/her tutorials on it.

A number of authors have identified gender as a significant factor responsible for differential achievement in the sciences among students. Papert (1992) in his work title "mind-storms: Children, computer and powerful ideas" suggested that males and females are every likely to respond differentially to computer-assisted instruction. But Wright (1993) argued against the speculations of Papert and stressed that since computer programmes lack specific gender attributes it would be very unlikely that male and female learners will vary in their response to computer assisted instructions. These arguments about the efficacy of CAI tend to generate some doubts as to whether it should be recommended for use in secondary schools or not. Before adequate recommendations on the appropriate model to be adopted for instruction will be made, there ought to be evidence of empirical research on the effect of the model on the achievement of the learner.

Some studies which tested the contention of the facilitative effect of CAI have produced positive findings. For instance, in engaging a sample of senior secondary two (SS II) students, Onyemechara (2007) found that the experimental classes which received instruction using CAI demonstrated superiority over control group in the post-test scores in mathematics. Kinzie, Larsen, Burch and Boker (1996) also found that CAI improved significantly biology students' achievement on frog dissection.

Empirical review as presented in this work indicates that a lot of research have been carried out on the effect of CAI in teachings science in recent times, but not much findings have been recorded in biology in general and ecology in particular. The paucity of CAI research finding in biology may be as a result of large number of students offering the course in secondary schools compared to the number of computers in the schools (Egbunonu, 2012). More so, there are a number of inconsistencies in the findings of the researchers, some reported that CAI enhanced achievements while others reported that CAI had no effect (Olikeze, 1999). No wonder, Holl (2011) advocated more research on the effect of CAI upon which to base firm conclusions about its advantages and disadvantages. This may be because; there are still many variables to be examined to ensure that the advantages of CAI more compared with its disadvantages. Hence, there is need to find out the effects of CAI on students achievement in ecological concepts.

Research Questions

The following research questions guided the study

1. What is the difference in the mean achievement scores of students taught ecological concepts using CAI and those taught using modified lecture method (MLM)?

2. What are the comparative effects of the teaching methods (CAI and MLM) on the mean achievement scores of male and female biology students in ecological concepts?

Hypotheses

Two null hypotheses guided the study

1. There is no significant differences (P<0.05) in the mean achievement scores of biology students taught ecological concepts using CAI and those taught using MLM.
2. There are no significant difference (P<0.05) in the mean achievement scores of male and female biology students taught ecological concepts with CAI and those taught using MLM.

Methods

The design of the study is quasi experimental, specifically, the pretest, post test non equivalent control group design. This design was used because intact classes were used since it was not convenient to randomly assign the students to experimental and control conditions. The sample for the study consists of sixty-six (66) senior secondary year two (SS II) biology students from two schools randomly sampled from twenty-seven (27) co-educational secondary schools in Aguata Education zone of Anambra State, Nigeria. Using flip of a coin one of the schools were chosen as the experimental group and the other, the control group. The experimental group had intact class size of 14 males and 18 females (N = 32) while the control group had 14 males and 20 females (N = 34). All the students in each of the two intact classes were used for the study.

Instrument

The only instrument for the study was a Biology Achievement Test on Ecological concepts (BATEC). BATEC is a 50 item, 5-option multiple choice objective test developed by the researchers based on two units in ecology (Ecology of population and ecological management) taught. A test blue print was developed based on the relative emphasis on each of the curriculum (appendix 1 refer). Out of the initial 55 items, 50 items were found suitable in terms of discrimination and item difficulty indices after careful items analysis. A reliability coefficient of 0.91 was established using Pearson product moment correlation technique.

Development of the programmed Instruction in Ecology (PIE)

The PIE was developed by the researchers, with the help of an expert in computer programming. Visual Basic language was used in writing the programmed instruction which was based on the validated lesson plans developed by the researchers.

Procedure

The experiment was conducted by the researchers while other regular classroom teachers observed what was going on. The researchers must teach the experimental group alone because of their wealth of experience in CAI. More so, biology teachers consider Ecology concepts difficult to teach (Okebukola, 2005). It may be very cumbersome for teachers to battle with how to teach ecology and how to deal with CAI which they may know little about how to implement. The researchers therefore had to teach both experimental group and control group to ensure uniformity. BATEC was administrated as pre-test to experimental and control groups before treatment commenced. The experimental group was taught using CAI while the control group was taught using MLM. (The teaching last for six weeks using the normal school timetable)
At the end of the six weeks set out for the study, the same test was administered on both the experimental and control groups as post-test. The scripts were collected, marked and scored using marking scheme prepared by the researchers.

Results

Mean and standard deviation scores of students achievement in BATEC were used to answer the research questions (Table 2 and 3) while Analysis of covariance (ANCOVA) was used to test the hypotheses at $P<.0.50$. Pre-test scores were used as covariates, thus serving to adjust for the initial differences between and within groups (Table 4).

