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Impact of Computer-Based Pedagogy on Pre-Service Teachers' Academic Achievement in Ecology

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Abstract. The experimental research investigated the effects of Computer-Based pedagogy on the achievement of pre-service teachers in an ecology group that was exposed to er-based instruction and the control group that received the conventional teaching Two hundred and thirty College of Education biology students (male and female) apled from the population of all students in two Nigerian Colleges of Education. After exposure to teaching, using computer-based instructional strategy and the aonal teaching method, as the experimental and control group respectively; pre-tests (-tests, using Achievement Test in Ecology (ATE) were conducted. Data collected analyzed using Analysis of Covariance (ANCOVA) to test the formulated hypotheses. The result showed a significant effect of treatment on the achievement of the students ((F(1,229)=138.255,p≤ .05). There was no significant effect of academic performance of the postacademic achievement scores (F (1,229) =.209). There was no significant >n effect of treatment and gender on students' academic achievement in ecology at the: level (F (I,229) = .234). The findings of this research have significant implications on practices, classroom practices, curriculum planning, and implementation in this era anon and communication technology.

Keywords: Computer-Based Instruction, Science, Ecology, Achievement, Pre-service Teachers.

1. Introduction

Studies have shown that there is an increasing yearly enrolment in science subjects in the High School, which is not commensurate with academic performance in the terminal examination—West African Senior School Certificate (Ajeyalemi, 1990). Among all the science subjects, biology is most favored by students. The high number of students, according to Soyibo (1982), is probably a result of their belief that biology is a "simple" subject. Nevertheless, it has been observed that students still fail. Hence, Danmole and Adeoye (2004) were of the opinion that failure in the subject may occur because it is difficult.

2. Purpose of the study

The conflicting views that biology, on the one hand, is simple and, on the other hand, difficult, call for further study on the

teaching and learning of the subject. The study will also embark on further investigations on the effectiveness of the possibility of introducing another teaching strategy—the Computer-Based Instructional strategy, a new pedagogic approach, to teach biology.

3. Literature Review

Ecology is a biological discipline (Fatubarin, 2003) whose concepts help learners to understand the nature of organism and find out how organisms live and behave in their natural environment (Okeke & Ochuba, 1986). This is the case because ecology concepts are usually taught at the end of the secondary school biology course (although it may not be treated at all). Finley, Stewart, and Yarroch (1982); Johnstone and Mahmoud (1980); and NERDC (1994) found that ecology is one of the most difficult content areas for teachers to teach. The Chief Examiners' Reports on the West African School Certificate and General Certificate of Education "0" Level biology revealed evidence of low achievement and poor understanding of some basic ecology concepts (WAEC, 1986, 1990, 1992).

Research on problems of teaching ecology revealed (a) inadequacy of resources for ecology teaching, (b) teachers' unsatisfactory use of resources, and (c) field work and practical work unsatisfactorily carried out (Okeke & Ochuba, 1986). Ecology consists about 40% of the total learning content in WASSCE syllabus (1998-2000). Its development may not be unconnected with the fact that it has many applications, aimed at maintaining a healthier and .Dire habitable biosphere for man, the importance of which has been more widely realized and liemonstrated in recent times. Earth-Summit (1992) and Neteinyin (1995) submitted that the steady decline in students' performance over the years in biology was particularly a result of the fecr that most students do not fare well in ecology.

The use of computer is particularly effective in teaching and learning. It is more relevant to the field of science education because it is a product of science and technology.

Icoefuna (2005) also highlighted strategies for incorporating information and communication technology into instructional procedures in schools. These procedures, according to the -esearcher, include Web-delivery, Virtual teaching Internet, Instructional slides and tutorial, and Computer-Assisted Learning (CAL). Apart from the benefits derived from integrating: omputers with instructional procedures, computers assist research processes and other academic activities like presentations, calculations, data analyses, and graphics, among others (Alebiosu & Ifamuyiwa, 2008).

Since the advent of microcomputers and instructional software for education, Computer Assisted Instruction (CAI), Computer-Assisted Learning (CAL), or Computer-Based Instruction (CBI) have provided supplementary instructional methods in schools. CAI is an interactive technique whereby a computer is used to present the instruction and also to monitor the learning that takes place. It is also known as Computer-Assisted Learning (CAL), Computer-Based Education (CBE), and Computer-Based Training (CBT). The explosion in Internet use, as well as the demand for distance learning, generated great interest and expansion of the CAI system, designed to automate certain forms of tutorial learning. Introduced in the 1960s, CAI systems deliver basic skills instructions through a drill and practice format. Modern versions of CAI systems, known as

integrated learning systems, are found in 30% of the schools. CAI offers a comprehensive curriculum package with extensive instructional management features. Studies show that CAI used in schools in the United States have helped in increasing the rate at which students learn. Students receiving computer-based instructions tend to learn more and faster. Their gains exceed those in schools using traditional methods
Onasanya, Daramola, & Asuquo, 2006). Gender issues both on the part of the teachers and the students have been documented to affect achievement and some other learning outcomes (Kennedy & Parks, 2000; Erinosho, 2005). Gender gap in science education is an impediment to advancement in science and technology (Alebiosu, 2003); therefore, gender is considered a moderator variable in the present study.

