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Computer-Aided Instruction (CAI) on Students' Achievement in Basic Science

Gaga Thomas Ali[1]*, Madumere Smart Onyemaechi[2]
[1]Department of Computer Science, Bingham University, Karu
[2]Computer and Robotics Education Department, Alvan Ikoku Federal College of Education, Owerri
Corresponding Author: Gaga Thomas Ali Oteh_c@yahoo.com

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A B S T R A C T

The purpose of the study was to find out how computer-aided instruction (CAI) affected the fundamental scientific proficiency of students in Idete North Local Government Area, Imo State, Nigeria. 15,055 people participated in the survey, including instructors and pupils from 33 junior secondary schools in Imo State's Ideate North Local Government Area. Eighty students from two junior secondary schools in the Local Government Area made up the study's sample, which used a questionnaire-experimental approach. A computer-assisted instructional package was created, approved, and given to a few basic science students. Four research questions guided the study were tested at a 0.05 level of significance. Four research questions guided the study, and four hypotheses were tested at the 0.05 level of significance. The t-test statistical method was used to test the hypothesis at a 0.05 level of significance, and the Arithmetic mean was used to answer the research questions. The findings revealed that the experimental group performed better than the control group. There were limitations, study implications, recommendations, and successes. The performance of the male and female basic science students exposed to CAI did not differ significantly, unless they were selected for additional research. It was recommended that the federal and state governments offer the required multimedia facilities for instruction based on the findings. designed to help teachers become computer literate in classrooms.

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INTRODUCTION

Science and technology have become crucial factors for sustainable national progress worldwide, which includes scientific discovery, major innovations, entrepreneurship, self-reliance, employability higher productivity. Sustainable development. To achieve this, there is a need to shift from rational methods of teaching to innovative teaching methods and instructional techniques. One of such teaching techniques is the use of computer-assisted instruction (CAI). The role of computers in our everyday life has made it compulsory that one must be computer literate, so that the growing use of computers in our society, if properly applied, will have a positive impact on our industrial and agricultural powers, especially in the present time. Many governments now realize that the economic future of their countries depends on the level of computer literacy. In order to provide children from nursery school through university with access to well-equipped computers, the Nigerian federal government founded the information technology institution in Lagos (Okeke C. 2011). The field of education known as computer-aided instruction (CAI) uses a teaching method where students communicate with a computer system (Nwoji, 2002). It is interactive; the student reacts to instructions given to him or her by the computer when the instruction is delivered through a computer. Computer-aided instruction (CAI) is an active, not passive, teaching tool that engages both the teacher and the students. The computer instructs, acting as the teacher. Both with and without a human teacher, pupils can learn new material.

Additionally, students can revisit or practice previously taught skills through computer-aided instruction (CAI). Efebo Awatua (2001). Knowledge is integrated through the use of computers, which allow for further practice for individuals once student groups have calculated a unit of instruction. Students can view other people's work and practice issues similar to those in the class using a computer. The computer logs the information in a database and tracks the approach used to make the attempts. The computer notes any discrepancies between the student's approach and a typical assessment form. Instant feedback is accessible, which is consistent with research by Mmaduabu M (1992), which highlights the value of giving students feedback right away after they've tried to answer a problem. Computers help improve evaluation, particularly formative evaluation.

The microcomputer can be utilized in a variety of ways in a science classroom, including lesson planning, science instruction administration, and evaluation. A competent scientific teacher who is computer savvy can use the microcomputer as a potent teaching tool to improve the teaching and learning process. Because of their speed, efficiency, flexibility, and adaptability, microcomputers are now frequently found in science classrooms in our schools. This is made worse by the fact that the mere mention of scientific names and objects minimizes or eliminates the abstract methods that some teachers use to teach the subject because there aren't enough laboratories. Students can also use computers to collect, analyze, and display data on their screens. For instance,

they can use computers to collect and analyze data on temperature variations, heart rates, brain waves, and other science-related phenomena.

