Effect of Computer Assisted Instruction (CAI) on Senior Secondary Students' Achievement in Chemical Reaction and Equilibrium in Egbeda Local Government Area of Oyo State

Busari Opeyemi Olanrewaju[*], **Ernest Seigha Better, Ugwuanyi Priscilla Ngozi**

Department of Science Education, Federal University of Technology, Minna, Nigeria

Email address:

yemyworld@yahoo.com (B. O. Olanrewaju)
[*]Corresponding author

Abstract: This study is an examination of the effect of the Computer Assisted Instruction (CAI) on senior secondary school students' achievement in chemical reaction and equilibrium. The study employs a pre-test, post-test non-randomized control group design. The sample size of the study comprises of 24 males and 31 female students (N =55). Simple random sampling was used to assign intact classes to experimental and control groups, while purposive sampling was used to select 3 public senior secondary schools in Egbeda, LGA of Oyo State used for the study. The instrument used for the study is the Chemical Reaction and Equilibrium Achievement Test (CREAT). The students' scores from CREAT were collected and analysed using mean and standard deviation to answer the research questions and ANCOVA was used to analyse data for testing the hypotheses at 0.05 level of significance. The result shows that there is a significant difference between the mean achievement of students taught chemical reaction and equilibrium using CAI and those taught same using conventional teaching strategy (P=0.003 < 0.05). Conversely, there is no significant difference in mean achievement between male and female students taught chemical reaction and equilibrium using CAI strategy (P =0.316 > 0.05). Based on the findings, the study recommends that, government should increase funding for the entire educational sector in order to procure reasonable number of computers and its software like CAI and develop policy that will see to the judicious use of this items for senior secondary school to enhance teaching and learning with CAI strategy to aid achievement in chemistry.

Keywords: CAI {Computer Assisted Instruction}, Chemistry Achievement, Chemical Reaction and Equilibrium, Gender

1. Background of Study

Chemistry plays a major role in the development of scientific base of a country and Nigeria is not an exception. Despite the increasing importance of chemistry to the unfolding world, the performance of Nigerian students has taken a nosedive. However, it is disappointing to note that the students 'performance in chemistry at internal and external examination has remained considerably poor despite the relative importance of chemistry (Saage, 2010).

Observation over the years is that students' achievement in chemistry at Senior Secondary School level (SSCE) has not been very encouraging. According to WAEC, [2013], candidates that offered chemistry performed poorly in the areas of understanding of the concepts of equilibrium of reversible reaction, writing of formulae and correct balanced chemical equations as well as explanation of basic chemical principles, concepts and their applications. Chemistry is one of the subjects in which the students' achievement at the SSCE level has remained persistently low in recent time [WAEC, "Chief examiners' report may/June West African Senior School Certificate Examination. Abuja: FME Pub, 2012].

The poor performance of students in chemistry at SSCE is attributed to a number of factors ranging from teachers' attitude, the learners' attitude, and the curriculum, method of instruction and instructional materials, mathematical deficiency among others [WAEC, "Chief examiner's report

May/June West African Senior School Certificate Examination", Lagos: WAEC Pub, 2003]. The problem of underachievement in chemistry is of great concern to the government, parents, chemistry teachers and researchers in chemistry and several attempts have been made to tackle the problem. These attempts focused more on methods adopted for teaching. For instance, Masek and Yamin, [2012] found that students' critical thinking ability in the problem based learning (PBL) group had not been significantly different from their counterparts in the conventional approach group, an indication that most of the so called innovative strategies have not given us the needed result. Though tried with other science subjects, the use of the Computer Assisted Instruction (CAI) is not common in chemistry especially at the SSCE level which is the focus of this study.

