

**EFFECT OF COMPUTER ASSISTED INSTRUCTION ON
SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT
IN CHEMISTRY IN UMUAHIA ABIA STATE**

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Abstract

This paper investigated the effect of Computer Assisted Instruction (CAI) on secondary school students' academic achievement in Chemistry in Umuhia Education Zone, Abia state. Quasi experimental design was adopted for the study. The sample size comprised 92 senior secondary school (SS2) students drawn from population of 8867 students in the study area. Two research questions were raised and two null hypotheses were formulated for the study. Chemistry Achievement Test (CAT) was used for data collection. The instrument was validated by three experts in Chemistry and Science Education (measurement and evaluation) and a reliability coefficient of 0.84 was established using Kuder-Richardson formula 20 (KR_{20}). Mean and standard deviation were used to answer the research questions while analysis of covariance was used to test the null hypotheses at 0.05 level of significance. Results revealed that students taught using CAI performed significantly better than those taught using conventional method. There was no significant difference between the mean achievement score of male and female students taught Chemistry using CAI. Based on the findings, it was recommended that professional bodies like Science Teacher Association of Nigeria (STAN), Teachers Registration Council of Nigeria (TRCN) and Association of Educational Researchers and Evaluation of Nigeria (ASSEREN) should organize seminars, conferences and workshops where teachers should be trained in the knowledge and skills of effective implementation of computer-assisted instruction in schools since it facilitates academic performance of secondary schools students and teachers should adopt this method in teaching of Chemistry since it is not gender biased. This will help to reduce discrepancies always observed in achievement of male and female science students.

Keywords: *Computer Assisted Instruction, Gender, Conventional Method. Chemistry teaching*

Introduction

Chemistry as a science subject plays a vital role in transforming the environment and improving the general quality of life. It is essentially needed for a nation's technological development. As a core science subject, the proper teaching and learning of chemistry in secondary schools facilitate students' enrollment in many professional disciplines like Nursing, Medicine, Pharmacy, Agriculture, Engineering and Geology among others. Hence, there is the need for effective teaching and learning of Chemistry in Nigerian secondary schools. For teaching and learning of Chemistry to be effective, the classroom environment has to be conducive to both teachers and students. Chemistry as an important science subject is taught in many secondary schools in Nigeria as a single subject at senior secondary school level. Yet, in spite of all the benefits derived from Chemistry, students' performance in Chemistry at the senior secondary school certificate examination in the last few decades is still low. Ajayi and Ogbeda (2017), Balogun (2018), and Akinyele (2019), all noted poor academic achievement in Chemistry in particular. Amoke (2020), noted that in 2018 and in 2019, of all the candidates who sat for senior secondary school chemistry examination, more than half of the students performed very poor in Chemistry that they could not use their result in Chemistry for further studies. Also WAEC annual report (2018, 2019 and 2020), noted poor academic achievement in Chemistry which manifested in constant poor grades and repetition of classes. Thus, one tends to question why the general unsatisfactory academic performance in Chemistry among the secondary school students. These poor performances in Chemistry have made some researchers to study the problem with the hope of finding the causes and possible solutions.

Science education at all levels is plagued by very many kinds of problems which include, under funding of science education; lack of adequate and appropriate instructional materials; lack of functional equipment; poor method of teaching; inadequate trained science teachers and laboratories that exist in dilapidated buildings (Akinsola, 2011). Chemistry as a core science subject is not counted out from the under listed problems. These problems lead to serious educational setbacks which invariably lead to low rate of secondary school students' science achievement in Nigeria.

Teaching of Chemistry requires making necessary provisions for students' active participation in the learning process so that they will be able to connect scientific theories and concepts to real purpose and practices in the world in which they live (Olorukooba, Lawal and Jiya, 2012). Among the methods and strategies for teaching science are problem-solving method, expository method, peer tutoring, guided inquiry approach, demonstration and cooperative learning among others.

Assortment and utilization of appropriate instructional methods and use of relevant instructional materials are the basic condition for successful teaching and learning of science. However, teaching of Chemistry in schools and colleges has been done by old and obsolete methods. For instance, the conventional lecture method used in teaching Chemistry entails verbal presentation of scientific facts, concepts and principles to students' attention on the key points in the lesson and may use graphs diagrams or other representations to elaborate on the subject matter (Okoli and Egbunonu, 2012). This predominant use of conventional methods does not enhance the understanding of chemistry concepts by secondary school students. This is because conventional methods do not take care of the individual differences in the students and does not actually involve the students in the learning process (Ahmad, 2010). Although the methods have the advantage of being less tasking, allows for wider coverage of content within a short time but it does not always produce positive learning outcomes in Chemistry.

