EFFECTS OF COMPUTER-ASSISTED INSTRUCTION (CAI) ON STUDENTS' ACHIEVEMENT IN SECONDARY SCHOOL PHYSICS IN PANKSHIN LOCAL GOVERNMENT AREA OF PLATEAU STATE

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Abstract

This research investigated the effects of Computer-Assisted Instructions (CAI), a learner-centred and activity-based method of teaching/learning, on achievement in Physics of Nigerian secondary school students. The research design used was the Solomon Four-group. Eighty (80) SSS III students in Pankshin Local Government Area of Plateau State, Nigeria were tested on the concepts of space, time and motion using a developed 25-item Physics Achievement Test (PAT) whose reliability was 0.72. The formulated hypotheses were tested using the pooled variance formula of the student t-test statistics. The analyses revealed that students taught with CAI achieved higher (mean of 68.25) than those exposed to the conventional lecture method (mean of 47.85). Furthermore, there was no significant difference in the mean physics achievement scores of male (68.90) and female (67.60) students treated with CAI. Based on the findings, recommendations were made. These include, among others, the provision of well- equipped CAI laboratories in every Nigerian secondary school for effective teaching/learning of Physics.

Introduction

The application of Physics through technology is crucial for providing the infrastructural resources needed by a nation. In 2005 stakeholders, including Physicists, met in South Africa to consider the role Physics plays in generating sustainable future for developing nations. This underscores the significance of Physics for the development of a nation. Physics, being the most basic of sciences, underpins the comprehension of other sciences and science-related fields. For instance, a thorough understanding of quantum mechanics is necessary for Chemists and Material scientists to understand the structure of every matter in the universe.

According to Boyo (2010) Physics is becoming increasingly inter-disciplinary, as physicists work with experts in other fields to understand and solve a wide range of problems confronting society. This implies that Physics, being a cross-cutting discipline, has industrial applications in many sectors of the economy such as health, mining, energy and engineering. A few of the many applications of Physics which benefits the society are as follows: Ultrasound wave is used in scanning machines to obtain the position and image of a foetus. In the petroleum sector, seismic prospecting workers use sound waves to probe the earth's crust for oil.

Many ordinary household utensils and appliances are designed, in whole or in part, by using the laws of thermodynamics. Instances include the heating and air-conditioning systems, the refrigerator, the pressure cooker, the water heater and the pressing iron. On a larger scale the laws of thermodynamics play a major part in the design and analysis of rockets, conventional and nuclear power plants, solar collectors, and the design of vehicles ranging from ordinary cars to aero planes. Newton's second law of motion plays a significant role in the design of high-performance motorcycles. To maximize the forward acceleration, the motorcycle is designed as light as possible (mass minimized) and uses the most powerful engine possible (forward force maximized). Furthermore, radioactive dating, carbon dating being the most familiar, has proved invaluable in the range of crime investigation. By measuring the amount of radiocarbon per gram of organic matter, it is possible to measure the time that has elapsed since the organism died.

The persistent poor achievement of students in Physics examinations over the years in Nigeria signify that little or no learning of concepts takes place in the students. This trend has been attributed mainly to the ineffective methods of instruction employed by Physics teachers in teaching Physics. Research report indicates that the traditional pattern of teaching (lecture method), identified as being ineffective, is still being employed in teaching Physics instead of Information Computer Technology (ICT) which is learner friendly (Boyo, 2010). The implication is that the traditional pattern of teaching does not give room for a more contemporary and effective method of teaching. The poor achievement of students in Physics examinations in Nigeria could, then, be mainly due to Physics teachers' failure to use the appropriate teaching methods that will enhance students' learning.It is worth noting that the development of any nation, which depends on science and technology, hinges on science education. In Nigeria, despite the enormous benefits Physics provides for national technological development and the seeming efforts of government and other stakeholders in improving science education, outcome of Physics examinations in certificated examinations such as the SSCE (WAEC & NECO) have not been encouraging. While the number of students by subject is increasing for the SSCE, students' performance in the basic sciences is not improving. The poor outcome, over the years, has been attributed to numerous factors which include among others non-utilization of appropriate teaching methods in science, poor

quality and quantity of secondary school science teachers, lack of equipped Physics laboratories and students' poor attitude and interests towards Physics (Akpan, 2001).

In spite of the diverse modern instructional strategies at the disposal of the Physics teacher, many in Nigeria still use the conventional and didactic lecture method to teach Physics in secondary schools. With teachers continually sticking to this old way of teaching Physics, poor results have been turned out over the years.

There is a dire need for teachers who are reasonably trained to teach Physics effectively by stimulating students' interest, building on their own ideas while benefiting from the teachers' experiences. Such Physics students should also benefit from interaction among themselves, and with the environment. The use of Computer-Assisted Instruction (CAI), a contemporary method of teaching and learning which is learner-centred and activity-based, has produced many positive effects. Brummer(2004) have used CAI to obtain interesting positive results in teaching and learning activities in various science and science-based courses.

