Chapter 14
Effectiveness of Computer–Managed Instruction on Students' Performance in Tertiary Institutions

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ABSTRACT

The roles of information technology in the contemporary world cannot be over-emphasized considering its enormous usage in the educational sector. This chapter investigates the effectiveness of computer-managed instruction (CMI) on students' performance in tertiary institutions in the North-Central Geopolitical Zone of Nigeria. The control group was taught Computer Science using traditional lecture method (TLM) approach, and the experimental group was taught using CMI approach. A total of 360 students in colleges of education (COE), polytechnic, and university participated in the study by using multi-stage sampling procedures. The null hypotheses were tested using ANCOVA and ANOVA statistical analyses at 0.05 level of significance. Findings revealed that there was a statistical difference in the performance scores of students using CMI and TLM approaches. There was also a statistical difference between private and public tertiary institution students' performance. Additionally, the students from the university had the highest mean when compared with students from COE and polytechnics.

INTRODUCTION

The world has revolutionized with remarkable impacts of information and communication technologies (ICTs) in different spheres of life. The benefits of ICTs in Engineering, Science, Commerce, Energy, Health/Medicine, Communication, Manufacturing, Financial Institutions, Transportation and Agriculture have tremendously created a world of all possibilities. The field of education is not left behind in exploiting the significance of ICTs towards achieving the educational goals and objectives at all levels of education. The teaching and learning processes could be enhanced with the adoption of ICTs into the classroom's discussion by teachers and students. ICTs can be used for repetition of instructions until the specific learning objectives are achieved or mastered, preparation and presentation of ideas, and analysis among others. Educational packages such as Computer Assisted Instructions (CAI), Computer Based Training (CBT), Computer Managed Instruction (CMI) and Computer Assisted Learning (CAL) are available for use in the dissemination of educational instructions.

Therefore, this chapter intends to draw attention to the effectiveness of computer-managed instruction on students' performance in tertiary institutions in North-Central geopolitical zone of Nigeria. The main objective includes finding out the difference between computer-managed instruction and conventional lecture method in computer science in tertiary institutions. However, students get distracted with certain graphical information via the internet which later negatively affects the overall academic performance in a chosen course of study. The researchers stated that instructions which are not well managed and disseminated through the use of ICTs could endanger the academic performance of students at tertiary institutions in Nigeria. The causes of poor academic performance in computer science among students include poor teaching and learning techniques, infrastructures, instructional management, lack of conducive learning environment and non-availability of computers for studying and researching (Rozema, 2011).

The roles of tertiary institutions cannot be ignored in the development of individual and society at large. Tertiary institutions offer opportunities to a group of individuals to acquire skills, do research and develop human capacity. Regrettably, many tertiary institutions lack qualified lecturers and the few excellent lecturers they have in education are looking for a better career outside the teaching profession. However, when the tertiary institutions lack qualified lecturers to deliver their modules and do research effectively, then this will have a negative impact on improving the current education and the society at large. The fundamental responsibilities for future advancement and development of nations in the world lie on the youths and students in particular. Therefore, adequate attention is required to ensure that the students are provided with the required information and skills for intellectual capacity.

Significantly, ICT could be useful to enhance teaching and learning processes among the lecturers and students at tertiary institutions. A computer-based learning package can be provided to help teachers and students to share information and do research projects at the same time. According to Bada, Adewole and Olalekan (2009), the benefits of computer applications in education include the followings:

- Students could learn at their own pace
- Provision of suitable feedback
- Motivation towards learning
- Enhancement of personalized instruction through individualized reactions
- Provision of adequate control over learning
- Enhancement of self-assessment towards repetition of instructions until desired objectives are achieved.

For every student to achieve higher academic achievement in the twenty-first century, an integration of technology into the learning process cannot be neglected (Padma & Adi, 2000). The poor academic performance of students in the tertiary institutions has been an issue of concern to parents and educators. The students were asked to explain the causes of their poor academic performance in computer science. The finding revealed that poor teaching techniques were attributed to their poor academic performance (Emmanuel & Olusegun, 2015). Therefore, if computer-managed instructions can help students enhance and improve their learning at tertiary institutions, then to what extent would computer-managed instructions affect the academic performance or outcomes of students in computer science needs urgent attention before a full adoption into the classroom is recommended? The chapter presents empirical findings on the effectiveness of computer-managed instruction on students' performance in tertiary institutions in North-Central geopolitical zone of Nigeria. The following research questions were asked to guide the conduct of the research:

1. What is the difference between the performance scores of students taught computer science using computer managed instruction and traditional lecture method?
2. What is the difference in the performance of male and female students taught computer science using computer managed instruction?
3. What is the difference in the performance of public and private schools' students taught computer science using computer managed instruction?