In order to promote basic science in Nigerian primary, secondary, and college education, the federal government of Nigeria implemented two complementary initiatives. The projects are related to the national economic improvement and development strategy (NEEDS), which outlines the worldwide vision of altering society, as well as the necessity of achieving the Millennium Development Goals (MDGS) by 2015. In actuality, fundamental science must be at the forefront of transforming Nigerian society into a knowledge-based one. Given the difficult development in Africa and other parts of the world, the scientific method of problem-solving ought to be encouraged at all levels and in all domains. Basic science is a fundamental training in scientific requirements for human survival, sustainable development, and societal transformation. Some people believe that basic science is essential to humankind's ongoing quest to understand their environment, technology, and development, as well as to design means of transforming resources for quality life improvement and sustainable livelihoods (FGN 2007). Students who study basic science are exposed to the development of science and technology abilities that will help them make wise decisions, create survival plans, and learn how to contribute and live quantitatively in a global society. (Udofia, N.A. and Dauda, D.M. 2010) The study examines the impact of computer-aided instruction (CAI) on student achievement and basic science learning in Ideato North L.G.A. of Imo State, Nigeria, in light of the subject's many importance and the need for an innovative teaching strategy that will engage students and lead to the subsequent acquisition of pertinent scientific skills.

LITERATURE REVIEW

Statement of the Problem

In reality, fundamental science is a sophisticated, integrated science. While fundamental science combined the courses in integrated science with applied scientific or technological skills, integrated science originally combined physics, chemistry, biology, and earth science. IT is either productive technology or survival science. Being a holistic science, it is fundamental. Universal Basic Education (UBE) uses basic science as a proper review of integrated science to make it current. The primary goal of this curriculum is to achieve the Millennium Development Goals (MGDS) by 2015, as well as the critical targets of the National Economic, Empowerment, and Development Strategies (NEEDS), which can be summed up as follows: values reorientation, poverty eradication, job creation, wealth generation, and using education to empower the people (Dauda, D.M. and Udofia, N.A. 2010). Basic science helps students become interested in science and technology, prepares them for further study in these fields, and allows them to take advantage of the many career opportunities that are provided by the application of basic science to the Millennium Development Goals. Poor teaching strategies utilized to teach basic science may be the reason these goals have not been attained. It has been

discovered that low fundamental science achievement is caused by teachers' use of inefficient teaching techniques and procedures. According to the study, the unsightly trend might be improved by the use of computer-aided instruction (CAI).

The issue, now presented as a question, is: How does computer-assisted instruction affect students' performance in secondary basic science schools?

Statement of Hypotheses

The study developed and examined the following null hypotheses.

- Ho (1) Students who get basic scientific training using computer-aided instruction (CAI) and those who do not do not significantly differ in their academic performance.
- HO (2) The mean achievement scores of male and female students receiving computer-aided instruction (CAI) in basic science do not differ significantly.
- HO (3) Based on cognitive ability, there is no discernible difference in the mean achievement of students receiving computer-aided instruction (CAI);
- Ho (4) Students who get computer-aided instruction (CAI) do not significantly vary from those who do not in terms of their ability to retain information.

Interactive System

An interface allows the user to interact with the program and vice versa. The user can stop the video, freeze the image, and play back a specific or chosen segment to interact with the program. Students' good attitudes toward science in general and basic science in particular may benefit from it.

Problem Solving

The focus of computer-assisted problem-solving programs is on actual circumstances that could hold great significance for the students. In a scientific lesson, it can greatly increase students' enthusiasm. To make the most of the computer as a teaching tool, computer-assisted problem-solving programs can be utilized.

Impact of CAI on Basic Science Students' Performance

Students today are growing up with visual aids like computers, televisions, and the internet. It is impossible to pique these youngsters' interest with conventional approaches that were employed in the past. There are significant differences in the methods that which knowledge is introduced into society as a result of the technical advancements that emerged in the latter quarter of the 20th century. Visually enriched tools, such as computers and televisions, which are mostly used in our daily lives, provide students with a wealth of knowledge. (London 2005; Cepni et al., 2004) Interest and success in integrated science are positively correlated (according to Nzewi, 2005). According to her, students who stated that integrated science was their favourite subject outperformed those who said it wasn't.