The Computer is an electronic device used for executing precisely stated rules with accuracy, rapidity and with real reliability. According to Eriba in Unongo, [2009], computer is capable of making calculation, storing information in various fields of study, designing devices, and making graphical representation of engineering parts and providing leisure in form of music. Studies have shown that computer self-efficacy has a positive effect on information literacy self-efficacy. Tuncer, [2013] and Geban, Askar, and Ozkan [2002] as well as Inci, John, Nilgun and Ozge [2006] and Mudasiru and Adedeji, [2010] all found the use of the computer in teaching to improve student's achievement in chemistry and other sciences. However, integration of ICT into education system in Nigeria is still relatively poor.

Implementation of CAI as teaching strategy in schools is one prominent aspect of use of ICT worldwide. In classroom, CAI holds the promise of carrying the learners along as well as making them active rather than passive participants, stimulating their interest through visual representations that catches their attention to explore especially in the field of sciences. The fact that CAI could be tailored to meet target audience presupposes that it is adaptable, which renders its usage wide acceptance.

Other factor among many that could be indirectly or directly related to student's achievement in chemistry is gender. Result from research findings have revealed that male students perform better than the females in physics, chemistry and biology generally [2010] while Agwagah as cited by Olom, [2010] revealed significant difference in achievement in favour of the females. Researcher such as Aiyedun, [2000] found no significant difference in the performance of boys and girls in mathematics. Thus there may be need to try the use of the CAI so as to be well informed of the achievement of male and female students. The purpose of the study therefore was to investigate the effect of the CAI on students' achievement in senior secondary chemical reaction and equilibrium in Egbeda Local Government Area of Oyo State of Nigeria.

1.1. Statement of the Problem

Student's failure in chemistry examinations pose a lot of threat not only to science teaching and learning but also to technological development of Nigeria both now and in the future. Some factors may be responsible for the massive failure of students in chemistry examinations. These factors could be in the abstract nature of the subject which explains why many concepts including chemical reaction and equilibrium are found difficult by students. Reports in literature indicate clearly that students have difficulty answering questions requiring specific learning skills in chemical reaction and equilibrium.

Efforts have been made by science educators, researchers and stakeholders like STAN to provide solutions to the problems of learning difficulties in chemical reaction and equilibrium, but little or no efforts have been directed to the problems of learners in relation to the specific areas of difficulties in the subject matter contents, factors associated with the experienced difficulties, and ways of remediating the learning difficulties which students experience. This explains why there has perhaps been no marked improvement in students' achievement in chemistry, in spite of efforts by professional bodies like STAN at teacher capacity improvement.

1.2. Purpose of the Study

According to Skinner, [1953], nearly all identifiable human behaviours fall into two categories namely; respondent and operant behaviours. Respondents' behaviours are involuntary (reflex) behaviours and result from special environmental stimuli. Skinner further posits that in order for behaviour to occur, it is first necessary that a stimulus be applied to the organism. Only a few of human behaviours are respondent behaviours.

Appropriately, computer based instruction can be applied as a stimulus to the students' responses of interest, motivation and consequent achievement in chemistry learning. In the same way, the design of computer based instruction programme makes immediate feedback as response to the chemistry student to stimulate him or her to generate commitment to the learning using his or her present status as a basis. This Skinner stimulus-response and the response-stimuli theory provide a strong framework for computer based instruction innovation.

In the computer facilitated learning, students' behaviours are reinforced by being permitted to proceed to the next frame when they get the right answer, [2005]. Ogunz, [2011] indicates that skinner illustrated how to develop programmed learning sequence which is being used directly to design tutorial modules.

1.3. Research Questions

The following research questions are raised to guide the study:
1 To what extent does the use of CAI in teaching chemical reaction and equilibrium improve students' achievement as against the use of conventional method?
2 What is the achievement of male and female students

who are exposed to CAI method in chemical reaction and equilibrium?

1.4. Research Hypotheses

The following hypotheses are formulated for this study and were tested at 0.05 level of significance:

1 There is no significant difference in the mean achievement scores of students taught chemical reaction and equilibrium using conventional method and those taught using CAI.
2 There is no significant difference in the mean achievement scores of male and female students taught chemical reaction and equilibrium using CAI strategy.