As a follow up to the research questions, the following null hypotheses were postulated:

1. There is no significant difference in the mean performance score of students taught computer science using computer managed instruction and conventional lecture method.
2. There is no significant difference in the mean performance scores of students taught computer science using computer managed instruction based on institutions.

Specifically, the objectives of the research were to:

1. find out the difference in the performance scores of students taught computer science using computer managed instruction and conventional lecture method;
2. examine the difference in the performance of male and female students taught computer science using computer managed instruction;
3. observe the difference in the performance of public and private schools' students taught computer science using computer managed instruction;
4. investigate if there is a significant difference in the mean performance score of students taught computer science using computer managed instruction and conventional lecture method; and
5. investigate if there is a significant difference in the mean performance score of students taught computer science using computer managed instruction and the institutions.

BACKGROUND

A computer managed instruction is an application of a computer to deliver learning instructions to the learners and resources for achieving a specific set of objectives at the end of instructions. (Mee-chin, Abrizah, & Lip, 2012). Objectives such as students should be able to define computer and mention the basic hardware components of computer could be stated as objectives.

Computer managed instruction is referred to the instructional technique where learning instructions and assessment of specific objectives are carried out through the use of computer applications. In a computer-managed instruction environment, the learners might listen and watch computer animation to acquire specific knowledge. The teachers or instructors are not major active facilitators, rather; the learners are active because computer-managed instruction is a learner-centered technique. This implies that the learners could repeatedly learn specific instruction or acquire specific knowledge at their pace without over dependence on their teacher.

John and Harrison (2018) stated that CMI is an instructional strategy that uses a computer to deliver learning objectives, learning resources, and assessment of learner performance. Significantly, computer-managed instruction engages the learners to learn at their own pace and relieves the physical stress of teachers who would not actively involved in the teaching. (John & Harrison, 2018). Padma and Adi (2000) encouraged the teachers to integrate CMI technology in higher education for effectiveness in the teaching and learning process.

Bliss, Mark, Jonathan, Godwin and Justine (2017) investigated the effect of CAI on students' academic achievement in Mathematics. The finding showed that the CAI was effective on the acquisition of mathematical skills with little teachers' supervision or instructions. The research of Bliss et al. (2017) dealt with the effectiveness of using CAI on Mathematics. However, the current research focused on CMI and Computer Science as a subject. If CAI was effective on students' achievement in Mathematics, could CMI be effective on students' performance in Computer Science?

Imhanlahimi and Imhanlahimi (2008) investigated the effectiveness of traditional or expository and computer-assisted learning strategy of teaching biology. A true experimental design was used. The results indicated that the traditional method was better than the computer-assisted learning method in teaching biology. If a traditional method was better in teaching and learning Biology, would the application of CMI enhance the effectiveness of teaching Computer Science? This research focused on an empirical investigation that could assist the stakeholders in the tertiary institution on the adoption of computer-managed instruction into the teaching and learning of computer science.

Hammed (2015) discovered that CAI resulted in the significant achievement of secondary students at all levels in mathematics. However, the research of Hammed did not show any statistical difference between gender and academic performance in mathematics. In the selection of individuals into the positions of authorities, either male or female person could be voted. This implies that the academic performance of male and female students needs to be compered for future success in a chosen career. This current study investigated the performance of male and female students in Computer Science.

Chang and Bower (2016) carried a research on the effect of CAI on reading achievement. The researchers discovered CAI had a positive effect on reading performance of K–12 students. If CAI was effective in reading performance of students, would the application of CMI enhance the effectiveness of teaching Computer Science? The gap here was to investigate the effectiveness of CMI among the students of tertiary institutions in Computer Science, not K-12.

Kesan and Crow (2018) conducted a research on the effect of CAI on the achievement and students' attitudes towards mathematics. An experimental research design was adopted and findings indicated that the teaching of mathematics with the aid of CAI method increased students' performance in mathematics. More studies have been conducted on the effect of CAI in mathematics achievement. However, if a higher performance had been recorded in the mathematics achievement of students, could the same results be obtained when computer-managed instruction is introduced in computer science?

