

PROBING COMPUTER-ASSISTED INSTRUCTIONAL EFFECT ON ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS IN PHYSICS

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Abstract: *This study explored the effect of Computer-Assisted Instruction (CAI) on academic achievement of senior secondary school students in physics in Awka south L.G.A in Awka Education Zone. Two research questions guided the study and three hypotheses were tested at 0.05 level of significance. The study is quasi-experimental research specifically pre-test post-test non-randomized control group was adopted. The population consisted of 553 (384 males and 169 females) senior secondary two (SS2) students offering physics and a sample of 41 (21 males and 20 females) SS2 students was drawn from the population using multi-stage sampling. The sample students who were in two intact classes were randomly assigned to experimental and control groups using a flip of coin. The instrument Physics Achievement Test (PAT) was used for data collection which was validated by three experts from Nnamdi Azikiwe University, Awka and a reliability coefficient of 0.89 was obtained using Kuder Richardson-21 formula. The research questions were answered using mean and standard deviation while the hypotheses were tested using Analysis of Covariance (ANCOVA). The findings revealed that CAI had significant effects on students' academic achievement in Physics than Lecture Method (LM). The result also showed that gender was not a significant factor in students' overall academic achievement when taught Physics using CAI. Also, there was no interaction effect of teaching methods and gender on student's academic achievement in physics. Based on the conclusion, the researcher recommended that Physics Teachers should use CAI in teaching physics to both male and female students so as to enhance their academic achievement in Physics and the*

curriculum planners to adopt CAI as an innovative teaching strategy in planning and reviewing physics curriculum in secondary schools.

Keywords: *Computer –Assisted Instruction (CAI); Academic Achievement; Physics; Gender.*

INTRODUCTION

In this 21st century, the world is becoming more digitalized in all aspects and the educational aspect cannot be left aside especially in teaching science subjects. Similarity, in educational term, computer assisted instruction can be understood as the application of digital equipment to all teaching and learning aspects (Adeyemo, 2020). Computer assisted instruction consists of the hardware, software, networks and media for the collecting, storing, processing, transmission and presentation of information. The use of CAI as stated by Adeyemo (2020), falls into four (4) major categories; constructing knowledge and problem solving through the internet, mail, CD-ROMs, database, video conferencing; using process skill; aiding explanation of concepts and communicating ideas. Teachers need to be active participants to make CAI effective for their students (Cavalluzo, Lowther, Mokher and Fan, 2022). CAI programs use tutorials, drill and practice, simulation and problem solving approaches to present topic; they test student's understanding and evaluate student's academic achievement.

Academic achievement has to do with how much knowledge the individual has acquired from school and how long it can be retained and retrieved when needed. Students' achievement connotes performance in school subject as symbolized by a score or mark on an achievement test. Students' academic achievement is dependent upon several factors among which are instructional methods and learning environment (Atherson, 2023). This is to say that inappropriate instructional methods adopted by a teacher has the ability to influence the learning outcome of students in a given classroom experience. The power of teaching method in the hand of a teacher cannot be overemphasized. Any teaching method that does not encourage interaction between the teacher and the students is incomplete (Muokwe and Okeke, 2021). Hence, the most effective and skilful teachers use a diversity of methods to assist their students in the learning process, arouse their interests and curiosity, engage the students thereby creating an impressive learning experience so that the concepts learnt remain with the students long after the class. Recognizing its significance, there is a strong advocacy for integrating computer-assisted instruction in science education to enhance students' academic achievement.

Physics is one of the science subjects taught at the senior secondary and

tertiary levels of education in Nigeria. It is defined a branch of science that is concerned with fundamental ideas about nature and attempts to establish relationship between different quantities as precise as possible. Physics is the most utilized basic science subject in most instruction-related professions. This may be why the federal government of Nigeria placed the subjects as one of the core subjects that each science student must be exposed to at the senior secondary school level, as stipulated in the National Policy on Education (FRN, 2014).