2. Methodology

A quasi-experimental design was employed for the study. Specifically, the non-randomized control group, pre-test, post-test design was adopted for the study. A total of 210 senior secondary (SS 2) students were drawn from 6 public schools in Egbeda, Local Government Area of Oyo State. This comprises of 98 males and 112 female students. The number of students taught chemical reaction and equilibrium were made of 55 students that consist of 24 males and 31 female students. 25 students were taught using CAI, while 30 students were taught using conventional strategy.

The sampling was done by random sampling of 4 intact classes from 4 schools that have computer facilities out of the 6. Similarly, by random sampling 2 classes were assigned to experimental group and the other 2 to control group. Accordingly, the respective chemistry teachers in each of the schools who were previously trained and ascertained to meet the selection criteria were used. Thus a total of 4 graduate chemistry teachers (2 in each study group) were engaged.

A 20 items multiple choice questions constructed by the researchers were patterned after West African Examination Council (WAEC) Senior School Certificate Examination Chemistry paper 2 called Chemical Reaction and Equilibrium Achievement Test (CREAT). It was validated by two experts from the department of curriculum and teaching. They were requested to do face, content and construct validity. Their comments further improved the quality of the instrument. From the trial testing the reliability of the instrument was determined using the Spearman-Brown Split-half reliability and was found to be 0.85. Thus the instrument was considered good for use based on literature. The students in experimental and control groups were both exposed to Chemical Reaction and Equilibrium Achievement Test (CREAT) as pre-test. The control group students were taught using the conventional strategy while the experimental group was taught using CAI strategy. The treatment for all the groups lasted for two weeks. Each group had equal contact hours (2hrs per week) with the students. While it took longer time to teach the CAI group because of its individualized nature, the control group used the same time but spread into teaching, interaction time and drawing summary of each lesson. After the treatment, the two groups were exposed to the CREAT which has been reshuffled as post-test. The mean and standard deviation were used to answer the research questions while data for the hypotheses were analysed using the Analysis of Covariance (ANCOVA) and testing done at 0.05 level of significance.

The CAI was developed jointly by the researcher, two experienced chemistry teachers and a computer expert reflecting relevant contents of chemical reaction and equilibrium. It was made interactive such that the learners could be engaged in dialogue and feedbacks provided immediately to enable learners proceed.

3. Results

Research question 1: To what extent does the use of CAI in teaching chemical reaction and equilibrium improve students' achievement as against the use of conventional method?

Data relevant to the research question one are presented in Table 1.

Table 1. *Mean, Standard Deviation of Pre-test and Post-test Scores of Students taught with CAI and conventional strategy.*

Variables	N	Type of Test	Mean	S. D
Experimental Grp	25	Pre-test	11.00	0.764
		Post-test	15.68	1.909
Conventional Grp	30	Pre-test	6.77	1.305
		Post-test	12.90	1.918

Table 1 shows that the Pre-test mean achievement scores of students in the CAI method (Experimental) is 11.00 with a standard deviation of 0.764, while the conventional strategy has mean and standard deviation of 6.77 and 1.305 respectively. Results further shows that the Post-test mean achievement score and standard deviation in the CAI method (Experimental) are 15.68 and 1.909 respectively, while the conventional strategy has a mean score of 12.90 and standard deviation of 1.918. This implies that students in both methods improved in the achievement after treatments, however students in the CAI (Experimental) gained by mean achievement difference of 4.68 while those in the conventional strategy gained 6.13. Thus, the Post-test mean difference shows the students taught with CAI performed better than students taught with the conventional strategy.

Data relevant to the research question two are presented in Table 2.