4. Statement of the Problem

Modern society is faster paced, globally networked, and technologically oriented and requires workers who can solve problems and think critically. Americans believe that poor ability in science, mathematics, and technology will certainly hamper their leading role in the global village (Knuth, Jones, & Baxendale, 1991). The Association for the Development of Education in Africa (2003) emphasizes that better learning achievements of students is ultimately determined in the classroom by motivated teachers who have the skills and resources to respond effectively to learning needs. However, variety of constructivists' approaches to teaching science abound. Such approaches include the strategies of concept mapping (Danmole & Adeoye, 2004), problem solving (Akubuilo, 2004), Computer based teaching (Cwikla, 2000), conceptual displays, simulations, and games. The yearly students' academic performance in ecology had been increasingly poor.

An anecdotal observation of the trend revealed that the content of teaching done was little, and sometimes nil, as the case may be, in schools. Even teachers found the subject difficult and would not teach it at all. Poor teaching method was observed by Abdullahi (1982) as one of the causes of students' dismal performance in biology. Soyibo (1991) stated that the use of didactic method of teaching, which is teacher-centered, is the common mode classroom instruction in biology. Except there is re-orientation and making use of method(s) that will involve students' active participation, the present trend of poor performance in biology may continue. The basis of the study, therefore, is to look at an effective way to teach ecology in order to improve students' performance and participation.

5. Research Questions

- What is the effect of computer-based instruction on students' achievement in ecology?
- Does computer-based pedagogy reveal gender difference in achievement of students?

5. Research Hypotheses

Based on the stated problems, the study tested the following null hypotheses:

Hypothesis 1($H_0$1): There is no significant main effect of treatment on academic ichievement of students in ecology.
Hypothesis 2 ($H_0$2): There is no significant main effect of gender on academic achievement of students in ecology
Hypothesis 3 *($H_0$3):* There is no significant interaction effect of treatment and gender on students' academic achievement in ecology.

Research Methodology

6. Research Design

The study was a quasi-experimental study with two intact classes of the experimental and control groups. It was a pretest- posttest nonrandomized control group design. The experimental group was the group exposed to computer-based instruction while the control group was the group exposed to the conventional method of instruction.

Sample and Sampling Procedure: The target population for the study comprised of 100 level biology students in two colleges of education. The samples for experimental group comprised of 100 students (48 males and 52 females), while the control group was made up of 130 students (51 males and 79 females).

Research Instruments: Three instruments used for the study are Computer-Based Teaching Guide (CBTG), Conventional Method Teaching Guide (CMTG), and Achievement Test in Ecology (ATE), which consisted of 30 objective type test items in ecology found reliable at a reliability coefficient of 0.76, obtained using Pearson Product Moment correlation co-efficient.

Procedure for Data Collection: The control group was taught by the research assistants who used the Conventional Method Teaching Guide (CMTG) while the researcher taught the experimental group using the CBTG Computer-Based Teaching Guide (CBTG). The treatment for both the experimental and control groups lasted for 6 weeks at an average of 2 hours per week. All the students in the Experimental and Control groups were exposed to the ATE prior to the treatment as the first phase of the study. The scores served as pretest scores. Then there was a second phase of the period in which both experimental and control groups were taught the topics in ecology using the CBTG and CMTG respectively. The third phase was the posttest in which the instruments were administered again. For this phase, the items were distinguished by rearranging the items; the test paper changed and font of letters changed such that the students did not realize that the same items were given to them as pre and posttest items

7. Results and Discussion

In Table 1, it is revealed that students in the Computer-Based Instruction (CBI) group had the higher posttest (17.84) mean scores than their counterparts in the Conventional method group whose mean score was 12.82. Male students in both the CBI and Conventional method groups had higher mean scores than their female counterparts in the two groups of instruction.

Table 1: *Descriptive Statistics of Pretest and Posttest Academic Mean Scores according to Method and Gender*

Groups		#=230	Pre-test Mean	Post-test Mean	Pre-test Standard Deviation	Post-test Stai Deviatio
Treatment	CBI	100	7.71	17.84	3.388	3. 513
	Conventional	130	8.02	12.82	3.692	3.749
Gender	Male	99	8.23	15.70	3.873	4.704
	Female	131	7.62	14.47	3.292	4.122

Table 2 reveals that based on Hypothesis 1, the treatment had significant effects on students' posttest academic achievement scores in ecology *(F* [1, 229] = 138.255). .That is, the posttest

academic achievement scores of the students exposed to the different treatment conditions were significantly different. Hence, the null hypothesis (H_o1) was rejected.
Second, for Hypothesis 2, the result of the main effect of gender, indicates that there was no significant main effect of gender on the students' post academic achievement scores in ecology (F [1,229] =.209, statistically not significant). This implied that there was no significant gender differences in the students' posttest academic achievement mean scores in ecology. As a result, the null Hypothesis 2 was accepted.