Ifeakor (2005) examined how secondary school pupils' cognitive performance in basic science was affected by commercially generated computer-aided instruction packages (CAIPs). The study sought to ascertain how gender, among other factors, affected science students' cognitive performance. Following data analysis, the researcher concluded that students'

interest in basic science was not significantly influenced by their gender. Practice and drill the previously demonstrated skill. Students who are slow learners or who want to raise their scientific marks might utilize it to improve their performance. Pupils frequently lament that the lesson is never appropriate for each student in the class. While some learn slowly, others pick things up quickly. Because a course is excessively dull, some students quit (Udoh, 1999). Ozofor (2001) investigated how students' performance in mathematics was affected by two different forms of computer-aided teaching (CAM). Students in junior secondary II (JSS 2), as well as a control group, were employed by the researcher. Drill-and-practice instruction was used with the experimental group, and tutorial instruction was used with the control group. According to Ozofor's analysis of the study's data, students learn more effectively in small, cooperative chemistry groups where they can negotiate meaning and build conceptual understanding in a learning community. This makes science instruction more relevant. In keeping with the aforementioned, Jajua (2006) claimed that integrating information and communication technology (ICT) into the educational process is one of the current social forces pushing for education to become more relevant. Computers, DVDs, and subject-matter phones are examples of typical electronic amenities.

In order to instill science culture and a healthy appreciation of science in pupils, Anyanwu (2002) noted that a large number of teachers lack a general understanding of the nature of science and the best approaches to teach its fundamental principles. Experimental evidence suggests that the oral explanation strategy alone is ineffective. Rich visual information makes training more effective and long-lasting when learning principles are considered (Mayer, 2005).

Impact of CAI on Pupils' Retention of Fundamental Science Knowledge

It is impossible to undervalue computer-aided instruction (CAI) in the modern environment. Numerous studies have been conducted on the educational benefits of computers, especially in developed nations. The value of computer-aided instruction (CAI) in education has been recognized by a number of recent studies. It has been discovered that CAI enables students to work independently or collaboratively, and that computers give students instant feedback on whether the answers they have chosen are accurate. If they are not, the program demonstrates how to respond to the question correctly. In addition to providing a variety of activities, computers may provide a change of pace from group or teacher-led learning. CAI enhances instruction by giving students instant feedback. A computer application can monitor a student's progress and mistakes while delivering teaching at their own pace. Because the program is interactive and encourages students to be competitive to improve their results, computers draw in students. Additionally, CAI progresses at the student's pace and typically doesn't advance until the student has mastered the skill (Yenice 2006). Inyama (2002) asserts that computers are used in a very flexible manner nowadays to help a wide range of students understand various subjects, particularly science and technology. He described how computers are used in the classroom.

Through a video display unit, the computer can lead a user through a course of instruction in a way that makes the material easier to understand. Science instruction can benefit from the use of microcomputers in a variety of ways, including practice and drill training. It gives students the chance to practice previously taught skills regularly. It can help students do better in scientific classes. Students who are slow learners, want to raise their scientific grades, or require help to get the repetition they need to retain the material. However, for the sake of this study, retention is defined as the capacity to store and recall learned basic science information (Hornby, 2001). This necessitates that basic science retention be achieved through effective teaching methods rather than rote memory alone. Students in the experimental group retained more than those in the control group, according to Iji (2010) and Chianson (2008).

According to Mkpa (1981) and Iji (2002), retention is the capacity to continue acting in a specific manner after learning it. Additionally, retention is examined in conjunction with achievement, according to Obodo (1990) and Iji (2010). Young children are more impacted by visual stimuli than by aural ones. Halis (2002). Because of this, it is challenging to engage students and impart knowledge without utilizing visual and audio aids in the classroom. CAI is a technique to add interest to training and increase the retention of knowledge.

According to research, using computers as an application tool in science and math classes makes the lessons more engaging and motivating. Thus, more complex scientific ideas can be learned in a more efficient and long-lasting manner. From language development to handwriting lessons, from social science to scientific courses, from mathematics to preparing students for school life, computers are used in a wide range of fields (Haris, 2002).