Table 2. *Mean and Standard Deviation of Pre-test and Post-test scores of Male and Female Students in CAI (Experimental) method.*

Variables	N	Type of Test	Mean	S. D
Male	11	Pre-test	11.00	0.894
		Post-test	15.27	2.005
Female	14	Pre-test	11.00	0.679
		Post-test	16.00	1.840

Table 2 shows the Pre-test mean achievement scores of male to be 11.00 with standard deviation of 0.894, while the female has mean achievement scores and standard deviation of 11.00 and 0.679 respectively. The Table further shows the

Post-test mean achievement scores and standard deviation of male to be 15.27 and 2.005 respectively, while female has a mean achievement score and standard deviation of 16.00 and 1.840. The Post-test mean difference between male and female is 0.73 in favour of the female. This means that the female students performed slightly better than their male counterparts in CAI strategy.

Data relevant to research hypothesis 1 are presented in Table 3.

H_{01}: There is no significant difference in the mean achievement scores between students taught chemical reaction and equilibrium using conventional method and those taught using CAI.

Table 3. *Tests of Between-subjects Effects on Means of Pre-test and Post-test of Students Taught with CAI and Conventional Strategy.*

Source	Type III Sum of Squares	df	Mean Square	F	Sig
Corrected Model	107.548[a]	2	53.774	14.565	000
Intercept	200.819	1	200.819	54.394	000
Pre-test	2.160	1	2.160	585	448
Method	35.618	1	35.618	9.648	003
Error	191.980	52	3.692		
Total	11333.000	55			
Corrected Total	299.527	54			

a. R Squared =.221 (Adjusted R Squared =.150)

Table 3 reveals that there is a significant difference between students taught chemical reaction and equilibrium using conventional method and those taught using CAI with significant level of 0.003 which is less than the α-level of 0.05. This indicates that teaching with CAI method is more effective than teaching with conventional strategy. Hence null hypothesis 1 was rejected, it then implies that there is a significant difference in the mean achievement score of students taught with CAI and those taught with conventional strategy in chemical reaction and equilibrium.

Data relevant to hypothesis 2 are presented in Table 4.

H_{02}: There is no significant difference in the mean achievement scores of male and female students taught chemical reaction and equilibrium using CAI strategy.

Table 4. *ANCOVA Tests of Between Subjects Effects of Pre-test and Post-test Means of Male and Female Students Taught with CAI.*

Source	Type III Sum of Squares	df	Mean Square	F	Sig
Corrected Model	19.330[a]	2	9.665	3.122	064
Intercept	76.375	1	76.375	24.670	000
Pre-test	16.071	1	16.071	5.191	033
Gender	3.258	1	3.258	1.052	316
Error	68.110	22	3.096		
Total	6234.000	25			
Corrected Total	87.440	24			

a. R Squared =.221 (Adjusted R Squared =.150)

Table 4 reveals that gender has no significant effect on students' achievement when taught chemical reaction and equilibrium using CAI strategy with significant level of 0.316 at α-level of 0.05 which implies that the difference is not significant. Therefore, the null hypothesis 2 is retained.

4. Discussion

Achievement of students taught chemical reaction and equilibrium using CAI is significantly higher than those students taught same with conventional strategy. This shows that the use of CAI in teaching chemical reaction and equilibrium can improve students' achievement. This finding agrees with the findings of Geban, Askar, and Ozkan, [2009] and that of Inci, John, Nilgun and Ozge, [2011] which are directly on chemistry. Similarly, the finding agrees with the studies of Mudasiru and Adedeji, [2010] in biology, thus establishing that the CAI is effective in enhancing students' achievement in chemical reaction and equilibrium in chemistry in similar manner as found by the afore mentioned authors in chemistry and biology from previous studies.

It could be explained that the use of CAI as emphasized in the theoretical frame work engages learners, makes them active participants and alert as well as motivates or enhances their interest through constant feedback mechanism. Feedback as noticed in this study could have served as link, how to follow instruction as well as an eye opening to where they must have missed the link or instruction. Thus it was possible for students to improve in their achievement since it acted like a reinforcement and source of stimulation. In similar manner like other innovative student centred methods, students do not only listen but were involved in doing and thinking which are found to aid remembrance and retention. Thus the finding in this study is seen as commensurate with the efforts put in to actively engage learners.