The importance of physics for the development of a nation and wealth creation cannot be over emphasized. For instance, Josiah (2022) noted that physics is a cross-cutting discipline that has applications in many sectors of economic development, including health, agriculture, water and energy and information technology. The knowledge of physics also facilitates the understanding of other disciplines. For instance, understanding physics concepts is equally necessary for developing new instrumentation and techniques in the health sector. With the help of medical physics, the right equipment for the diagnosis of diseases and the efficient communication of medical data are provided. Adeyome (2020) added that, physics is a unique subject that promotes the acquisition of specialized science skills and knowledge that explains the natural phenomena of life in society. It is a subject that evolved with civilization as man's quantitative needs increased. It has contributed to science and the development of civilization. Students acquire the knowledge and skills to understand how and why natural things happen the way they do, to make predictions and venture into unknown areas of knowledge, and more importantly, to use the knowledge and skills to design and make new things. The subject's relevance underscores the need for instructional method like computer-assisted instruction, which not only deepens students' understanding but also enhances their academic achievement (Akabuike & Achufusi-Akah, 2023).

Furthermore, the study considers gender as a significant factor in learning preferences, with historical tendencies showing a division in subject interests between males and females (Chiketa & Okigbo, 2021; Nwoye et al., 2020; Nwuba & Osuafor, 2021; Obikezie et al., 2023). Nigerians generally uphold that males are superior to females in terms of physique, cognition, logical reasoning and even in academic achievements (Anigbogu as cited in Okafor, 2016).

Research Objectives

The study was guided by the following research questions:

1. What is the difference in the mean achievement scores of students taught physics using CAI and that of those taught with LM.

2. What is the difference in the mean achievement scores of male and female students taught physics using CAI.

Literature Reviews

The theory adopted for the study was the cognitive theory of multimedia learning

The Cognitive Theory of Multimedia Learning

The cognitive theory of multimedia learning proposed by Richard E. Mayer in 1997 states that people learn more deeply from words and pictures than from words alone. According to Mayer, words should be presented in a personalized conventional style rather than a detailed description style. He explained that deeper learning is achieved when the following multimedia combinations are used; text and picture explanation rather than verbal explanation. He further explained the importance of the removal of irrelevant words, sounds and video, avoidance of complex verbal and pictorial representation with no relationship to prior knowledge of the learner. Based on Mayer’s assumptions and research, the cognitive theory related to multimedia learning has shown how people construct knowledge from words and pictures.

Mayer explained that the human mind has two channel systems of processing information which the use of multimedia took care of. The two channels are visual and verbal processing channels.

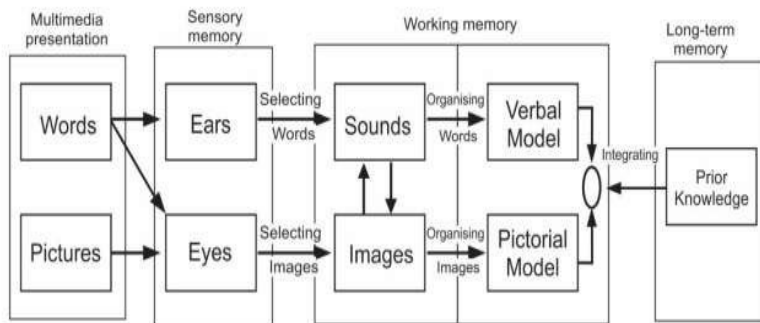


Fig 1: Mayer’s Cognitive Theory of Multimedia Learning

The verbal channel processes the sound we hear while the visual channel processes the things we see. The combination of these two processes enhances learning and improves students’ academic achievement.

The cognitive theory of multimedia learning is relevant to this study as the researcher focuses on improving students' academic achievement using CAI technique. From the theory it has been derived that visual-verbal (i.e text) is combined with visual-non-verbal materials (i.e graphics, etc) in order to enhance learner's academic achievement. Such learning method is learner-centred and not teacher-centred and supports learners learning at their pace (Akabuike & Achufusi-Akah, 2023).

