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DESIGN AND DEVELOPMENT OF COMPUTER-AIDED LEARNING SOFTWARE FOR INDIVIDUALIZED INSTRUCTION OF PHYSICS IN SOME SELECTED SECONDARY SCHOOLS IN NIGER STATE

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Abstract

In this, paper, the effect of a researcher-designed Computer-Aided Learning software on students' physics achievement in senior secondary school in Niger State, Nigeria was investigated. The pre-test-post-test experimental-control group research design was employed. Stratified random sampling was used to select 80 students (40 males and 40 female) for each of the experimental and control groups. A 50-item achievement test, the Physics Achievement Test (PAT), was administered to the students as pre-test and pos-ttest. Two hypotheses were postulated and tested at 0.05 level of significance. From the analysis the following findings were reached: (i) There was a significant difference between the achievement scores of physics students taught with the Computer-Aided Learning (CAL) software and those taught without the CAL software on the post-test ($t = 15.74$, $df = 39$, $p \leq 0.05$). This shows that CAL is a better approach to embark upon by physics teachers for meaningful learning than traditional lecture method. (ii) There was no significant difference between the mean achievement scores of male and female physics students taught with the Computer-Aided Learning software ($t = 0.31$, $df = 19$, $p \geq 0.05$). This shows that the CAL software stimulated males and females alike. The implications of the findings for the use of CAL software were discussed. Recommendations for the improvement of physics education in Niger State and suggestions for further studies were made.

Keywords: *Computer-Aided Learning (CAL); CAL software; Individualised Instruction; Physics; Achievement; Senior Secondary Students; Niger State.*

Introduction

One of the problems of teaching and learning is the method of imparting knowledge to learners. According to Stone (1991), the major difficulty in sciences is the method by which the subjects were customarily taught without regard to instructional materials. The pedagogical approach in imparting knowledge to learners has become inadequate to their needs. Bajah (1995) and Okeke (1986) found that science subjects has not been taught in Nigerian schools the way that pupils would benefit most, as science instruction has mostly been teacher-centred.

For the past two decades, science education has been facing a lot of difficulties which include poor performance of students in science subjects (Adeyegbe, 1992). Physics, like

other science subjects, recorded poor students' performance both in national and international examination (Ali, 1983). Many factors contributed to the poor performance of students in physics examination (Akale, 1986; Okebukola and Jegede, 1986; Offiah, 1987; and Ali, 1988). The factors include:

(i) Inability of the physics teachers to put across the physics concepts to the students
(ii) Lack of skills and competence required for teaching physics
(iii) Shortage of qualified physics teachers
(iv) Lack of teaching materials and equipment

Physics as a subject is very important for the scientific and technological advancement of any nation. Though its usefulness cuts across all fields of human endeavour, the low enrolment of students in the subject at both secondary and post secondary levels has been a source of concern to various people especially physics educators at various times (Omosewo, 1999; Balogun, 1985; Otuka, 1983; Ogunneye, 1982; Orisaseyi, 1977; Ogunyemi and Eboda, 1974).

Lack of active participation of students is one of the factors responsible for students' poor performances in science subjects (Inyang, 1988; Bichi, 1988). This has also been indicated in West African Examination Council (WAEC) results of secondary schools where students' performances are generally poor in physics, chemistry, biology and other science-related subjects (WAEC, 2000). This pattern of poor performance in the sciences by students is also observed in tertiary institutions (Olarinoye, 1987). Omosewo (1999:99), asserted that

> *"physics teachers were using the lecture method for teaching the subject in the secondary schools. The direct impact of this method on learners is that it often leads to lack of understanding and this might cause poor performance and low enrolment of students in the subject. The low enrolment in physics is a cog in the wheel of the scientific and technological progress in this nation".*

Many of the students see science as too abstract to comprehend, thereby resorting to memorization or rote method of learning. Many students have also changed from science subjects to art and commercial subjects while some dropped out and some failed woefully at the final examination. Meanwhile, various attempts have been made by government, school proprietors and teachers to facilitate effective teaching and learning of these science courses which are the rudiments of development of any nation. Textbooks have been constantly reviewed and rewritten in simpler forms and instructional materials of various types had been designed yet the problems persist.