Though the use of CAI might not have been the only variable that must have influenced achievement in this study, the effects of all other variables were to some extent held constant (that is, applicable to both control and experimental groups). Thus, teachers of same qualification and same experience were engaged, initial difference in learners was taken care of by using ANCOVA in data analysis to remove the starting difference. Also, the use of intact classes was expected to neutralize the differences in abilities of learners. Thus it was assumed that Hawthorne Effect was taken care of in the study.

The study revealed that gender has no significant effect on the achievement of students in chemical reaction and equilibrium when taught with CAI strategy. This finding on gender agrees with the earlier findings of Mudasiru and Adedeji, [2010], Husaini and Mohammed, [2012] on gender. Thus it can be said that the use of CAI method enhanced the achievement of both male and female students similarly in chemical reaction and equilibrium. The implication of this finding could be that what matters in teaching and learning is the effectiveness of the instructional strategy. Accordingly, once an instructional strategy is motivating and engages students' attention, it does not discriminate in the performance of males and females. The corollary could be that where male and female students' achievement differs

after teaching, the interactive nature of the method should be questioned.

5. Conclusions and Recommendations

The use of the CAI in teaching chemistry concepts facilitated the achievement of students in chemical reaction and equilibrium better than the use of conventional strategy. The gender difference among students exposed to CAI was not significant implying that CAI is capable facilitating learning in similar manner among male and female students in chemical reaction and equilibrium.

It is recommended therefore that:

1 Computer literacy and operation in the secondary schools should be encouraged while relevant CAI packages should be accorded attention and developed for use within the Nigeria school system. This can be done by bringing experts in chemistry and computer together to design something in line with the senior secondary curriculum.

2 Educational curriculum planners should endeavour to integrate a practical computer application course in their curriculum design for pre service teachers. This will enable them to use computer to teach chemistry and other science subjects effectively.

References

[1] A. J. Idowu and M. Esere, ICT and higher education in Nigeria, Educational Research and Review, 8(21), 2021-2025, academicjournals.org/ERR

[2] A. Masek and S. Yamin, "The impact of instructional methods on critical thinking: A comparison of problem-based learning and conventional approach in engineering education," International Scholarly Research Network; doi: 10. 5402/2012 /759241, 2012.

[3] B. F. Skinner, "Science and human behavior," Macmillan, New York, 1953.

[4] B. T. Danmole, "The influence of teacher preparation and the use of Instructional material on primary school pupils' performance in Integrated science," *Ilorin Journal of Education, 12, 56-64, 2010.*

[5] J. O. Aiyedun, "Influence of sex difference of students on their achievement in Secondary School," *Journal of the Mathematics Association of Nigeria, 25(1), 109-113, 2000.*

[6] M. Inci, H. P. John, S. Nilgun and O. O. Ozge, "Introduction to precipitation and solubility within a computer-enriched module for analytical chemistry", *The Chemical Educators, 11(5), 11-18, 2006.*

[7] M. Tuncer, "An analysis on the effect of computer self-efficacy over scientific research self-efficacy and information literacy self-efficacy*," Educational Research and Reviews,* 8(1), 33-40; academicjournals.org/ERR, 2013.

[8] O. Geban, P. Askar and L. Ozkan, "Effects of computer-simulations and problem-solving approaches on high school students," *Journal of Educational Research, 86(1), 5-10, 2002.*

[9] O. P. Olom, "*Effect of improvised materials on Junior Secondary School two students' achievement and retention in mensuration,* A dissertation in the Faculty of Education, Benue State University, Makurdi, 2010.

[10] O. Y. Mudasiru, and O. A. Adedeji, Effect of Computer Assisted Instruction (CAI) on secondary school student performance in Biology," TOJET: *The Turkish Online Journal of Educational Technology,* 9 (I), 62-69, 2010.

[11] WAEC, **"**Chief examiner's report May/June West African Senior School Certificate Examination", Lagos:WAEC Pub., 2013.

[12] WAEC, "Chief examiners' report may/June West African Senior School Certificate Examination. Abuja: FME Pub., 2012.