Review of Empirical Research on the Impact on Basic Scientific Achievement of CAI Students

Over the past year, the main focus of research has been on basic science accomplishments. According to Eze (1995), achievement serves as a gauge for the degree of comprehension of the nature of science. Computer-managed instruction (CMI) and computer-aided instruction (CAI) are individual and mastery learning strategies that are more effective than the conventional "chalk and talk" methods.

The impact of commercially marketed computer-aided programs on secondary school pupils' cognitive performance in basic science was examined by Ifeakor (2005). 140 JSS 1 Integrated Science students from two private secondary schools in Onitsha Urban were used by the researcher. After examining the study's data, she concluded that pupils who were taught using the CAI approach outperformed those who were taught using the expository method. Expository studies on secondary school achievement were carried out by Nwoye (2005). The goal of the research was to ascertain the degree of scientific achievement as well as the factors that contribute to students' low scientific achievement. Despite recording the highest level of enrolment in another research development, he noted that the overall performance level in integrated science is really low.

Ali (2004) found that scientific performance is often depressing. He divided the scientific students into two groups: the control group and the experimental group. While the group without CAI received basic science instruction, the experimental group received it with CAI. In this study, the impact of CAI on conceptual comprehension of chemical bonding and attitude toward biology was examined. The findings showed that CAI is a very beneficial exercise for promoting cognitive accomplishment in basic science.

With 25 students in an experimental group and another 25 in a control group, the study used a quasi-experimental approach. The main instruments for gathering data were the 25-item Biology Attitude Scale (BAS) and the 15-item Chemical Bonding Achievement Test (CBAT), which had two tiers of questions. A pre-test and a post-test were used to administer the CBAT and CAS instruments. After comparing the scores of the two groups on the post-test, a statistically significant difference in favor of the experimental group was discovered. Additionally, it appears that students in the experimental group performed better than those in the control group. This study's result indicates that using computer-aided materials can help students learn more about science-related topics (Haluk, O. K., 2008).

Anyawu (2002) noted that a large number of teachers lack a general understanding of the nature of science and how to properly teach its foundational ideas in order to instill in their students a healthy respect for science and a science culture. Peer pressure, students' anxiety levels, and the accessibility of basic scientific teaching materials are other elements that affect basic science accomplishment. According to Ludeogu (2007), vocational inclination was also linked to interest in integrated science (Nwonye 2005). He emphasized that most students exhibit a good interest in the subject that leads to their intended career path. while they work to meet the prerequisites for admittance. Actually, the main focus on motivation and success in science has been on teaching strategies and educational materials (Bola, 2008).

METHODOLOGY

According to research studies and a review of the literature, science teachers mostly employ lectures and expository teaching methods, and the lack of suitable teaching resources in schools hurts the academic performance of 100 students. The assessment of computer-assisted instruction for student achievement in secondary school fundamental science was the focus of this study. After reviewing the advantages and disadvantages of CAI, it was anticipated that its application would significantly improve student accomplishment in comparison to the traditional teaching technique (CTM). Research on CAI's impact on students' academic performance was examined. It was observed that the findings of these investigations were conflicting and unclear. Nonetheless, the impact of CAI on students' performance in fundamental science is demonstrated by their strong knowledge and comprehension of the specific subject matter being taught. Both sexes were expected to comprehend and do exceptionally well on the students' pretest with the help of CAI. The pupils made a solid effort and were able to comprehend

without the teacher's explanation using CAI. The practice exercises carried out with CAI's assistance were pleasant and effectively applied to the pupils' understanding.

Table 1. The Practice Exercises Carried Out with CAI's Assistance were Pleasant and Effectively Applied to the Pupils' Understanding

L.G. A	Schools	Basic Science Teachers	Number of Students
Ideato North	33	55	15,000

Sample and Sampling Techniques

Two privately owned secondary schools were chosen at random to form the sample, and 80 JSS II students were drawn from each of the two schools in the Ideato North Local Government Area.

Table 2. Sample and Sampling Techniques

S/N	School	CLASS	Number of Students Selected
1	Roselec International Secondary School	JSS II	40
2	Christ the King Secondary School	JSS II	40
Total	2	2	80

The 25-item objective Science Achievement Test (BSAT) was created by the researcher and consists of 20 multiple-choice questions and 5 matching items. Each question is worth four (4) marks, for a total of one hundred (100) points.