Ogunleye (2000) found out that in the era of technological advancement, technology has had minimum impact on education. This is because 80% of teachers in Nigeria are mostly using the chalkboard and textbook method (traditional method) in teaching. Actually most schools do not have modern equipment and materials. The few schools that have these equipment are unable to use them effectively as a result of erratic electric power supply and at times the inability of some teachers to operate some of these equipment. However, constant use of the traditional method of teaching is a major factor contributing to poor academic achievement of physics students.

One of the major problems faced by students is inability to remember what has been learnt. This problem is often caused by too much theoretical expression by the teachers while learners are passive listeners. Students memorize and regurgitate facts and concepts.

The above problems confronting the teaching and learning of physics can be handled using Computer-Aided Learning (CAL). Computer Aided Learning is a learning process in which a student interacts with and is guided by a computer through the course of study aimed at achieving certain instructional goals (Eke, 1988). Computer has been used in developed countries to tackle most of these problems it could be used to transform classroom instruction into a series of rich memorable experiences and thus reduce boredom and forgetfulness.

Computer can be used to teach all school subjects including science. In recent years, the use of computer in the process of teaching and learning has become widespread in educational institutions with the development of microcomputer (Ezeliora, 1997). According to Ezeliora (1997),

> *"Computer is useful in almost all spheres of life such as in hospitals for keeping records of patients, drugs, staff and accounts, instruments for diagnosis and treatment. It facilitates the banking system and quickens banking services to clients. It is very useful in professional services such as engineering, chartered firms and business. Thus computer is regarded as an all-purpose machine".*

Abimbade (1996) reported that the use of computer: (i) increase the time of learners devote to learning, (ii) Enhance the speed of availability of data and information, (iii) Provide immediate feed-back (iv) Assist less qualified teachers and (v) increase teachers efficiency and effectiveness. Udousoro and Abimbade (1997) and Adeniyi (1997) pointed out that students taught mathematics and physics with computer achieved higher cognitively than those taught without computer.

The purpose of the study was to compare the effect of Computer-Aided Learning and the traditional method of teaching (chalk-and-talk method) in teaching and learning physics in senior secondary schools in Niger State, Nigeria.

Research Hypotheses

The following null hypotheses were formulated and tested at $p \leq 0.05$ so as to obtain answers to the research questions:

(i) There is no significant difference between the mean achievement scores of physics students taught with Computer-Aided Learning (CAL) software and those taught without it.

(ii) There is no significant difference between the mean achievement scores of male and female physics students taught with the Computer-Aided Learning software.

Methodology

Research Design: The research design was a pretest-posttest experimental control group design.

Sample and Sampling Technique: The population for this study was made up of all the senior secondary class one (SSI) students in two Local Government Areas in Niger State. The

sample subjects were drawn from two co-educational and two single gender schools in Bosso and Shiroro Local Government Areas of Niger State. The subjects from the co-educational schools were selected by the use of stratified random sampling technique. This method was chosen so that the gender variable could be appropriately represented.

Twenty (20) science students were randomly selected for the study from each of the four schools. In all there were forty (40) males and forty (40) females. The students were taught the same concept of physics using chalk-and-talk method and Computer-Aided Learning software.

Research Instrument: The research instrument was made up of 50 items of the Physics Achievement Test (PAT) which was used as pretest and posttest to measure both the lower and higher cognitive skills of the students in physics. The fifty questions were selected from eighty questions initially prepared. To obtain the fifty questions, the initial eighty questions were subjected to the processes of validation and item analysis to determine the discrimination and facility indices. The questions were also subjected to pilot study, and reliability test before using them as a research instrument. The time allocated for the test was eighty minutes.

A stem followed by four (4) options lettered (A-E) out of which only "one" was correct. Students were instructed to select only one option as answer for each item. All the options were plausible answers to the item.

Development of Self–Instructional Computer-Based Package: The Computer-Aided Learning (CAL) software was developed by the researcher using the lesson notes prepared for the traditional (chalk–and–talk) method. The program was written in Visual FoxPro programming language. The topics treated was selected based on senior secondary school syllabus. The topic selected was from first term scheme of work and falls between the period that research was carried out.