The impact of gender on students' academic performance is still under discussion among scholars. Hammed and Ola (2012) stated that electronic learning calls for active participation among male and female students. Likewise, Paul (2014) revealed there was no significant difference between male and female students in the aspects of examination scores, learning attitudes, and learning portfolios in computer managed instruction and traditional method. Yoohang (2014) reported that male students performed better than their female counterparts when taught using computer managed instruction.

Lilain and Musa (2017) investigated the use of CMI and its impact on students' performance in Chemistry. An experimental research design which involved control and experimental group was used and the finding showed a significant difference between male and female students who used CMI in learning Chemistry. However, the gap here was to investigate the effectiveness of CMI among the students of tertiary institutions in Computer Science not in Chemistry.

MAIN FOCUS OF THE CHAPTER

This section gives research methodology, such as research design, population, sample of the study, instruments and instruments validation, data collection and data analysis, and findings of the study presented in this chapter.

Research Design

The research design adopted for this study was experimental. The experimental design involved a group of students that received treatment, whereas the other group did not receive treatment. This research used a group called the experimental group (Computer Managed Instruction Approach, CMIA) and another group called control group (Traditional Learning Approach, TLA). The control group was taught computer science using traditional lecture method, while the experimental group was taught using CMIA.

In this study, the main independent variable was the categorical variable, methods (CMIA and TLA) while the dependent variable was the continuous variable, students' performance (scores). To determine the reference performance scores, the researcher with the assistance of computer lecturers in the tertiary institutions began the research by first measuring students' general performance on a selected topic in computer science with a set of questions titled Computer Science Assessment (CSA). The results of the pre-test were recorded on the Assessment Score (AS) and saved for reference at the end of the experiment.

Secondly, the control and experimental groups were taught the same topic in computer science, where students' general performance was evaluated, for three weeks under closed supervision of the researchers who are computer lecturers and experts with over ten years teaching experience. The same lecturers were used for the two groups to establish that the lecturers' years of teaching experience did not affect the students' performance score rather to investigate the effect of instruction methods either Computer Managed Instruction Approach (CMIA) or Traditional Learning Approach (TLA). The two

groups were provided with a post-test after three weeks of instructions. The results of the post-test were recorded on a data collection sheet as carried out during the pre-test. The comparison was carried out on how the performance of both the control group and the experimental group changed from a pre-test to a post-test after being taught either with Computer Managed Instruction Approach (CMIA) or Traditional Learning Approach (TLA).

Population

The population of the study comprised of all the first-year students in Colleges of Education (COEs), Polytechnic (Poly) and University (Uni), North-Central geopolitical, Nigeria. There are six (6) states in the North-Central geopolitical, Nigeria namely, FCT-Abuja, Kogi, Nassarawa, Kwara, Niger and Plateau. The first-year students were used for the study because this is the first class in the tertiary institutions which requires effective learning towards excellent academic performance. A poor academic performance at the first-year examination could lead to an overall poor academic result at the final examination.

Sample of the Study

The research adopted a multi-stage sampling procedure. Firstly, a convenience sampling technique was used to select six Colleges of Education, four Polytechnic and six Universities from the public institutions while three Colleges of Education, two Polytechnic and three Universities were selected from the private institutions in North-Central geopolitical zone, Nigeria. According to Hamed (2016), a convenience sampling is a non-random sampling method that involves selecting participants because they are often readily and easily available for investigation. Secondly, a simple random sampling technique was used to select fifteen students from each institution. Thus, Table 1 showed the selected samples.

Table 1. Sample selected based on population

Institutions	COE	Polytechnic	University	Total
Public	90	60	90	240
Private	45	30	45	120
Total	135	90	135	360

Thirdly, purposive random sampling was used to select one hundred and eighty students for the experimental group and one hundred and eighty students for the control group. Therefore, a total of three hundred and sixty first-year students made-up the sample.

Instruments and Instruments Validation

The treatment instrument (Computer Managed Instruction Approach Package, CMIAP) and the test instrument (Computer Science Assessment, CSA) were used. The treatment instrument, CMIAP was developed by the researchers with the assistance of professionals such as system programmer, the instructional designers and educational technologists. A C# programming language was used to develop

the package with other applications such as Microsoft Visual C# 2015. The sample of the package was presented to computer programmers and educational technology experts for validation. The contents of the package were validated by computer science specialists. Sample of the questions was presented to the experts in Educational Measurement and Evaluation for correction.