Table 2. Mean (x) and Standard Deviation (SD) of students' overall post-treatment achievement score due to teaching methods

Group	N	X	SD
Experimental group (CAI)	32	54.44	10.75
Control group (MLM)	34	42.35	13.52

The result as presented in table 2 showed that there was a remarkable difference between the post-test scores of students exposed to CAI (experimental group) and post-test scores of those exposed to CAI (Control group) in favor of CAI. This means that students taught ecological concepts using CAI approach scored higher than those taught the same concepts using MLM.

Table 3. Mean (x) and Standard Deviation (SD) scores of students' post   treatment achievement score due to Teaching Methods and Gender

Teaching Method	Statistics	Gender	
		Male	**Female**
CAI	X	55.71	53.44
	SD	9.67	11.70
	N	14	18
MLM	X	44.14	41.10
	SD	14.39	13.09
	N	14	20

The results as presented in table 3 revealed that the mean scores of male students taught using CAI was slightly higher than the mean scores of their female counter part and also higher than the mean scores of male and female students taught using MLM.

Table 4. Summary of Analysis of Covariance (ANCOVA) of students' overall Achievement score by Teaching Methods and Gender

Source	Sum of squares	DF	Mean Squares	f-cal	f-crit	Sign	Decision	Remark
Corrected model	6868.422	8	85.8533	9.505		0.000		
Intercept	11.417	1	11.417	0.126		0.724		
Pretest	103.168	1	103.168	1.142		0.290		
Methods	686.484	1	686.484	7.600	3.92	0.008	S	Reject H0:1
Gender	165.078	1	165.078	1.828	3.92	0.182	NS	Accept Ho:2
Error	5148.608	57						
Total	165428.00	66						
Corrected Total	12017.030	65						

The ANCOVA of students' overall achievement scores presented on table 4. show that the effect of CAI in teaching ecological concepts was significant at $P<0.05$. The f-calculated was 7.60 against a critical value of 3.92 at 1 degree of freedom for numerator and 66 degree of freedom for denominator at the 0.05 level of significance. Since the calculated f-value (7.60) exceeded the critical value (3.92), the null hypothesis of no significant difference is rejected. Therefore it was concluded

that there is a significant difference in the mean achievement scores of biology students' taught ecological concepts using CAI and those taught using MLM.

Table 4 further revealed that, there is no significant difference due to gender on students' achievement in the ecological units understudy. The calculated f-value is 1.83, as against the critical value of 3.92 at 1 degree of freedom for numerator and 66 degree of freedom for denominator at 0.05 level of significance. Therefore gender (male and female) is not a significant factor in students' achievement.

Discussion and Conclusion

The study shows that CAI had significant effect on biology students' achievement in ecological concepts. The students taught using CAI performed better than those taught using MLM. This finding were in line with those of Kinzie, Larsen, Burch and (1996) and Onyemechara (2007) who observed that the use of CAI improves students' achievement greatly. This superiority of CAI over MLM could be explained by the fact that CAI provided the students opportunity of going through the Programmed Instruction (PIE) at their pace and more than once in most cases. Again, the idea of self-evaluation and remedial activities provided by CAI could have helped the students to master the concepts without difficulty better than the control group.

Though there was a difference in the mean achievement of male and female students in favor of the male in both the experimental and control groups, the difference was not statistically significant. This present findings were in agreement with Olikeze's (1999), Imoko and Usman's (2008) and Onyemechara's (2007) findings that there is no significant difference in science achievement between male and female students taught with CAI.

From the findings of this study, we can conclude that CAI is more effective in improving students' mean achievement score in ecological concepts than the use of modified lecture method. This approach too does not discriminate between male and female students rather it appears to guarantee a learning experience that will be beneficial to all.

Recommendations

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

1. Biology teachers in Nigerian secondary school should incorporate CAI as one of the methods used in teaching difficult concepts in biology

2. The government should utilize the services of various bodies like the science teachers Association of Nigeria (STAN), Nigeria Union of Teachers (NUT) and others to organize seminars, workshops and conferences to inform and train biology teachers and other science teachers on the use of CAI in teaching and learning

3. Teacher education programmes should include computer literacy programmes in biology method course content. This will ensure that the biology teachers are adequately trained on how to use CAI in teaching and learning.

4. Ministries of Education, both state and federal, should sponsor teachers to attend in-service course on the necessary ICT tools for teaching and learning. This is to make the teachers computer literate and to help them master the operation principles of CAI.

5. Government of Nigeria should provide adequate number of computers in schools, provide standby electricity generating sets and provide standard computer software in different topics of biology

(especially on difficulty concepts) to as many schools as possible. This will encourage teachers and students to make maximum use of the computer systems available in schools.

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