Academic Achievement and its features

In an organized formal teaching and learning process, assessment of whether learning has taken place or not is central and paramount. This is because different categories of people who are involved in the educational system are often interested in ascertaining the effectiveness of the entire teaching-learning process. Academic achievement is the result of what an individual has learned from some educational experiences. It refers to an academic position a study occupies in the class relative to the position of others in the class usually assessed by the teacher's use of rating scales, tests and examinations (Anekwe, 2011). Aroson (2012) stated that academic achievement depicts students' performance on a standard of measurement such as performance test, skill test, analytical test etc. Dagbonyi (2015) hinted that academic achievement is frequently measured in terms of examination performance using achievement test whose question are selected from the contents the individual has been taught over a given period of time in a particular program instruction.

Recognizably, academic achievement is very important in education as it is used to ascertain how much an individual has benefited from a programme or to what extent the programmed goals are achieved (Etuk, Koko, and Ebo, 2021). Ricarda, Anja, Anne and Linda (2017) stated that it prepares students for future careers, refines their intellect, and helps in shaping their mind which in return can help them in all spheres of life. Ricarda *et.al* (2017) further explained that academic achievement is the benchmark of academic progress as it helps educational bodies monitor students in schools and make changes in the educational system where necessary, as it prepares them for the future. So, in the context of this study, a student's academic achievement is defined as the gain in knowledge of a student which occurs as result of taking part in a learning activity or programme and will be ascertained in the study using Physics Achievement Test (PAT).

RESEARCH METHOD

Research design

In this quasi-experimental study, a non-randomized control group design was employed.

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance.

1. There is no significant difference between the mean achievement scores of students taught physics using CAI and that of those taught with lecture method.
2. There is no significant difference between the mean achievement scores of male and female students taught physics using computer assisted instruction (CAI).
3. There is no interaction effect of teaching methods (CAI and Lecture method) and gender on academic achievement of students in physics.

Population and Sampling

A sample size of 41 (20 males and 21 females) senior secondary year two (SS2) students drawn from the 553 SS2 students in Awka South LGA in Awka Education Zone of Anambra State, Nigeria, using multi-stage sampling procedure were the research participants. The research participants who were in two intact classes were randomly assigned to experimental and control groups using a flip of a coin.

Instrument for Data Collection

Physics Achievement Test (PAT) validated by three experts with a reliability coefficient of 0.89 established using Kuder-Richardson 21, was used for data collection.

Experimental Procedure

The experiment commenced with the briefing of the physics teachers (research assistants) from the two sampled schools, on three contacts, before the treatment process. The teacher in the control group was told to carry on as usual using the lesson plans on Lecture Method (LM), developed by the researchers, while the teacher in the experimental group was briefed on CAI, its features, and how to efficiently implement the instructional approach, during the teaching and learning process, using the lesson plans also developed by the researchers. Following the briefing, the PAT which functioned as the pretest, was given to the two drawn intact classes that were divided into the control (13 boys and 8girls) and experimental (7 boys and 13 girls) groups. Following the pre-testing, the two groups began a 4-week long treatment (teaching) activity. After the instructional sessions, both groups completed a post-test, which was used to calculate the post-test score.

Data Analysis

Data collected from the administered tests were analyzed using mean and standard deviation to answer the research questions while Analysis of Covariance (ANCOVA) was employed at 0.05 alpha levels for testing the null hypotheses. In taking decisions, null hypothesis was rejected if the Probability (P) value is less than or equal to the level of significance (0.05), if otherwise, the null hypothesis was not rejected.

FINDINGS AND DISCUSSION

Research Question One: What are the mean achievement scores of students taught physics using Computer Assisted Instruction (CAI) and that of those taught with Lecture method?

Table 1: Pretest and Post-test Mean Achievement scores of students taught Physics using CAI and LM

Gained Groups		Pre-test			Post-test
		N	Mean	SD	Mean
SD	Mean				
Experimental		20	39.70	8.57	80.25
12.79	40.55				
Control		21	33.81	13.53	40.24
13.41	6.43				
Mean Difference			5.89		40.01
34.12					

Results in Table 1 reveals that the students taught using CAI had pre-test mean achievement score of (39.70) and post-test mean achievement score of (80.25) with gained mean achievement score of (40.55) while those in the control group taught with the lecture method has pre-test mean achievement score of (33.81) and post-test mean achievement score (40.24) with gained mean achievement score of (6.43). Students taught using CAI had a less spread of scores in the post-test (12.79) than those in the lecture group (13.41) indicating that students taught using CAI had a more homogeneous score in their post-test.

