

Effects of Computer Assisted Instruction (CAI) on secondary school students' academic achievement in physics in Adamawa State, Nigeria

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ABSTRACT

The study investigated the effects of Computer Assisted Instruction (CAI) on secondary school students' academic achievement in Physics. The influence of gender on the academic achievement of students taught with CAI package was equally examined. The study adopted a pretest, post-test quasi experimental design, involving 2 x 2 factorial matrixes for matching the variables involved. A sample of 120 SS II students selected from two public secondary schools in Adamawa State, Nigeria participated in the study. Data were collected using a validated instrument of Physics Achievement Test (PAT) which consists of 30 items with reliability index of 0.74. One research question and three null hypotheses guided the study while data were analyzed using Analysis of Covariance (ANCOVA). Findings of the study showed that the academic achievement of students taught with CAI were significantly higher ($F = 74.840$; $p < 0.000$) than their counterparts exposed to the conventional classroom instruction. There was also significant difference between the male and female students taught with CAI ($F = 76.118$; $p > 0.05$) in favour of the male students. Based on the findings, recommendations were made on the need to develop relevant CAI packages for teaching Physics in Nigerian secondary schools.

Key words: CAI, gender, academic achievement, software, application package.

INTRODUCTION

The use of Information and Communication Technology (ICT) has caught the attention of many educators and researchers. Computer based multimedia applications, because of their flexible and varied presentation capabilities, are considered appropriate alternative to traditional teaching methods. Physics is regarded as a difficult subject by many people [1]. This may be because of the abstract nature of the subject or the way the teachers teach it. If concepts in physics are taught well with the aid of ICTs, fewer learners would call it difficult subject. It is true that some mechanisms may be complex to explain but technology has resolved this problem through education softwares. Educational software can be used to teach abstract concepts or observe difficult skills in physics. For example, teaching of electric generator in physics can be facilitated with the assistance of educational software. Most physics teachers in the past could not explain the mechanism of electric generator to students properly because of its complexity. The rotation of the coil in

the magnetic field is very clear when students see it demonstrated through such softwares. It has been stated that the reason for not reaching the aims in the lessons involving abstract concepts like Snell's law in physics was because of the application of traditional teaching methods and approaches [2]. Educational softwares help in making abstract concepts concrete in the teaching and learning of Physics. The softwares also avail students the opportunity to learn more effectively and relatively permanent, be active learners unlike the traditional methods where the learners are passive. It enables students to construct their own knowledge, learn to think and develop positive attitude toward physics. Computer based learning has the potential to facilitate the development of students decision making and problem solving skill, data processing skills and communication capabilities because computer has the capacity to unveil all hidden details. Through computer based instruction, students can gain access to expansive knowledge links and broaden their

exposure to diverse people and perspective [3]. [4] Confirmed that Computer has been used in both junior and senior secondary schools to teach various subjects. [4] study revealed that Computer Assisted Instruction (CAI) had positive impact on students' academic achievement as well as their perceptions about computer supported instruction [5] noted that in Nigeria today, teachers, textbooks, chalkboards and traditional facilities are no longer adequate to cope with the amount and type of skills and competences expected of students. Accordingly, [6] suggests that teachers need resources that can assist them to carry out their duties efficiently. [7] Stated that teaching methods over the years have revealed that there have been changes from one method to another, and that several efforts have been made to improve the teaching methods through the use of instructional material such as computer. The use of computer in the classroom has given rise to Computer Assisted Instruction (CAI) software packages for classroom instructional purposes. According to [8], CAI is a program of instruction or package presented as computer software for instructional purpose. The nature of physics makes it necessary for the use of innovative pedagogical strategy that will enable teachers meet the challenges of teaching and learning of the subject especially in this era of information age. However, there are contradicting findings on whether CAI has positive effect on students' academic achievement or not. Researchers such as [9] and [10] in their separate studies confirmed that there was no significant effect of CAI on students' academic achievement at the secondary school level. On the other hand several researches have shown that using computer assisted instruction produced more positive effect on students' achievement compared to traditional methods. For instance, [11] found that CAI enhanced students' academic achievement in chemistry, [12] used it in technical education courses, in geography while [13] applied it in counseling education. They all confirmed CAI to be more effective in enhancing students' academic achievement in all the subjects compared to conventional classroom

teaching method. These conflicting research reports call for further studies on the effects of CAI to improve on students' academic achievement especially in physics where this has been documented as a problem [14]. Nowadays, it is obvious that visual materials are being used in every field and technological devices (especially television and computers) have affected students' learning outcomes positively. As a result of instructional materials that are supported by a variety of sound, image and animations, it is observed that learning has become more lasting, enjoyable and effective. In many educational and training programs of today, interactive computer programs are used to teach students and adults' computer literacy skills [15]. Also, many schools in Nigeria have integrated Information and Communication Technology (ICT) with specific attention to computer based multimedia into their teaching and learning considering its prominent role in the modern world particularly in the area of teaching and learning [16]. Learning is said to result from seeing, 83%, hearing, 11%, smelling, 3.5% touching, 1.5% and tasting, 1% [17]. [18] similarly reported that seeing accounts for 75%, hearing, 13%, smelling, 6%, touching, 3%, and tasting, 3% a result similar to Demirel. There is experimental evidence that indicate that only oral explanation method does not work well. According to [19], [17] and [20] learning is gained by reading 10%, hearing 20%, seeing 30%, both seeing and hearing 50%, telling 70%, and doing and telling 90%. These shows that visual materials supported by audio and animations are more effective on students' learning, perception and synthesizing. If principles of how students learn are taken into account, richness of the visual content makes instruction more lasting and effective [21]. When more sense organs deal with learning, faster and better instruction occurs. The best learning is doing and living oneself [18]; [17]). For this reason, there is need to develop science lessons that are supported by visual and audio instructional materials to draw students' attention and so provide lasting learning, reflect science nature and