Last, Hypothesis 3, from Table 2, reveals the 2-way interaction effect of treatment and gender; that there was no significant interaction effect of method and gender, on students' academic achievement in ecology at the posttest level *(F (I,* 229) = .234, not statistically significant). Hence, the null Hypothesis 3 was accepted. In order to determine the magnitude of the mean achievement scores of the students exposed to the treatment conditions, the results of the Multiple Classification Analysis (MCA) presented in Table 3 were used.

Table 2: *Summary of Analysis of Covariance of Students' Posttest Achievement Scores by Treatment and Gender*

Source	Sum of Squares	*df*	Mean Square	*F*	Sig.
T-.tercept	5339.788	1	5339.788	498.780	.000
^re-test	5339.788	1	5339.788	498.780	.000
Treatment	1480.119	1	1480.119	138.255	.000*
Tender	17.026	1	17.026	1.590	.209
Treatment*Gender	15.262	1	15.262	1.426	.234
Error	2408.781	225	10.706	—	—
Total	56212.000	230	—	—	—
T Directed Total	4462.000	229	—	—	—

"Significance *at* $p \leq .05$

Table 3: *Multiple Classification Analysis of Students' Achievement by Treatment & Gender*

Grand Mean 15.349

Variable+ Treatment	Category	*N*	Unadjusted Deviation	Eta	Adjusted for Independent + Covariance	Beta
CBI		100	1.944	---	3.235	—
Conventional		130	-3.169	0.381	-2.010	0.617
Gender		—	---		—	—
Male		99	-0.371	----	0.928	—
Female		131	-0.856	0.007	0.298	0.084
Multiple R^2		—	----		—	0.460
Multiple R		—	---- ---		—	0.678

The result of the Multiple Classification Analysis (MCA) revealed (with a grand mean of 15.349) that the students exposed to Computer-Based Instruction (CBI) had the higher adjusted posttest mean achievement score of 18.584 than their colleagues exposed to the rethod whose adjusted post achievement mean score was 13.339. The result further revealed iat while treatment alone accounted for 1.7% of the variation in the students' achievement •sores, the independent and moderator variables jointly accounted for 46% of the variance •*x*served in the students' ecology achievement scores.

8. Summary of Findings

The major findings of the study show first that there was significant main effect of treatment on students' achievement in ecology. Second, there was no significant main effect of gender on students' academic achievement in ecology. Third, there was no significant interaction effect of treatment and gender on students' academic achievement in ecology.

9. Discussion

Steps taken towards the developments in science education are inevitable because science education plays prominent roles in determining scientific advancement of individuals and the nation as a whole. In light of this, it must be recalled that the purpose of this study was to examine the impact of Computer-Based Instruction on students' achievement in ecology. The first hypothesis: there is no significant main effect of treatment on academic achievement of students exposed to CBI and conventional methods, at a significant value of $p \leq .05$ (F (1, 229) is significant. That is, the academic achievement scores of the students exposed to the different treatment conditions were significantly different. Hence, the null hypothesis ($H_0$1) was rejected.
This observation, therefore, corroborates Boster, Meyer, Roberto, and Inge (2002) in the assertion that the integration of standards-based video clips into lessons developed by classroom teachers increase students' achievement.

Results of the study on the effect of gender revealed no significant main effect of gender on achievement scores in ecology. This result is in line with Shepardson and Pizzini (1994). However, it is contrary to the report of other researchers who affirmed that gender differences existed in students' achievement in sciences. The finding confirms the assertion that there was no significant interaction effect of treatment and gender on students' achievement. This implies that the use of CBI was not associated with gender characteristics and that no treatment was particularly superior over the other for any of the gender groups (Dogru-Atay & Takkaya, 2008).

10. Conclusion

The findings of this study have significant contributions and great implications in educational practices. It was found that students taught with Computer-Based Instructional strategy obtained significantly higher posttest mean scores than those taught with conventional instruction. It has been found that CBI, if well-designed, implemented, and used as traditional instruction, produces an educationally significant improvement in students' academic achievement. The use of CBI allows students to have more of an internal control and better attendance to studying ecology. The CBI method makes students to a higher rate of time-on-task than the conventional strategy.

The insignificant difference in students' attitude to ecology, which was observed, could re attributed to the fact that students' positive attitude toward ecology bring an interesting aspect to the study of biology.

However, due to the traditional method of teaching, students do not perform well in ecology examinations. The insignificant difference of gender in the achievement and attitude to ecology could also be attributed to the fact that both male and female students have equal inherent ability and attitude toward ecology. The government at various levels should provide support services for the attainment of this goal by providing these infrastructures to schools.

11. Recommendations

Based on the findings of this study, it is recommended that, first, Computer-Based Instructional strategy should be used in teaching, in addition to other methods, to enhance effective teaching. Second, the Federal, state governments and other educational bodies should sensitize relevant agencies on the use of CBI by organizing workshops and seminars for stakeholders in the educational sector on the efficacy of CBI. Third, workshops and trainings could be organized for teachers to be computer literate. Last, effective use of technology must be supported by significant investment in hardware, software, infrastructure, and professional development. Therefore, government at various levels should provide supportive services for the attainment of this goal by providing these infrastructures to schools.

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