The speed with which the technical world is moving has left no alternative but to adopt the new tools for teaching Chemistry. The time has come when we have to create new ideas to show to chemistry students, to give them live show of Chemistry concepts, to tell them what is actually happening in a flask and the mere change in colour in chemical reaction is not Chemistry but a whole process involved in changing the colour in chemical reaction is Chemistry. Here technology comes to rescue. Technology in form of Information Communication Technology (ICT) can be harnessed to improve and simplify teaching and learning of Chemistry. Jamilu (2015) reported that teaching some chemistry concepts with the aid of computer and other ICT devices to plan and present lessons has contributed a lot in teaching and learning among secondary school students.

Computer-Assisted Instruction (CAI), as the name suggested, is the use of computer to plan and provide instruction. CAI is an application of computer software package in instructional process. Aultant and Abdullahi (2016)

define computer assisted instruction as the integration of hardware and software to develop an instructional material. Thus, computer assisted instruction packages represent some aspects of reality in a simpler way that one is unable to present directly to the students. CAI brings several potential benefits as a teaching and learning medium; these include self-paced learning, self-directed learning, the exercising of various senses and the ability to represent content in a variety of media (Jamilu, 2015). According to Fletcher (2010), people remember 20% of what they hear, 40% of what they see and hear and 75% of what they see, hear and do. The fact that computer can exercise various senses and present information in a variety of media can enhance the learning process of students. Meskill and Mossop (2017) report that computer encourages learning as they provide a stimulating environment and promote enthusiasm. Computer may help the reticent student who is afraid to make mistakes in a classroom situation (Chun, 2014; Meskill and Swan, 2016). According to Nsofor and Nasiru (2013) the use of computer dominated human activities especially in the last two decades.

There are conflicting reports in literature concerning effect of teaching strategies on students' academic performance. Some strategies like cooperative learning have been found to enhance male and female academic performance in Chemistry (Okoli and Egbunonu, 2012; Okoli, 2015; & Spencer, 2016). Similarly, Onasanya, Daramola and Asuquo (2016) in another study found and reported that students taught using CAI package performed better than those taught using the conventional method. However, Hall (2010); Bayrak, Kanli and Kandilingec (2017) did not find any difference between the performance of students taught with computer assisted instruction and those taught with traditional lecture method.

Besides differences in achievement between high and low ability student's gender difference is often reported in science achievement test. Jamilu (2015) maintained that gender is another major factor that influences the performance of students in Chemistry. They also state that boys outperformed their female counterparts in the different science subjects. Abdulmalik (2015) reported that gender differences in Chemistry achievement exist, but it is reducing over the years. Therefore, the issue of gender cannot be overlooked in this study, since most of the schools in the study area are coeducational with mixed classes of boy and girls. Gender issues have been linked with students' performance in science subjects but without any definite conclusion. Some studies revealed that male students performed better than the female in science courses. For instance, Kost, Pollock and Finkelstein (2019) found that male students

performed better than female in interactive Physics, while Ezeliara and Anagbogu (2017) found that female students performed better than their male counterparts using science process skills methods of teaching. However, Gambari, Folade, Fagbemi and Idris (2012) reported that gender had no effect on students' academic performance. The present study, investigated senior secondary school students achievement in Chemistry and ascertained whether there was gender differences in the students when taught Chemistry using computer-assisted instruction.

In spite of the need for scientific and technological development, coupled with the fact that Chemistry is a very vital subject for scientific and technological development of a nation and as such, its teaching and learning as well as students' poor academic performance have become a source of concerns to all stakeholders. Many factors such as lack of science equipment for practical, inadequate qualified Chemistry teachers and use of inappropriate teaching methods by Chemistry teachers have been identified by researchers like Ezeugo and Agwagah (2010) and Spencer (2016) as contributing to student's poor performance in Chemistry. The problem of the present study is to investigate the effects of using computer-assisted instruction on secondary school students' achievement in Chemistry. The purpose of this study was to determine the effect of computer assisted instruction (CAI) on secondary school students' academic achievement in Chemistry in Umuahia Education Zone, Abia state.

The following research questions guided the study:

1. What are the mean achievement scores of students taught chemistry concepts using computer-assisted instruction and those taught the same concepts using conventional method?
2. What are the mean achievement scores of male and female students taught chemistry concept using computer-assisted instruction?

The following hypotheses were formulated for the study and tested at 0.05 level of significance

H₀₁ There is no significant difference between the mean achievement scores of students taught chemistry concepts using computer-assisted instruction and those taught the same concepts using conventional method

H₀₂ There is no significant difference between the mean achievement scores of male and female students taught chemistry concepts using computer-assisted instruction.