The contents of the package were validated by computer science specialists. The package had a topic selected from computer science and was subdivided into five lessons that covered three weeks. On the home page, there were Registration, Lesson: Modules, Exercise: Practice and Quit buttons. Each button on the Home page was linked to another page for a specific task. A student registered using the "Registration" button. On the Lesson: Modules, the students could acquire the instructions provided. The "Exercise: Practice" provided the opportunity for self-assessment. Lastly, the "Test/Examination" button was used to test the students' level of achievement in computer science based on the learning and acknowledge acquired using computer managed instruction, CMI.

Figure 1. Computer managed instruction approach package
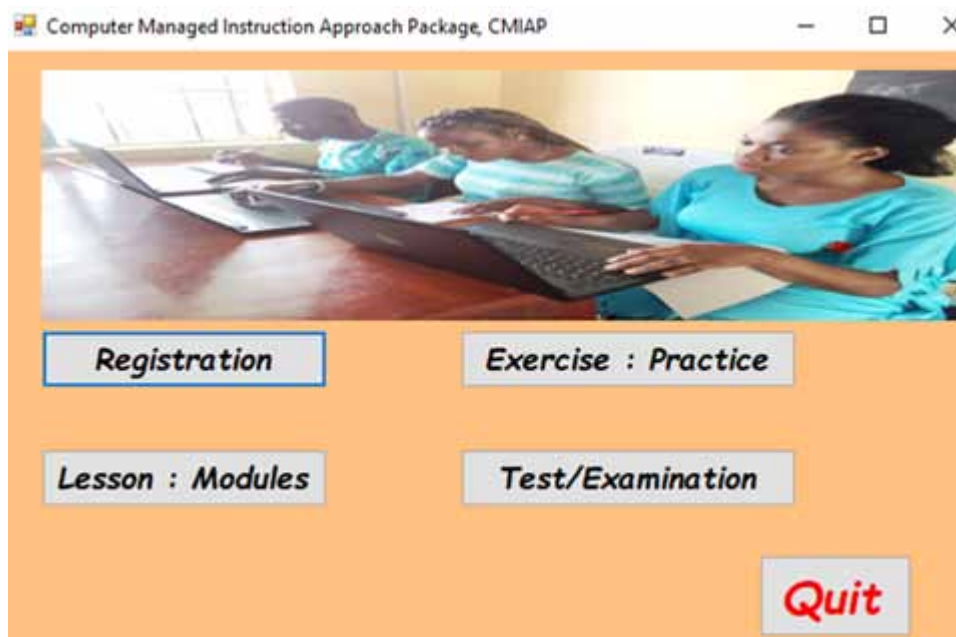
Also, a test-retest method was used to determine the reliability coefficient of the test instrument and score sheet. One hundred students of Federal University of Technology, Akure in South West of Nigeria were used as a pilot sample. The instruments were administered during the pilot stage on two different occasions at four weeks' interval. A Cronbach's alpha statistical tool was used to determine the internal consistency of the instrument and 0.83 was obtained. Also, the Spearman correlation coefficient of 0.81 was obtained for the test instrument. These statistical values were considered reliable hence suitable for use in this research.

Data Collection

A correct answer provided by each participant had 1 mark. Nine hundred (900) copies of the Computer Science Assessment (CSA) were produced for pre-test and post-test. The performance scores at the pre-test stage were collected, collated, marked, recorded and kept for further analysis. The same questions were also distributed to the participants in both the control and experimental groups after the experiment (post-test). The performance scores at the post-test stage were collected, collated, marked, recorded and kept for comparison with the scores in the pre-test stage.

Data Analysis

There were twenty (20) objective-questions for a participant and one (1) mark for a correctly answered question. The maximum obtainable mark was twenty (20). The research questions were analyzed using mean and standard deviations while Analysis of Covariance (ANCOVA) and Analysis of Variance (ANOVA) statistical analysis were used to test the two null hypotheses postulated for the study at 0.05 level of significance. All the analyses were carried out in IBM Statistical Package for the Social Sciences (SPSS) 21.0 version.

Results

The three (3) research questions used for this study were analyzed, answered and presented as shown in the following subsections:

Research Question One: What is the difference in the performance scores of students taught computer science using computer managed instruction and traditional lecture method?