The difference between the mean gained achievement scores of the students in both groups is (34.12) in favour of CAI.

Research Question Two: What are the mean achievement scores of male and female SS II students taught Physics using CAI?

Table 2: Pre-test and Post-test Mean Achievement Scores of Male and Female Students taught Physics using CAI

Gender	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
Gain in Mean					

Male	7	43.57	9.15	84.29	11.78
40.72					
Female	13	37.62	7.40	78.08	12.79
40.46					
Mean Difference		5.95	6.21		0.26

Table 2 reveals that the male students taught physics using CAI had pretest mean achievement score of (43.57) and post-test mean achievement score of (84.29) with a gain in mean scores of (40.72) while the female students have pretest mean achievement score of (37.62) and post-test mean achievement score of (78.08) with a gain in mean scores of (40.46). There was a higher spread of scores among the female students in the post-test (12.79) than among the males (11.78) indicating that the male students had a more homogenous score in the post-test. The difference between the mean gain achievement score of the male and female students is 0.26 in favour of the females.

Testing Null Hypotheses

Hypothesis 1: There is no significant difference between the mean achievement scores of SSII students taught physics using CAI and those taught using Lecture method.

Table 3: ANCOVA Test of Significant in Mean Achievement Scores of students in Physics Based on Methods and Gender.

Source	SS	Df	Mean Square	F	Sig.
Decision					
Corrected Model	21531.748	2	5382.937		107.153
.000					
Intercept	1626.539	1	1626.539		32.378
.000					
Pre-test	5251.394	1	5251.394		104.535
.000					
Method	101199.911	1	101199.911		203.040
.000 Sig					
Gender	26.292	1	26.292	.523	.474
Not sig					
Method * Gender	5.339	1	5.339	.106	.746
Not sig					
Error	1808.496	36	48.451		
Total	168550.000	41			
Corrected Total	23340.244	40			

a. R. Squared = .923 (Adjusted R Squared = .914)

Table 3 shows that there is significant effect of the treatment on students' academic achievement in Physics $F(2, 36) = 203.040, P = 0.000 \leq 0.05$. Therefore, the null hypothesis is rejected meaning that there is a significant difference between the mean achievement scores of students taught physics using CAI and that of those taught using Lecture method in favour of CAI.

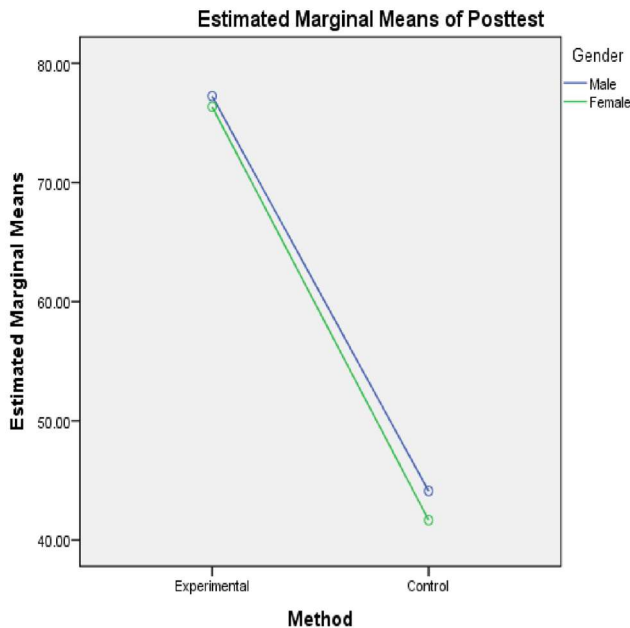
Hypothesis 2: There is no significant difference between the mean achievement scores of male and female students taught physics using CAI.

From table 3, it also shows that there is no significant main influence of gender on students' academic achievement in Physics $F(2, 36) = 0.523, P = 0.474 > 0.05$.