Method

The design of the study was quasi-experimental research design. It utilized the non-randomized pre-test post-test control group design. Intact classes were used to avoid disruption of the class. The target population for the study consisted of all the SS2 Chemistry students in Umuahia Education Zone, Abia State. The total population of SS2 students is eight thousand eight hundred and sixty-seven (8,867) according to the Abia State Ministry of Education, Research and Statistics Units, 2022. The sample of the study involves ninety-two (92) SS2 Chemistry students drawn from the study population. Two Local Government Areas were selected using simple random sampling through balloting and from each Local Government Area; one school was randomly selected to participate in the study from each Local Government Area. One school was assigned as experimental (Computer Assisted Instruction) group and the other as control (Conventional) group. The CAI was used for the treatment group. The researchers developed Computer-Assisted Instruction (CAI) Chemistry Package with the assistance of a professional programme developer using Dream weaver and flash that is written in Hypertext Markup Language (HTML) with illustrations converted to Graphic Interchange Format (GIF). Intrinsic programming sequence in which single alternative frame (animations, sounds and text) exist to reinforce concepts that appear difficult to some students was adopted. At a consistent portion of each frame, navigation buttons were included. CAI was a self-instructional because students take active roles in learning the processes while the chemistry teacher goes round the class to guide the students. It contained four lessons structured into modules. The CAI package was designed to provide visual and audio information. The CAI package included readiness activities and brief summary of previous lesson. It also contained the instructional content, series of questions related to instructional content and then followed by a summary of the content. The visuals sound and pace and the language were considered appropriately. CAI was installed on desktop computers. Other applications such as internet access, games, and so on were removed to avoid distractions. The sampled subjects for each school were intact classes of forty-five (45) students for experimental and forty-seven (47) students for control group.

The instrument for the study was Chemistry Achievement Test (CAT), comprised of 50 multiple choice tests items developed based on electrolysis as it's in the curriculum. The Chemistry Achievement Test (CAT) was used to establish the base line of students before the commencement of the treatment. The posttest was used to determine the effect of computer assisted instruction on students' achievement in Chemistry. The instrument was subjected to both

content and face validity, the content validity was established by ensuring that the test reflected the test blue print. Face validity was established by subjecting the instrument to three experts in the area of Chemistry and Science Education (Measurement and Evaluation) for scrutiny. To ensure the consistency of the items, reliability of the instrument was established. The instrument was administered to another set of respondents (25 students) in Aba Education zone who were not part of the respondents in the main study. The scores obtained were analysed using Kuder-Richardson formula 20 (KR₂₀). A reliability coefficient of 0.84 was obtained. Mean and standard deviation were used to answer the research questions while analysis of covariance was used to test the null hypotheses at 0.05 level of significance.

Results

Table 1: Mean achievement scores of students taught chemistry concepts using computer-assisted instruction and those taught the same concepts using conventional method

Teaching Method	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
Experimental	45	42.250	5.467	73.462	7.665	31.212
Control	47	43.745	5.632	47.547	5.973	3.802
Mean difference		-1.495		25.915		

Result in Table 1 indicated that the pre-test mean achievement score for experimental group and control group were 42.25 and 43.74 with standard deviation of 5.46 and 5.63 respectively and mean difference of -1.49 at pre-test. This indicated that both experimental and control groups were relatively at the same performance before treatment. However, the post-test achievement mean scores for experimental and control groups were 73.465 and 47.44 respectively with standard deviation of 7.66 and 5.97 respectively with mean difference of 25.91. The higher mean gain score of experimental group of (31.21) over control group of (3.80) indicated that students taught Chemistry using computer-assisted instruction performed better than those taught the same concepts using conventional method.

Table 2: Analysis of Covariance (ANCOVA) for the mean achievement scores of students taught chemistry concepts using computer-assisted instruction and those taught the same concepts using conventional method

Source of variation	Sum of Squares	Df	Mean Square	F	p-value
Corrected Model	10959.803 ^a	2	5479.902	55.403	.000
Intercept	9519.316	1	9519.316	96.242	.000
PRETEST	2967.443	1	2967.443	30.001	.000
GROUP	9984.920	1	9734.204	98.415	.000
Error	9198.651	91	98.910		
Total	63340.660	94			
Corrected Total	31670.33	93			

a. R Squared = .782 (Adjusted R Squared = .612), S = Significant

Source: Field Survey 2022

Result of data analysis in Table 2 shows that the probability value associated with the calculated value of F (98.415) for the mean achievement scores of two groups of students taught Chemistry using computer-assisted instruction and conventional methods is 0.000. Since this value (0.000) is less than the 0.05 alpha when tested at 0.05 level of significance, the null hypothesis is rejected. Hence, there was a significant difference between the academic achievement of students in Chemistry when taught using computer-assisted instruction and those taught the same concepts using conventional method. This result indicated that computer-assisted instruction is better to conventional method in enhancing students' achievement in Chemistry.