The development of courseware for this research material follows the systematic and recursive approach of instructional development model put forth by Mervill and Goodman (1972); Philips et al. (1987); and Dick and Carey (1996). However, five trials were made before the packages become successful. It was then tested with some few selected secondary schools in Minna, Niger State. These schools used for testing the package falls between the population of the study but not part of the schools selected for research study. Some of the complaints from these selected pupils about the package was later used for further modification and finally perfected the package

Validity and Reliability of the Instruments: The Computer-Aided Learning (physics package lesson) and the physics achievement test (PAT) items were pilot tested and found to satisfy face, content and construct validity by three experts in educational technology, physics and computer science departments. Item analysis of the instrument was also carried out to determine the facility and discrimination indices after which the final items for the instrument were selected and the reliability coefficient computed using the split-half approach and the Richard Kuderson formula 21 (KR–2). The value obtained for the reliability coefficient was 0.97 and this was considered to be quite adequate for this study.

Method of Data Collection

The data for testing the hypotheses were collected from the pre-test and post-test administered to the subjects used in the study. Each of the tests was marked and scored over hundred percent. The experimental group were exposed to physics lesson using Computer-Aided Learning software for the period of six weeks while the control group were taught the same physics lesson with traditional (chalk-and-talk) method. The total number of lesson within six weeks is eighteen periods lasted for forty minutes.

After the duration of six weeks of treatment for the experimental group and six week of lecture method with control group, the post-test was administered to both groups at the same duration in the usual paper per-pencil method.

Method of Data Analysis

The scores obtained by different groups were computed and used in testing the hypothesis. This data were analysed using mean, standard deviation and the t–test statistical analysis. The level of the significance adopted for the analysis was $p \leq 0.05$. This level of significance formed the basis for or rejecting or not rejecting each of the hypotheses.

Results and Discussion

Two Research questions were raised in this study and two null hypotheses were formulated and tested to provide answers to the research questions. Analysis of the pre-test and post-test data collected by means of the physics achievement test (PAT) were used to answer the research questions using the two null hypotheses as guide. Means, standard deviations and the t-test were employed in analysing the pre-test and post-test data.

The level of significance adopted for the analysis is 0.05. This level of significance formed the basis for rejecting or not rejecting a null hypothesis. The summary of the data analyses and results is presented below.

Performance of Experimental and Control Groups on the Pre-test

A pre-test was administered to both the experimental and control groups. The test was the 50-item multiple-choice physics objective test (PAT). The subjects were allowed forty minutes to do the test. The test was given to determine the academic equivalence of the experimental and control groups.

The mean scores of students in the experimental and control groups on the pre-test were calculated and the t-test computed for the two means. Table 1 shows the means, standard deviations and the result of the t-test analysis.

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

Variable	N	df	$\overline{X}$	SD	t-value calculated	t-value critical	p-value	Remark
Experimental Group	40	39	14.43	2.91	0.24^{ns}	2.02	0.81	Not significant
Control Group	40		14.35	3.13				

ns - Not significant at $p > 0.05$

The result in Table 1 indicates that there is no significant difference at 0.05 level of significance between the pre-test mean scores of the experimental and control groups (t = 0.24, df = 39, p > 0.05). This means that subjects in the experimental and control groups were at the same entry level with regard to academic ability before the physics topics were presented to them. Their mean scores were statistically the same.

Performance of the Experimental and Control Groups on the Post-test

Hypothesis 1: There is no significant difference between the mean scores of physics students taught with Computer-Aided Learning (CAL) software and those taught without the use CAL software.

To test this hypothesis the posttest means scores of the experimental and control groups were computed and compared using the t-test statistic. The result is shown in Table 2.

Table 2: t–test Comparison of the Posttest Mean Scores of the Experimental and Control Groups

Variable	N	df	$\overline{X}$	SD	t-value calculated	t-value critical	P-value	Remark
Experimental Group	40	39	68.95	5.99	15.74*	2.02	0.001	Significant
Control Group	40		58.90	5.38				

* - Significant at p < 0.05

The result (of the t-test analyses) in Table 2 shows that there was significant difference between the post-test mean scores of the experimental and control groups at 0.05 level of significant (t = 15.74, df = 39, p <0.05). Hypothesis I was therefore, rejected. This means that there was a significant difference at 0.05 level of significance between the performances of students taught with the CAL software and those taught without the software. Students taught with the CAL software performed better than those who were taught without it. Hence, the CAL software enhanced the learning of physics.