Validation of the Instrument

Two experts in computer science education from Madonna University, Okija, validated the tool. The first draft of the instrument was provided to these experts to assess the items' appropriateness and applicability for the hypothesis. Their comments and corrections were appropriately considered, and the initial document was then forwarded to the project supervisors, who followed up with other colleagues to make the required changes. The researcher had an impact on the supervisors' corrections.

Reliability of the Instrument

The researcher used two schools in Nnewi Education Zones that were not included in the sample to assess the reliability. They utilized test, retest. After giving the participant the first test and then another two weeks later, the researcher used Pearson's product-moment correlation to correlate the test results, yielding a reliability score of 0.81. According to the study, this is a good reliability trait. Thus, the gadget was utilized as a trustworthy tool.

Method of Data Analysis

The study employed the t-test and the arithmetic mean as data analysis tools. The t-test was employed to test the hypothesis, and the arithmetic mean was used to answer the study questions.

Normal value was assigned to the scaling items as follows:

Excellent 70 and above = 4.00
Good 60 – 69 = 3.00
Fair 40 – 50 = 2.00
Bad 0 – 39 = 1.00

RESULT AND DISCUSSION

Research Question 1

How much does the average performance of students taught basic science using computer-assisted tools differ from that of students taught without it?

Table 3. Showing the Extent of Mean Achievement of Students Taught Basic Science with Computer-Aided Instruction and Those Taught without it

Question items in the instrument for students	Number of students per rating point							Summary of students' ratings	
	Bad point, fair Point, Good					Point Excellent Point		TR	AMR
Performance of students taught with CAI	1	1	8	16	11	33	20 130	80	32.5
Performance of students taught without CAI	20	20	4	8	6	18	10 86	40	20.1

The arithmetic mean rating of students taught with CAI is 32.5, while the arithmetic mean rating of students taught without CAI is 20.1, as shown in Table 3 above. This demonstrates how the application of CAI affects students' academic achievement in basic science.

Research Question 2

To what extent does the use of computer-aided instruction (CAI) affect performance based on gender?

Table 4. Displaying the Level of Proficiency of Basic Science Students by Gender

Question items in the instrument for students	Number of students per rating point							Summary of students' rating	
	Bad point, fair Point, Good					Point Excellent Point		TR	AMR
Performance of male students taught with CAI	2	2	3	6	5	15	30 143	120	3.5
Performance of female students taught with CAI	2	2	6	12	2	6	30 140	120	3.5

The arithmetic mean rating for male students taught with CAI is 3.5, whereas the arithmetic mean rating for female students taught with CAI is 3.5,

as shown in Table 4. As a result, there is little difference in the academic achievement of men and women.

Research Question 3

How much does the use of computer-aided instruction (CAI) impact cognitive ability-based performance?

Table 5. That shows the Degree of Achievement of Students Taught with CAI Based on Cognitive Capacity

Question items in the instrument for students	Number of students per rating point						Summary of students' rating	
	Bad point, fair Point, Good					Point Excellent Point	TR	AMR
Performance of students taught with CAI	2	2	9	18	10	30 76 126	19	31.5
Performance of students taught without CAI	15	15	4	8	7	21 56 100	14	25

Students taught with CAI received an arithmetic mean rating of 31.5 in Table 5, while students taught without CAI received an arithmetic mean rating of 25. According to cognitive ability, students who receive CAI in basic science perform better academically than those who do not.

Research Question 4

How much does the knowledge retention of students taught fundamental science with computer-aided instruction (CAI) differ from that of students taught without CAI?

Table 6. Shows that Students Who Received Instruction

Question items in the thin instrument for students	Number of students per rating point					Summary of students' ratings		
	Bad point, fair Point, Good				Point Excellent Point	TR		AMR
Performance of students taught with CAI	2	2	3	6	10	30 25	100 128	3.45
Performance of students taught without CAI	15	15	5	15	5	15 16	60 105	2.62

Table 6 shows that students who received instruction using CAI had an arithmetic mean rating of 3.45, while students who did not get CAI had an

arithmetic mean rating of 2.62. This suggests that pupils who get instruction via CAI retain information to a far greater degree than those who do not.