Table 3: Mean achievement scores of male and female students taught chemistry concept using computer-assisted instruction

Groups Method	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
Male	24	40.653	5.378	72.453	6.431	31.800
Female	21	40.951	5.396	72.861	6.279	31.910
Mean difference		-0.298		-0.408		

Source: Field Survey 2022

Table 3 indicates that the pre-test male and female mean achievement scores for experimental group were 40.653 and 40.951 with standard deviation 5.378 and 5.396 respectively and mean difference of -0.298. However, the post-test male and female mean achievement scores were 72.453 and 72.861 with standard deviation of 6.431 and 6.279 respectively. The higher mean gain achievement scores of males (31.800) and females (31.910) in experimental group indicated that male and female students taught Chemistry using computer-assisted instruction had equal performance. Therefore, CAI enhances student's achievement in Chemistry irrespective of gender.

Table 4: Analysis of covariance on the mean achievement scores of male and female students taught Chemistry concept using computer-assisted instruction

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	900.048 ^a	2	450.024	4.955	.049
Intercept	671.064	1	671.064	7.389	.023
Gender	592.023	1	592.023	6.518	.035
Retention	126.655	1	126.655	1.395	.343
Error	3996.259	42	90.824		
Total	10772.002	45			
Corrected Total	5386.001	44			

Data in Table 4 shows that the F-ratio of 1.395 was obtained with exact probability value of 0.343 at alpha level of 0.05. However, since the alpha at 0.05 is less than the p-value at 0.343 ($p > 0.05$). The null hypothesis is thereby accepted. This implies that there is no significant difference between the academic achievement of male and female students in Chemistry when taught using computer-assisted instruction. This implies that treatment has no effect on gender of Chemistry students mean gain achievement scores.

Discussion

Finding of this study showed that Chemistry students taught using computer-assisted instruction performed better than the counterparts taught using conventional method. The corresponding hypothesis affirmed there was a significant difference between the academic achievement of Chemistry students taught using computer-assisted instruction and those taught the same concepts using conventional method. This result indicated that computer-assisted instruction is better than conventional method in enhancing students'

achievement in Chemistry. This finding is in agreement with the findings of Jamilu (2015) which indicated that computer-assisted instructional strategy helped students achieve greater understanding of Chemistry and helped them become more successful in completing academic assignment. The finding is also in tandem with the work of Onasanya, Damamola and Asuguo (2016), in a study conducted on the effects of computer-assisted instruction on the acquisition and retention of high frequency sight words for first grade students in an urban elementary school. Their findings revealed a functional relationship between computer-assisted instruction and improved reading performance for first-grade low-achieving students. The higher performance of students taught Chemistry concepts using computer-assisted instruction was as a result of the ability of the strategy to help students participate actively in the lesson as it involved more senses than just hearing and seeing as in the case of conventional method and a reflection of the remarkable interest which they exhibit.

The findings also revealed that computer-assisted instruction enhanced the achievement of male and female chemistry students. This was shown in their mean gain achievement score which were high in both male and female. The corresponding hypothesis affirmed that there was no significant difference between the academic achievement of male and female students in Chemistry when taught using computer-assisted instruction. This implies that treatment has no effect on gender in chemistry students in their mean gain achievement scores. This report agrees with the earlier reports by Ezeliora and Anagbogu (2017), Jamilu (2015) and Olatoye (2018)' reported that there was no significant difference between students' performance in Biology and Agricultural Science but reported a significant difference in Physics (boys scoring higher). Olatoye (2018) confirmed that, there was no significant difference between male and female achievements in science. The finding of the present study indicates that the use of CAI in teaching of Chemistry is not gender biased.

Conclusion

Teaching and learning in digital age involve application of computer complemented by a lot of other electronic devices, all of which are now collectively regarded as Information Communication Technology (ICT). Teaching Chemistry to students using computer-assisted instruction has helped in bringing them in to the fold of digital age. Students in the experimental group did better than their counterparts in the control group. Hence, computer-assisted instruction can be taken as one of the teaching

strategies that could be used to enhance academic performance of students in Chemistry. The findings of the present study have also revealed that computer-assisted instruction enhanced performance in male and female students, so it is not gender biased.

Recommendations

The following recommendations are made based on the findings.

1. Professional bodies like Science Teacher Association of Nigeria (STAN), Teachers Registration Council of Nigeria (TRCN) and Association of Educational Researchers and Evaluation of Nigeria (ASSEREN) should organize seminars, conferences and workshops where teachers should be trained in the knowledge and skills of effective implementation of computer-assisted instruction in schools since it facilitates academic performance in secondary school students.
2. Teachers should adopt this method in teaching of science especially Chemistry since it is not gender biased. This will help to reduce discrepancies always observed in achievement of male and female science students.
3. Nigerian public schools should be equipped with necessary ICT facilities to leverage the potentials of ICT in Nigerian schools. Also, alternative power supply should be provided in schools by government and non-governmental organization to enhance effective use of ICT, especially in the local areas.

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