



TEACHERS' INSTRUCTIONAL TECHNIQUES AND STUDENTS' RETENTION IN CHEMISTRY

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Abstract:

The study investigated the effect of teachers' instructional techniques on students' achievement and retention in Chemistry in senior secondary schools in Ondo State, Nigeria. The study also determined the effects of the instructional technique on gender achievement in Chemistry. A quasi-experimental design was adopted for the study. The sample for the study consisted of 240 Senior Secondary School Two (SSS II) Chemistry students selected in stages using simple random sampling techniques. Six science intact classes from six senior secondary schools were selected from three senatorial districts in Ondo State. Four formed the experimental class while two formed the control group. The students in the experimental group were exposed to Computer Assisted Instruction (CAI) while the control groups were taught with the conventional teaching method. Chemistry Achievement Test (CAT) was used to collect relevant data for this study. The experimental group was treated using CAI package while the control group was treated using conventional classroom teaching. t-test, ANCOVA (Analysis of Co-Variance) and Multiple Classification Analysis (MCA) were used to test the research hypotheses at a 0.05 level of significance. The result from the study showed that the achievement of students in the experimental group was better than those of their counterparts in the control group, students in the experimental group also retain better than their counterparts in the control group and that gender did not have a significant effect on the retention ability of the experimental group. Based on the findings of the study, it was recommended that the potential of CAI should be utilised to enhance better achievement and retention of students in Chemistry. There should be regular training and re-training of Chemistry teachers on the use of computers so as to improve the method of teaching the subject and the government should establish a CAI promotion department to plan, organise and coordinate efforts to develop and utilise CAI softwares.

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1. Introduction

The current state of secondary school achievement in sciences, especially Chemistry, has been observed to be poor. The West African Examinations Council (WAEC) Chief Examiners' report in recent years has equally corroborated this. If this trend of poor achievement is allowed to continue unabated, it will be difficult to achieve the goals of the science education programme in the National Policy on Education (NPE). Evidence from a study carried out by Moore (2000) points to the fact that science teachers in Nigerian secondary schools predominantly use the conventional method which is considered ineffective when used solely for science teaching. Farrant (as cited by Neboh, 2009) believed that an increase in knowledge lies solely in the ability to remember. He further explained that if an individual could not grasp and keep hold of what was taught and learned, it would seem like trying to fill a bucket without a bottom with water. This means that if one cannot retain what one learned, then there is no need to expect one to perform in that activity in the future. This implies that students' participation in a lesson is a basis for understanding, achievement and retention. For instance, if a student memorizes some principles, concepts, or process in the class and quotes them when the teacher asks, and forget them immediately, the students cannot be expected to remember them in the future.

More so, Ndukwe (2000) in his study on achievement and retention in expository versus project-centred method of instruction in Biology using SSS I students, the result from the retention test given after the treatment showed that there is no significant difference in the two mean scores. Sungur and Tekkaya (2003) findings also agreed with this that there is no significant difference in the acquisition of science process skills when two methods are employed but Erinoshio (2005) investigation is not corroborating this, he found out that there is a significant difference in the acquisition and retention of the science process skills when different methods are employed. The overall achievement and retention in Chemistry and other science are very much related to many other variables which are evident in separate studies carried out by Ogunleye (2010) and Eccles (2002). These include: the ability levels of the learners, gender issues, teaching-learning environment (location), teaching methods, teachers' ability to use the various methods and material provided. It has been observed that effective teaching may facilitate learning and make it more meaningful because it makes the students to learn better while poor teaching would naturally lead to poor learning and consequently poor achievement (Neboh 2009). The basic factors responsible for students' under-achievement in Chemistry and other science subjects can be grouped into teacher related and facility-oriented factors. These factors include materials used, and the teaching method employed among others. Evidence from the literature showed that most science teachers in Nigeria secondary schools predominantly use the conventional method in teaching

science which may be due to poor knowledge and non-exposure to another learner-centered method, leading to poor achievement and retention (Omoniyi, 2006).

In the word of Neboh (2009), retention is a direct correlate of positive transfer of learning. This means that high retention may lead to high achievement which is a factor of many variables such as the interval between learning and retrieval, the special subject involved, teaching methods used, and environmental situations, among others. Researchers, such as Nnadi (2001) and Eze (2002) showed that there was no significant difference between students' mean achievement scores and retention scores while Uduosoro (2002) and Udeji (2007) showed that the methods employed in teaching science led to students' high achievement and retention. Kareem (2015) revealed that innovative methods of teaching such as computer-assisted instruction improved students' achievement and retention. Also, Olakanmi et al. (2016) also found that innovative instructional technique (CAI) makes students achieve better and retain better what they were taught than those taught using conventional method and that the female students achieved and retain better in the CAI-taught group.

However, Eriba and Sesugh (2006) in their study found out that male students achieve and even retain what they learned better than their female counterparts while Iloputaife (2001) and Eze (2001) in their studies on achievement and retention of physics students found that male and female students who offer Physics have no significant difference in their mean achievement and retention in Physics. These findings suggest that there is a need to carry out more studies to clarify issues related to achievement and retention. Since there is no consensus on the effect of teaching methods on students' retention and achievement, there is a need to examine a student-centered activity-oriented method and its effect on achievement and retention and this may include CAI method of teaching in this study. The above-reviewed literature showed that achievement and retention can be unaffected by gender, and instructional technique among others. The present study found out the effect of the method, computer-assisted instruction on retention and achievement.