Null Hypothesis (H01)

Table 7. T-test Summary Examining the Effect of CAI on Students' Performance in Basic Science

Group	N	X	SD	DF	T-CAL	T-CRIT	Level of Sign	Decision rule
Experimental group	40	65.63	18.82	78	2.19	2.00	0.05	H0 Rejected
Control group	40	56.93	16.60					

The likelihood (p) that the difference is the result of error is less than the 0.05 level of significance, according to table t. The crucial value of 2.00 is less than the computed t-value of 2.19.

The aforementioned indicates that there are notable variations in the average student performance. This results in the rejection of the null hypothesis (H0). Accordingly, there is a substantial difference in performance between students who were taught fundamental science with CAI and those who were not, as determined at the 0.05 level of significance.

Null hypothesis (H02)

The mean achievement score of male and female students who received basic scientific instruction using CAI does not differ significantly.

Table 8. T-Test Summary: Looking at How CAI Affects Students' Performance in Basic Science According to Gender

Group	N	X	SD	DF	T-CAL	T-CRIT	Level of Sign	Decision rule
Experimental group	20	2.64	0.14	38	0.376	2.00	0.05	H0 Rejected
Control group	20	2.69	0.12					

Table 8 shows that, at the 0.5 level of significance, the chance (p) that the difference is the result of a mistake is more than 0.5. The computed t-value of 0.376 is below the 2.00 threshold.

Accordingly, there is no discernible difference in the mean performance of men and women. Thus, the null hypothesis (H0) is maintained. Accordingly, at the 0.05 level of statistical significance, gender has no discernible impact on the performance of students taught fundamental science with CAI.

Null Hypothesis (H03)

Based on cognitive capacity, there is no discernible difference in the mean achievement of students taught using CAI.

Table 9. T-Test Summary Examining the Effect of CAI on Students with Cognitive Ability

Group	N	X	SD	DF	T-CAL	T-CRIT	Level of Sign	Decision rule
Experimental group	40	66.63	18.54	78	2.2	2.00	0.05	H0 Rejected
Control group	40	54.75	16.94					

The likelihood (p) that the difference is the result of error is less than 0.05 at the 0.05 level of significance, according to Table 9. In comparison to the critical t-value of 2.00, the computed t-value of 2.2 is higher.

In light of the aforementioned, the null hypothesis (H0) is now rejected since there is a substantial difference in the students' mean achievement according to cognitive capacity.

Null Hypothesis (H04)

Students who were taught with CAI and those who were not showed a notable difference in their ability to retain information.

Table 10. The T-Test Summary Looks at How CAI Affects Students' Ability to Remember Basic Science Information

Group	N	X	SD	DF	T-CAL	T-CRIT	Level of Sign	Decision rule
Experimental group	40	67.65	18.56	78	2.29	2.00	0.05	H0 Rejected
Control group	40	51.75	16.4					

Table 10 shows that, at the 0.05 level of significance, the probability (p) that the difference is the result of mistake is less than 0.05. The essential t-value of 2.00 is less than the computed t-value of 2.29. In light of the aforementioned, the null hypothesis (H0) is now rejected because there is a substantial difference in the mean achievement of students based on information retention between those who were taught basic science with and without CAI. According to the study's findings, pupils studying fundamental science who receive CAI perform better than those who do not. Therefore, secondary school teachers ought to embrace the use of CAI for their students. The Ministry of Education, on behalf of the government, will recognize the value of allocating funds for a well-equipped computer to enhance fundamental scientific instruction in Nigeria.

CONCLUSIONS AND RECOMMENDATIONS

The following recommendation ere made:

- Teachers of fundamental science in secondary schools ought to be encouraged to employ CAI in their instruction.
- Professional organizations like the Science Instructors Association of Nigeria (STAN) should host workshops, conferences, and seminars for basic science instructors on the use of CAI.
- Computers should be provided by the state government to all secondary schools across the nation.

FURTHER STUDY

This research still has limitations, so further research on this topic is still needed.

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