Studies and findings from such studies indicated a vast majority of outcomes in favour of CAI usage in the science classroom due to its importance and effectiveness in learning science (Jenks & Springer, 2002). Not much of such studies have been conducted in Physics, especially in Nigeria. The use of CAI in the Physics classroom in Nigeria is quite inadequate. Even its presence is questionable. In a study to ascertain the status of computer usage in science learning Josiah, Pam & Okooboh (2003) found out that only 12.9% of Physics students in Plateau State (Nigeria) have used CAI in learning Physics. In other words, the conventional and didactic method of teaching and learning leaves no room for the use of CAI to teach and learn Physics.

Based on the importance of Physics to the technological development of a nation and the dwindling standard of Physics education in Nigeria this study examined the effects of CAI on the achievement in Physics of secondary school students. It ascertained the effects of CAI on students' achievement in Physics in secondary schools. It also intended to find out whether the use of CAI can bridge gender gap in learning Physics. Despite efforts aimed at improving science education in Nigeria, the benefits of such gesture have not been the same for male and female students in the learning of Physics in Nigerian secondary schools. The female under-achievement in Physics in WAEC and NECO SSCE is a pointer.

Purpose of Study

This study investigated the effects of CAI on students' achievement in Senior secondary school physics. Specifically, it sought to:

i. determine the difference in Physics achievement between students who learn Physics using CAI and those who learn through the conventional lecture method; and

ii. determine the difference in achievement between male and female students who learn Physics using CAI.

Research Questions

The study answered the following research questions raised:

i. What is the effect of Computer-Assisted Instruction (CAI) in learning Physics concepts on students' achievement in Physics?

ii. To what extent does the use of CAI influence students' achievement in Physics based on gender?

Research Hypotheses

The following null hypotheses were formulated and tested:

1. There is no significant difference between the mean achievement scores of Physics students exposed to CAI and those exposed to conventional lecture method of teaching.
2. There is no significant difference in the mean Physics achievement scores of female students exposed to CAI and their male counterparts also exposed to the same treatment.

Method and Procedure

This study used the experimental design (Solomon Four- group) to determine the effects of CAI on Nigerian secondary school students' achievement in Physics. The aim of the design was to find out the achievement scores of the groups so as to determine whether CAI has any effect on achievement in Physics. In this study CAI is the independent variable while achievement and sex are the dependable variables.

The population of the study comprised all the SSS III students who offered Physics in 2008 in all the co-educational secondary schools in Pankshin Local Government Area, Plateau state. A sample of 80 Senior Secondary School (SSS III) students was randomly drawn from four co-educational secondary schools. The four schools were earlier selected by the simple random sampling (lottery) method. The randomly selected sample was again randomly divided into two groups (40 Experimental and 40 Control).

One of the groups was randomly designated 'experimental group' while the other became the control group. The two groups had equal number of male and female sample (20 male and 20 female). In this study the experimental group was treated with CAI while the control group was treated with the lecture method.

The instrument used for the study was a twenty- five (25)-item Physics Achievement Test (PAT) which was constructed to test whether CAI has any effect on students' achievement in Physics. PAT was based on WAEC WASSCE syllabus on the concepts of space, time and motion. These concepts were chosen for the study so as to enhance

students' knowledge on such concepts. The questions from these concepts, though popular, are poorly attempted by students (WAEC chief Examiner's report, 2005).

PAT was administered by the researchers themselves. Treatments were meted out over a period of eight (8) weeks after which the test (PAT) was administered, with the assistance of the Physics teachers in the schools. The content validity of PAT was established by two experts in the University of Jos, Nigeria. KR -21, a measure of internal consistency, was used to estimate PAT's reliability. It was found that the reliability of PAT was 0.72.

Results

The t-test statistic was used to analyze the data. Since the calculated value of F (1.19) for H_{01} is less than the critical value of F (1.69) from the F distribution table, and the calculated value of F (1.04) for Ho_2 is also less than the critical value of F (2.12) from tables the researchers used the pool variance formula of the t-test. The level of significance for F was 0.05.The degree of freedom (N_1 + N_2-2) at 0.05 level of significance was used for the t –test.

Ho_1: There is no significant difference between the mean achievement scores of Physics students exposed to CAI and those exposed to conventional lecture method of teaching.

Table 1 shows the results of the t –test analysis carried out on Ho_1.