accelerate learning. Lifestyles of people affect their learning style and even determine how they learn and develop them. This implies that, provision of instructional material having more visual content is necessary in order to teach the present day generation who lives visually and are in the bombardment of visual knowledge [22]. Today's students are maturing with visual devices like television, video, computer and internet. It is not possible to draw these students' interest by using traditional methods that were used in the past. As a result of technology development that appeared in the immediate past, a big difference has occurred between the ways of introduction of knowledge at schools and the ways of getting knowledge in the society. Students get a lot of information by visually enriched resources like computers and television that are mostly used in our daily life. Because of varied ways through which students gain knowledge now it has become imperative for teachers to adopt unconventional way of teaching other than the conventional (traditional) methods ([22]; [23]). According to [24] teachers are expected to provide assistance, equip the students, provide the techniques involved and at the end clarify students' worksheet. Hence, physics teachers should be involved in using computer assisted instruction. It is against this background, this study investigated the influence of computer assisted instruction on the academic achievement of senior secondary students in physics.

Another variable of concern in the teaching and learning of science is the gender related difference. Gender has been identified as one of the factors influencing science students' academic achievement at secondary school level [25]. According to [26] gender differences in academic achievement have been among the contemporary issues of research all over the world. Hence, this study also sought to find out the effects of CAI on the academic achievement of male and female students in physics when taught using CAI. Gender differences have been linked with achievement of students in academic tasks, and there is imbalance that existed among gender in the use of

computer, access, career and attitude. That is why [27] based on their review on gender issues in computer science education suggested that, current gender imbalance in technology and the role that technology had played should be of concern to men and women, practitioners, policy makers and parents. According to [28] more difficult tasks are usually reserved for males while less difficult ones are considered feminine in a natural setting. Example of this in the Nigerian society is the breaking of firewood, which is often seen as manly task while washing plates is seen as a female task at home. Thus, at school males are more likely to take to difficult subject areas and challenging problem solving situations Physics inclusive while females on the other hand, may prefer simple subjects and shy away from difficult tasks and problem solving situations. This is in line with [29] finding that male secondary school students achieved better than their female counterpart in sciences and mathematics. Gender differences in academic achievement can also be attributed to gender stereotyping which encourage male and female students to show interest in subjects relevant and related to roles expected of them in society. Gender differences in attitudes, parental as well as teacher expectations and behaviours, differential course taking and biological difference between the sexes may all be instrumental to gender differences in achievement [30]. Several studies such as [31], [32], [33], [29], [34] and [35] among others found that there is significance influence of gender on students academic achievement in Physics in favour of the males. These findings are contrary to that of [36], [37], [38],[39], [40], [41], [42], [43], [44] who based on their findings concluded that students academic achievement in physics is free from gender bias. These contradictions in research reports call for further investigation into gender and how it affects students' academic achievement in physics at the secondary school level.

Consequently upon the foregoing, it is imperative to determine the effects of CAI and gender on students' academic achievement in physics at the senior secondary school level. This study was

conducted in Adamawa State of North Eastern Nigeria. The 21st century philosophy of teaching is child-centred. The computer technology is deployed to compliment the teacher whose role is redefined to be that of a guide on the side and not a sage on the stage [45]. The world today is in the era of Information and Communication Technology [ICT] where information is

not restricted by time, space and channel [46]. [47] pointed out that the method of teaching have gone beyond traditional (chalk-talk) method otherwise known as lecture method of teaching which renders students passive listeners and makes teaching ineffective, thus, affecting the students' academic achievement, especially in physics.

Theoretical Framework

The study was guided by the constructivist theory and technology acceptance model. The technology acceptance model developed by [27] which states that the user's motivation for any technology is predetermined by three factors namely, perceived ease of use, perceived usefulness and attitude towards using the technology. According to technology acceptance model, for CAI to be effective it needs to make the learners and teachers experience a feeling of the technology's usefulness and ease of its use. The more successful is the CAI- technology in generating positive attitudes in learners towards using the CAI in learning, the better their learning experiences and outcomes. Thus, technology acceptance model proved to form an appropriate framework for use of CAI technology by learners in this study. Consequently, on the other hand according to [31], constructivist learning is described by four principles: the principle of knowledge construction; the principle of active learning; the principle of social interaction; and the principle of situated learning. Constructivists view learning as an active process (principle of active learning) in which learners construct