Table 2. Mean and standard deviation of students' performance in computer science using CMI and TLA methods

| Group		Pre Score	Post Score	Difference
Control	Mean	6.72	7.09	0.37
	Std. Deviation	0.38	0.16	
	Minimum	3.00	5.00	
	Maximum	9.00	11.00	
Experimental	Mean	7.03	18.64	11.61
	Std. Deviation	0.31	0.03	
	Minimum	3.00	8.00	
	Maximum	12.00	19.00	
				11.24

Table 2 presents mean and standard deviation analysis of students' performance in computer science using computer-managed instruction (CMI) and traditional learning approach (TLA). Table 2 further

showed that the scores of the participants in both experimental and control groups were relatively equivalent at the initial stage (pre-test) with means of 7.03 and 6.72 respectively and as illustrated in Figure 2. However, in the post-test, the experimental (using CMI) group had a mean of 18.64 while the mean of the control group (using TLA) was 7.09. Also, there was a statistical difference of 11.61 in the scores of students in the experimental group between the pre-test and post-test. Likewise, a statistical difference of 0.37 was recorded between the pre-test and post-test scores in the control group. Since the final score of 18.64 was greater than the initial score of 7.09 at the post-test, this implied that computer-managed instruction (CMI) was effective to learn computer science than the traditional learning approach (TLA). Therefore, there was a statistical difference of 11.24 in the performance scores of students taught computer science using computer-managed instruction (CMI) and the traditional learning approach (TLA).

Figure 2. Students' performance using CMI and TLA
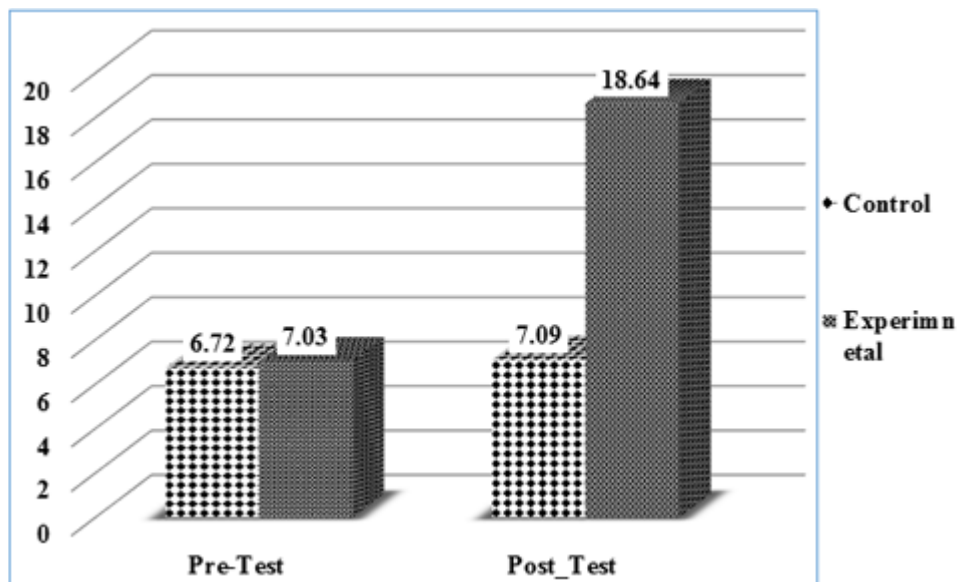
Research Question Two: What is the difference in the performance of male and female students taught computer science using computer managed instruction?

Table 3 indicates mean and standard deviation analysis of male and female students' performance in computer science using computer-managed instruction (CMI). Table 3 further showed that the scores of the participants at the initial stage (pre-test) were comparatively equivalent. The male and female participants had means of 10.33 and 9.64 respectively at the pre-test stage as illustrated in Figure 3. However, in the post-test, the male had a mean of 17.11 while the female had 12.34. In addition, there was a statistical difference of 6.78 in the scores of male students between the pre-test and post-test. Likewise, a statistical difference of 2.7 was recorded between pre-test and post-test scores of female students. The mean difference of male students was greater than the mean difference of female counterparts (6.78 > 2.7). This implied that the performance of male students was better than the performance of female students in computer science using computer-managed instruction. Therefore, there was a difference of 4.08 in the

performance of male and female students taught computer science using computer-managed instruction. Statistically, at 0.05 level of significance, there was a significant difference (0.05 > p < 0.001) in the performance of male and female students taught computer science using computer-managed instruction.