Performance of Male and Female Students in the Experimental Group on the Post-test

Hypothesis 2: There is no significant difference between the mean achievement scores of male and female physics students taught with the Computer-Aided Learning software.

To test this hypothesis, the post-test mean scores of male and female students in the experimental group were computed. The analysis was carried out using the t-test statistic and the result shown in table 3.

Table 3: t–test Comparison of the Post-test Mean Scores of Male and Female Physics Students in the Experimental Group

Variable	N	df	$\overline{X}$	SD	t-value calculated	t-value critical	p-value	Remark
Males	20	19	68.70	6.37	0.31^{ns}	2.09	0.757	Not
Females	20		69.20	5.75				Significant

ns - Not Significant at p> 0.05

From the result in Table 3, it can be seen that there was no significant difference between the post-test mean scores of male and female physics students in the experimental group at 0.05 level of significance ($t = 0.31$, $df = 19$, $p > 0.05$). Null hypothesis 2 was therefore not rejected. The performances of the male and female physics students in the experimental group were equally enhanced by the use of the computer physics software. Hence the CAL physics software was gender friendly.

Discussion

Findings on Table 2 indicate that there was a significant difference in the physics achievement of students taught with the Computer-Aided Learning software. Those students taught with the computer software performed better in the physics achievement test compared with those who were taught without the computer software. The result seem to agree with earlier studies which concluded that students taught mathematics and physics with computer achieved higher cognitively than those taught without computer (Udousoro and Abimbade, 1997; Adeniyi, 1997; Hassan, 1997; and Jonah, 1991). Computer can, therefore, be seen as a tool for effective teaching and learning of science subjects. CAL is an effective tool and efficient development of individual cognitive structure, psychomotor and affective abilities.

Findings on Table 3 indicate that there was no significant difference between the performances of male and female students who were taught physics with the computer software. The male and female students performed equally well. The result agrees with the findings of Abdullahi (1981) and Fuller (1982) who found that gender did not influence students' performance in science generally.

Conclusion

From the findings of this research work, the following conclusions were drawn:

(i) Instructional strategies that teachers employ in teaching science subjects at senior secondary school level have significant effects on students' achievement. The findings of the present study showed that better performance in physics was achieved through the use of CAL software.

(ii) The male and female students were affected positively and equally by the use of CAL software in teaching physics. This showed that the effect of CAL software is not gender dependent.

Recommendations

From the findings of the present study, the following recommendations are made:

1. The use of computer for teaching and learning in our schools should be encouraged. Therefore, computer education should be made compulsory for teachers and students in all levels of our educational systems.
2. Curriculum planners should enforce/inculcate the use of computer in teaching/learning into school curricula.
3. Educators should continue to lay more emphasis and implement the concepts of educational technology as a means of enhancing the quality of education.
4. Federal Government should fully implement computer literacy policy formulated in 1988.

5. In–service training should be given to teachers on Educational Technology particularly on the production and use of computerised instructional media so that they can appropriate the use of modern instructional technology.
6. There is need for government and non-governmental organisations to organise seminars, workshops, conferences as well as in-service training for teachers on methodology of teaching so as to be able to compare and contrast effects of different methods of teaching on students' achievement.
7. Schools should be equipped with computers and Internet facilities and other necessary instructional packages for teaching and learning.
8. Science teachers should learn how to prepare Computer-Aided Learning software.
9. Emphasis should be placed on making learning to be a learner-centred affair as well as teaching for meaningful learning.
10. The role differentiation amongst boys and girls should continue to be avoided when teaching science. Each gender deserves equity in exposure to educational experience.
11. Academic cooperation, though not to the point of replication or subjugation, should be worked out by departments of Mathematics/Computer science, Physics/Computer science and Educational Technology to develop adequate software for effective science teaching and learning.

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