new ideas or concepts based on the current or past knowledge and not simply acquiring the knowledge (principle of knowledge construction). Active learning of students may serve as a driving force to hard work that eventually translates to improved learning outcomes. Social interaction which include; learner-learner and learner- teacher interactions are important ingredients of learning[31]. Social Constructivists argue that human beings construct knowledge through interaction with others. In social constructivist classrooms collaborative learning is a process of student interaction mediated and structured by the teacher. The use of CAI is related to constructivist learning in that students are at the centre of the learning process and that are actively involved in constructing knowledge rather than being passive recipients of instruction. The purpose of the study was to determine the effect of computer assisted instruction on students' academic achievement in physics at the senior secondary school level in Adamawa state. In order to achieve this purpose, three specific objectives and three hypotheses guided the study:

Objectives

The study was guided by the following specific objectives:

I.To determine the effect of CAI on students' academic achievement in physics.

ii.To determine the effect of gender on students' academic achievement in physics when taught using CAI.

iii.To determine the interaction effects of CAI and gender on students achievement in Physics

Hypotheses

Ho₂: There is no significant effect of CAI on students' academic achievement in Physics.

H_{o2}: There is no significant effect of gender on the academic achievement of students in physics when taught with CAI.

H_{o3}: There is no significant interaction effect of CAI and gender on the academic achievement of students in Physics.

METHODOLOGY

The study adopted the quasi experimental design which involved pretest, post test, non-equivalent control group using intact groups. The study targeted all the 19,800 SS 11 physics students in public secondary schools in Adamawa State. Purposive sampling technique was employed to select sample of 120 students as participant. In order to match the various factors, a 2 x 2 factorial matrix

was used. One public school was purposely selected and assigned experimental group because the school has computer laboratory while another co-educational school was selected and assigned to control group. The instrument used for data collection is the Physics Achievement Test (PAT). Data collected were analyzed using Analyses of Covariance (ANCOVA).

RESULTS AND DISCUSSION

The three null hypotheses formulated and tested at 0.05 level of significant using ANCOVA as follows;

H_{01} : There is no significant effect of CAI on students' academic achievement in Physics.

Table 1: Summary of ANCOVA Showing the Effect of Treatment and Gender on Academic Achievement. Dependent Variable: Post-test scores

Source	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4	908.282	22.086	.000	.434
Intercept	1	19414.745	472.091	.000	.804
Pretest	1	7.267	.177	.675	.002
Treatment	1	3077.813	74.840	.000	.394
Gen	1	307.882	7.486	.007	.061
Treat * Gen	1	12.149	.295	.588	.003
Error	115	41.125			
Total	120				
Corrected Total	119				

From Table 1, it can be seen that there is significant effect of CAI on academic achievement of students in Physics, { $F = 74.840$, ($DF=1,119$), $P<0.05$ }. This implies that the null hypothesis of no significant effect was rejected. The result shows that there is a significant effect of CAI on students' academic achievement in Physics. This implies that students taught with CAI had higher mean scores than their counterpart who were taught using the conventional (traditional) method. The difference that existed among the students' academic achievement could be attributed to the different methods of instruction employed. This result is in agreement with findings by [48] and [2] who found that CAI package is more effective than conventional method on students' academic achievement levels. However, studies by [9] revealed that there was no significant effect of CAI on students academic achievement in Physics at secondary school level.

H_{02} : There is no significant effect of gender on the academic achievement of students in physics when taught with CAI.

Result from Table 1 also revealed that there is a significant effect of gender on academic achievement of students in Physics when taught with CAI. { $F = 76.118$ ($DF 1,119$), $p< 0.05$ }. This implies that the null hypothesis of no significant effect was rejected since the computed p - value (0.007) is less than 0.05. This finding implied that gender had a significant effect on the students' academic achievement in Physics when taught with CAI package. This finding agrees with studies by [11], [12], whom in their separate studies established that there is significant effect of gender on students' academic achievement in Physics when taught using CAI package. However, this result is contrary to findings by [4], [48], [49], and [50] who found no significant difference between male and female students taught

mathematics, statistics, physics and history respectively using CAI package .
 H_{03} : There is no significant interaction effect of CAI and gender on the academic achievement of students in Physics. From table 1, the results showed that there is no significant interaction influence of CAI and gender on the academic achievement students in

CONCLUSION

The study showed that the use of CAI packages improved students' academic achievement in Physics more than those who taught using conventional teaching method. In addition, there was

physics, { $F=0.293, (DF= 1,119), p>0.05$ }. Since the P-value is greater than 0.05 level of significance, the null hypothesis of no significant interaction influence is therefore not rejected. This implies that there is no significance interaction influence of CAI and gender on academic achievement of students in physics.

significant gender difference on students' academic achievement in physics when CAI package is used in favour of the male students.

RECOMMENDATIONS

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

1. Computer-Assisted Instruction CAI should be encouraged for teaching and learning of Physics.
2. Government should provide computers adequately programmed with

variety of computer assisted instructional packages to secondary schools for teaching Physics.

3. Curriculum planners should embed the use of computer in teaching/ learning of physics in our educational system especially at the secondary level.

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