Table 3. Mean and standard deviation of male and female students' performance in computer science using CMI

Gender		Pre Score	Post Score	Difference	Sig.
Male	Mean	10.33	17.11	6.78	
	Std. Deviation	0.25	0.13		
	Minimum	3.00	8.00		
	Maximum	12.00	19.00		
Female	Mean	9.64	12.34	2.7	<0.001
	Std. Deviation	0.44	0.91		
	Minimum	3.00	8.00		
	Maximum	12.00	19.00		
				4.08	

Figure 3. Students' gender performance using CMI
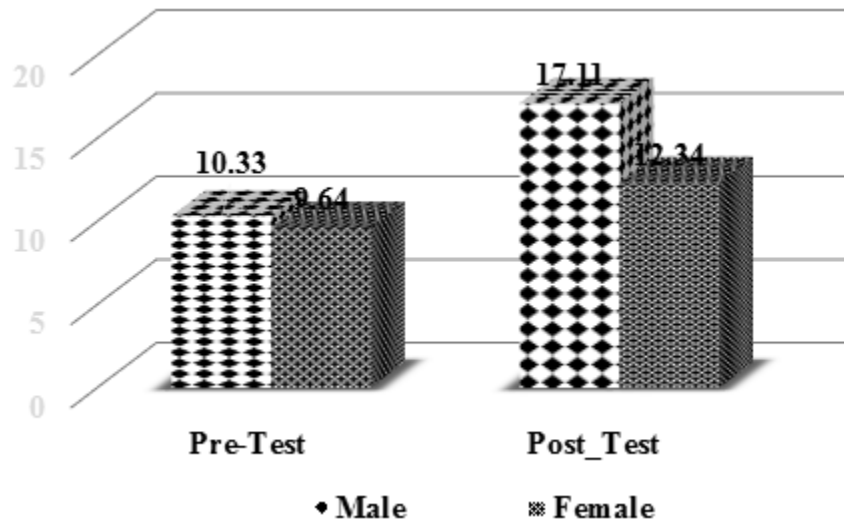
Research Question Three: What is the difference in the performance of public and private schools' students taught computer science using computer managed instruction?

Table 4. Mean and standard deviation of public and private students' performance in computer science using CMI

Institutions		Pre Score	Post Score	Difference	Sig.
Public	Mean	5.83	9.07	3.24	
	Std. Deviation	0.37	0.16		
	Minimum	3.00	8.00		
	Maximum	12.00	19.00		
Private	Mean	6.96	16.17	9.21	<0.001
	Std. Deviation	0.29	0.11		
	Minimum	3.00	8.00		
	Maximum	12.00	19.00		
				5.97	

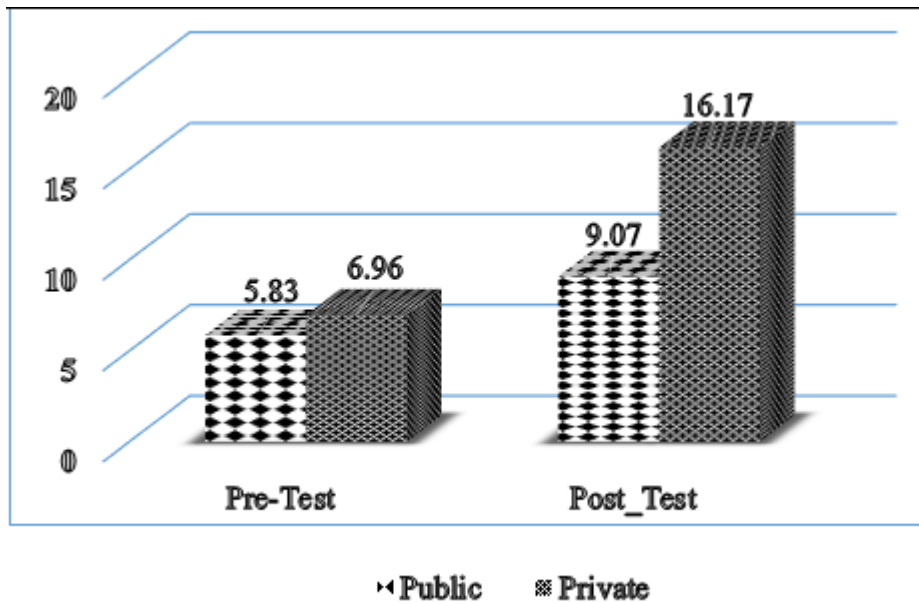*Figure 4. Students' institutions performance using CMI*