Therefore, the null hypothesis is not rejected meaning that there is no significant difference between the mean achievement scores of male and female students.

Hypothesis 3: There is no interaction effect of teaching methods and gender on students' academic achievement in Physics

From table 3, it further shows that there is no significant interaction of teaching methods and gender on students' academic achievement in Physics $F(2, 36) = 0.106, P = 0.746 > 0.05$. Therefore, the null hypothesis is not rejected meaning that there is no significant interaction effect of teaching methods and gender on students' academic achievement in Physics.



Covariates appearing in the model are evaluated at the following values: Pretest = 36.6829

Figure 4: Plot of Interaction effect of teaching methods and Gender

on students' academic achievement in Physics.

The study revealed that the students taught physics using CAI performed significantly better than those taught using lecture method. The level of higher academic achievement by the experimental group who received treatment could be as a result of self-evaluation and remedial activities provided by CAI which helped the students to master physics concepts better than the control group who were not exposed to CAI. The superiority of the use of CAI could be explained based on the presentation of the concepts with pictorial illustrations which sometimes appear in motion. The pictorial illustrations are considered effective in enhancing academic achievement in science for both concrete operational and formal students (Ajayi, 2017). These pictorial illustrations provide concrete basis for conceptual thinking and therefore facilitate a better and proper understanding of physics concepts. In addition, the use of CAI in teaching physics created multisensory channels for learning. This situation usually enhances learning since the students tend to learn more and better when more of the sense are involved than when one sense is involved. (Ratner, 2018). The findings of the study is in line with that of Ibrahim (2020) and Mudasiru and Adedeji (2010) which have shown that innovative instructional approaches like CAI enhance students' academic achievement more than traditional methods.

Regarding gender, the study found that there was no significant difference in the mean achievement score of male and female students taught physics using CAI. The finding of the study is that CAI uniformly affected the students. Since every student irrespective of gender partook in the activities, their academic achievement was equally affected but this was not significant. The study revealed that gender has no significant influence on academic achievement of students in physics. The result agrees with that of Ogbianigene (2014) and Anya (2017), that there is no significant difference in the academic achievement of physics students with respect to gender.

Additionally, the research indicated no interaction effect of teaching methods and gender was no significant for academic achievement in physics. Since both male and female students benefited from the instructional approach, it might help to reduce gender related differences in the study of physics. This is in line with Joseph, John, Eric, Yusuf and Olubunmi (2015) and Shazli (2017) that recorded no significant interaction between teaching methods and gender on students' academic achievement in social studies.

CONCLUSION

Considering the findings, the study established that Computer-Assisted Instruction (CAI), regardless of gender, significantly improved students' academic achievement in physics. The study also revealed a non-significant influence of gender and teaching methods on students' academic achievement in physics. In light of this, it is therefore pertinent to say that CAI is a gender friendly instructional approach that promotes students' academic achievement in physics.

Following the results, the following recommendations were made:

1. Physics teachers should adopt CAI while planning their lessons to enhance students' interaction with each other and the learning materials to facilitate effective learning and improved academic achievement.
2. Curriculum Planners should adopt CAI as an innovative teaching strategy in planning and reviewing of curriculum in senior secondary schools physics.
3. The Science Teachers Association of Nigeria in collaboration with the government should organize seminars and workshops to train physics teachers on how to use CAI in teaching and learning of Physics.
4. The government, especially the Ministry of Education should introduce the use of CAI into the school curriculum for physics instruction.

LIMITATION AND FURTHER RESEARCH

The major limitations of the study are outlined as follows:

1. The study was delimited to two intact classes of small size, this as a result may limit the generalizability of the study.
2. The study was carried out using only one level of students (SS2 physics students)
3. The study was conducted using only four concepts (machines, types of machines, classes of simple machines and friction) in physics.

In light of these limitations, the following suggestions for further studies were made:

1. A larger sample size should be sampled and studied to improve the generalizability of the study.
2. This study may be conducted using other levels of secondary school students to ascertain if the same effectiveness of CAI will be established.
3. The study could be conducted using other topics in physics to ascertain if CAI is effective in enhancing students' academic achievement.

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