Table 1: results of t-test analysis on Ho_1

Group	N	$\overline{X}$	S	t-cal	t-table	df
Experimental	40	68.25	7.25	11.59	1.98	78
Control	40	47.85	8.62			

$P< 0 \cdot 05$

Table 1 indicates that the calculated t-value (11.59) was greater than the critical t-value (1.98) from tables, at 0.05 level of significance and 78 degree of freedom. This implies that there is significant difference between the mean achievement score of Physics students exposed to CAI (X=68.25) and the mean achievement score of those not exposed to CAI (X=47.85).

Ho_2: There is no significant difference in the mean Physics achievement scores of female students exposed to CAI and their male counterparts also exposed to the same treatment.

Table 2 shows results of the t-test on Ho_2.

Table 2: Results of t-test analysis on Ho_2

Gender	N	$\overline{X}$	S	t-cal	t-table	df
Male	20	68.90	7.95			
				0.542	2.021	38
Female	20	67.60	7.67			

$P > 0 \cdot 05$

From table 2, the calculated t-value was 0.542 while the critical t-value from tables was 2.021 at 0.05 level of significance and 38 degrees of freedom. The implication is that the mean achievement score in Physics of male students ($\underline{X}=68.90$) was not significantly different from the mean score of female students ($\underline{X}=67.60$) who were both taught using CAI.

Discussion of Results

Hypothesis one (Ho_1) was rejected on the basis of t-cal > t-table (Table 1). This hypothesis (Ho_1) sought to find out if there exists, any significant difference between the achievement in Physics of students exposed to the Computer -Assisted Instructions (CAI) and those not taught by CAI, but rather, are taught by the conventional lecture method. The study discovered a significant difference in the achievement of students in the two groups (Experimental and Control) used in the study.

The result showed that the mean score of the students in the experimental group increased from 48.50 (pretest) to 68.25 (post test), while the mean score of the students in the control group barely increased from 47.50 (pretest) to 47.85 (post test). The increase in the mean score of the students in the experimental group indicates a significant difference in achievement of students that were taught the concepts space, time and motion using CAI. The significant difference in the mean scores of the experimental and control group, as indicated by the calculated t-tests value in table1, signifies that the CAI approach to teaching/learning of Physics concepts facilitates students' understanding.

Hypothesis two (Ho_2) was accepted on the basis of t-cal< t-critical (table 2). The result of hypothesis two (Ho_2), as shown in table 2, revealed that no significant mean difference existed in the achievement of both male and female students who were taught the concepts space, time and motion using CAI. The mean score for the male students was 68.90 while that for female students was 67.60. Apart from their mean score comparison, their standard deviations were also close (7.95 for the male students and 7.67 for their female counterparts). Besides, the t-test statistic for significant mean difference revealed (table2) the non-existence of such between the two genders.

The finding (from table 2) implies that there is no disparity between male and female students' performance, which leads to achievement, when CAI is used as a

method of instruction in the Physics teaching/ learning process. This finding is in line with the assertion of Nwosu (1991), Anekwe (1997) and Madu (2004) that there is no gender disparity in science performance, provided that both genders are exposed to the same condition of teaching and learning.

When computers and CAI packages are effectively used in teaching Physics concepts learning will, indeed, be enhanced; and subsequent achievement in the subject will be improved. This observation is in consonance with Stone (1991) who concluded in his study that students learn better in classes where a form of computer is used for teaching. This research identifies the most important factors that contribute to the success of CAI as a teaching/learning method. These are the flexibility of the software (CAI) and the individualized instruction it offers. The software places no restriction on learning. A major characteristic of CAI (Akinyemi, 1997) is that proper individualization of instruction is enhanced when a student can control his or her learning in terms of choice of material and in accordance with his or her intellectual ability. Merril (1980) supplements Akinyemi by saying that learners need to be allowed to control instructional flow. This view is supported by CAI.

Recommendations

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

i. Physics teachers should endeavour to adopt CAI method of teaching/learning as their prevalent teaching method.

ii. Workshops should be organized for Physics teachers so as to educate them on the use of CAI. These workshops should be held periodically for freshly recruited teachers. Refresher courses for old teachers are suggested for them to keep abreast with new innovations.

iii. CAI laboratories for the purpose of science teaching/learning should be provided in every secondary school where science subjects are taught. Such laboratories should be stocked with sufficient computers and subject CAI software so as to provide conducive learning environment and for effective CAI implementation.

iv. Students should have access to computers to help them utilize the CAI software for effective learning of Physics concepts.

Conclusion

The main concern of this study was to investigate for an efficient and motivating means of communicating Physics concepts to students. This can be achieved by providing novel learning environments to the students, for example the use of computers to the teaching and learning of Physics in secondary schools. While CAI cannot replace the Physics teacher, it can be used (both inside and outside the classroom) as a supplement to the teacher since it is student-centred and inquiry-based and has been shown to enhance performance. In this study, students benefited maximally when they

were exposed to the use of CAI. The study also revealed that no significant mean difference existed in Physics achievement based on gender.

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