Table 4 showed mean and standard deviation analysis of public and private schools students' performance in computer science using computer-managed instruction (CMI). Table 4 further showed that the scores of the participants at the initial stage (pre-test) were fairly equivalent. The participants from public and private institutions had means of 5.83 and 6.96 respectively at the pre-test stage as graphically illustrated in Figure 4. However, in the post-test, the public institutions had a mean of 9.07 while the private institutions had 16.17. In addition, there was a statistical difference of 3.24 in the scores of students in the public institutions between the pre-test and post-test. Similarly, a statistical difference

of 9.21 was noted between pre-test and post-test scores of students from private institutions. The mean difference of students from private tertiary institutions was greater than the mean difference of students from public tertiary institutions. $(9.21 > 3.42)$. This implied that the performance of students in private institutions was better than the performance of students from public institutions in computer science using computer-managed instruction. Therefore, there was a difference of 5.97 in the performance of public and private schools' students taught computer science using computer-managed instruction. Statistically, at 0.05 level of significance, there was a significant difference $(0.05 > p < 0.001)$ in the performance of public and private schools' students taught computer science using computer-managed instruction.

Testing Research Hypotheses

The null hypotheses postulated for this research were tested at 0.05 level of significance as given in the following subsections.

H_{01}: There is no significant difference in the mean performance score of students taught computer science using computer managed instruction and conventional lecture method.

Table 5. ANCOVA post-test on experimental (CMI) and control (TLA) groups

Source	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3.936	2	1.968	36.291	0.000
Intercept	321.943	1	321.94	5937.46	0.000
Post Score	0.116	1	0.116	2.140	0.144
Main Effect	3.797	1	3.797	70.020	0.000
Error	19.357	357	0.054		
Total	2356.040	360			
Corrected Total	23.293	359			

a. R Squared = 0.169 (Adjusted R Squared = 0.164)

Table 5 presents the Analysis of Covariance (ANCOVA) between experimental (CMI) and control (TLA) groups. The table further indicated a computed F-ratio for the main effect of the computer-managed instruction (CMI) and traditional learning approach (TLA) on the mean achievement of students was 70.020 which was significant at P-value of 0.000 (p-value $0.000 < 0.05$). This resulted in the rejection of the null hypothesis of no significant difference in the mean performance score of students taught computer science using computer managed instruction and conventional lecture method. In conclusion, there was a significant difference in the mean performance score of students taught computer science using computer managed instruction and conventional lecture method.

H_{02}: There is no significant difference in the mean performance score of students taught computer science using computer managed instruction based on institutions.

Table 6. Mean and standard deviation of students' performance in computer science using CMI and institutions

Institutions	N	Mean	Std. Deviation
COE	120	9.53	0.53
Poly	120	12.62	0.32
Uni	120	18.46	0.17

Table 6 shows mean and standard deviation analysis of students' performance in computer science using CMI and their respective institutions. The Colleges of Education (COE), Polytechnics (Poly) and University (Uni) had means of 9.53, 12.62 and 18.46 respectively in computer science. These statistical values revealed that the students from the University had the highest mean when compared with the scores of students from Colleges of Education and Polytechnics. However, to test if there is a significant difference between the students' performance in computer science using computer managed instruction and the institutions, the ANOVA statistical test was carried out.

Table 7. ANOVA analysis between students' performance in computer science and institutions

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.486	4	0.372	6.049	0.000
Within Groups	21.807	355	0.061		
Total	23.293	359			

Table 7 shows the Analysis of Variance (ANOVA) between students' performance score in computer science using computer-managed instruction (CMI) and the institutions. Table 7 further indicated the F-value of 6.049. The tested p-value of 0.05 was greater than the computed –p-value ($p < 0.0001$). These statistical values led to the rejection of the postulated null hypothesis. Therefore, there was a significant difference in the mean performance score of students taught computer science using computer managed instruction based on institutions.

DISCUSSION

The analysis of the first research question revealed that the computer-managed instruction (CMI) was effective in learning computer science among the students of tertiary institutions in the North-central geopolitical zone of Nigeria than the traditional learning approach (TLA). It was discovered that there was a significant difference between the use of computer-managed instruction (CMI) and traditional learning approach (TLA) to learn computer science. This study has similar results with Adewole and Frank (2013), who discovered that the computer managed instruction was statistically more significant than the traditional teaching method with regard to students' performance in Physics. The cumulative performance score of students in the CMI group was higher than the performance score of students

who did not use CMI to learn computer science. In addition, this finding further supported Adel (2015) that recorded higher scores for middle school students that used computer managed instruction to learn Computer Science in Saudi Arabia. The second research question focused on the difference in the performance of male and female students taught computer science using computer-managed instruction. The findings revealed that the performance of male students was higher than the performance of female students in computer science when computer-managed instruction was engaged. This result was akin to Okwuduba, Offiah and Madichie (2018) who recorded higher achievement for male students in chemistry than the mean achievement score of the female students using computer simulations. It was discovered that there was a statistical difference in the performance of male and female students taught computer science with the aid of computer-managed instruction. The third research question was on the difference in the performance of public and private schools' students taught computer science using computer-managed instruction. The researchers gathered that the performance of students in private institutions was higher than the performance of students from public institutions in computer science when computer-managed instruction was used. In Yildirim, Ozden and Aksu (2011), it was highlighted that private schools' students performed better than the public schools' students in Social Studies when computer-managed instruction was used to teach. This was an indication that the computer-managed instruction would be effective for the teachers and students at different levels of education and for different subjects of study, particular at the tertiary institutions.

In the testing of the null hypotheses postulated for the research, the findings revealed that there was a significant difference in the mean performance score of students taught computer science using computer managed instruction and conventional lecture method, the students from the University had the highest mean when compared with the scores of students from Colleges of Education and Polytechnics, and there was a significant difference in the mean performance score of students taught computer science using computer managed instruction and the institutions. The findings of this research agreed with that of Yoohang (2014), Andrew (2015), and Yerri and Henry (2016) which revealed that a group of students that used computer managed instruction was more successful in academic performance than their counterpart that used traditional teaching method in tertiary institutions.

FUTURE RESEARCH DIRECTIONS

The results of this research have strong implications for learning computer science in Nigeria and across the world at large using computer-managed instruction (CMI) approached. The ultimate consequence of this research was that CMI could make the performance scores of students in tertiary institutions to be higher and better than the traditional method of learning using chalkboard, papers and writing materials such as pencils, biro. Principally, the empirical findings and reports provided would serve as pieces of literature for scholarly examination and further investigations on the related subject matter.

Based on the findings of this research, the following recommendations were made:

i.   Financial support to assist the institutions in procuring facilities such as computers, computer-managed instruction (CMI) software should be provided to the enhancement of students' academic performance.

ii.   Qualified teachers that have deep knowledge of computer-managed instruction (CMI) to teach computer science should be employed to stimulate students' interest in learning.

iii. Standby generators should be provided to tackle the problem of power supply interruption during teaching and learning process.
iv. Technical support should be provided for the effective use of computer-managed instruction (CMI).
v. Adequate infrastructures such as buildings and laboratories should be provided in the institutions to facilitate the use of computer-managed instruction (CMI) in learning computer science.
vi. The effects of CMI on other courses in the tertiary institutions should be investigated towards promoting effective students' learning experiences.

CONCLUSION

The significance of computer-managed instruction (CMI) could not be over-emphasized. The effectiveness of computer-managed instruction on students' performance in tertiary institutions was investigated among the students of tertiary institutions in the North-central geopolitical zone of Nigeria. Students were selected from three types of tertiary institutions, Colleges of Education, Polytechnics and University. The students were grouped into experimental and control groups, tests were conducted and the results were analyzed. The researchers discovered that the computer-managed instruction (CMI) was effective in learning computer science among the students of tertiary institutions. The male students performed better than the female students in computer science when computer-managed instruction was engaged. It was highlighted that the performance of students in private institutions was higher than the performance of students from public institutions in computer science when computer-managed instruction was used. Conclusively, there was a significant difference in the mean performance score of students taught computer science using computer managed instruction and conventional lecture method, and the students from the University had the highest mean when compared with the scores of students from Colleges of Education and Polytechnics.

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KEY TERMS AND DEFINITIONS

Computer: An electronic device designed and implemented to sequentially accept, process and store data on the basis of a predefined set of instructions to produce valuable information.

Computer-Managed Instruction: This is a computer application software that is used the by learner to acquire relevant skills without depending on the instructions of teachers.

Effectiveness: The degree of attainment of stated objectives towards desired results.

Institutions: An organization where teaching and learning are experienced by the teachers and learners on specific areas of needs.

Performance: A measurement of completion of a task with specified knowledge, skills, and abilities.

Students: A group of learners enrolled in an institution for acquisition of specific learning experiences.

Tertiary: A higher institution of learning after post-secondary education.