2. Purpose of the Study

The study investigated teachers' instructional techniques and students' retention in Chemistry.

2.1 Research Questions

The following research questions were raised for the study:

- 1) Is there any difference in the Chemistry mean achievement score of students exposed to CAI and the group not exposed after treatment?
- 2) Will there be any difference in the retention mean scores of the group exposed to CAI and the group not exposed in Chemistry.
- 3) Will there be any difference in the retention mean scores of male and female students exposed to CAI?

2.2 Research Hypotheses

The following null hypotheses were generated for empirical verification:

- 1) There is no significant difference in the Chemistry mean achievement scores of students exposed to CAI and the group not exposed after treatment.
- 2) There is no significant difference in the retention mean scores of the group exposed to CAI and the group not exposed in Chemistry.
- 3) There is no significant difference in the retention mean scores of male and female students that were exposed to CAI.

3. Research Method

The research design for this study is a quasi-experimental design, employing the pretest, posttest control group design. The population for the study consisted of all the Senior Secondary School class II (SSS II) Chemistry students in public secondary schools spread across Ondo State. As of the time of this study, Ondo State has a total number of 590 public secondary schools. There were 11,560 SSS II students offering Chemistry (Source: Ondo State Ministry of Education, Akure). The sample consisted of 240 SSS II Chemistry students found in the intact classes of the six SSS randomly selected from each of the three senatorial districts in Ondo State. Three Local Government Areas (LGAs) were selected from the three senatorial districts in Ondo State using a simple random sampling technique. Four schools formed the experimental group while two schools formed the control group. A science class was chosen using a simple random sampling technique where there was more than one science class. The intact class was used in each of the selected schools. An instrument tagged 'Chemistry Achievement Test (CAT)' was used to collect the relevant data for the study. CAT was a 40-item four optioned multiple-choice questions drawn from topics taught during the treatment (i.e. chemical bonding and the periodic table).

Respondents were asked to choose the most appropriate option for the item. Items on the CAT instrument were selected from senior secondary school examination past questions. Each correct option for each item of the instrument was scored one (1) mark while each incorrect response was scored zero (0) mark. Thus, the maximum score obtainable is 40 marks.

The instructional package used for this study was the Computer-Assisted Instruction software which was developed by the researcher with the aid of programme developer. The software is titled 'Computer Interactive Device (CID)'. The programme was designed in a branched form and responded to instructions. The software was developed using the Rapid Application Development (RAD) model of James Martins approach of 1980. The model consisted of four operational stages of the requirement planning; user design phase; construction phase; cut over or the implementation phase. Text material in the Senior Secondary School Chemistry curriculum used for the study was transformed into CAI software. To transform the text material into software, it was divided into segments suitable for tutorials, and terms and words representing unfamiliar concepts in the text were explained. Multiple-choice items based on tests were

constructed to enhance and assess students' learning. The segmented text material, explanation of unfamiliar terms, was transformed into computer software through the computer language package 'Flash' with the aid of a programme developer. This software is an interactive and user-friendly programme and is composed of CAI tutorials. In each tutorial, text material is presented in one or more windows. After reading the text and explanations, students come across a quiz comprising multiple choice questions with an arrangement of immediate feedback. The CID (software) was installed in the computer laboratory of the experimental schools for the students to be exposed to while the control group is left to the conventional teaching method.

4. Research Procedure

The research procedure was in three stages, namely: pre-treatment stage, treatment stage and post-treatment.

The pre-treatment stage involved taking permission from the school principals, Head of Science Department, and also the SSS II Chemistry teachers involved in the study. It also involved giving orientation to the research assistants on how to administer the instruments. Having done this, the researcher then administered the pretest to the two groups in order to ascertain homogeneity. All these were done during the first week of the experiment.

The treatment stage: At this stage, the experimental group was exposed to the treatment using the Computer Interactive Device (CID) to learn the concepts chosen for the study. During the same period, the control group was also taught the same concept but through conventional methods. This stage lasted for four weeks. At the end of the four weeks, the CAT items were re-arranged and re-administered to both groups.

The post-treatment stage: Immediately after the treatment, the post-test was administered to the two groups respectively; and two weeks after the administration of the post-test, the post-test was re-administered to the two groups to ascertain how much of the concepts learned they could retain. Thus, the whole experiment lasted for seven weeks; One week for pre-test, four weeks for treatment, and two weeks for post-test and retention.

5. Results

H₀₁: There is no significant difference in the Chemistry mean achievement scores of students exposed to CAI and the group not exposed after treatment.

In order to test the hypothesis, the mean achievement scores of students exposed to the use of CAI and the group not exposed in Chemistry were subjected to statistical analysis involving Analysis of Co-Variance at 0.05 level of significance. The result is presented in Table 1.

Table 1: Summary of ANCOVA of students' achievement in Chemistry after treatment

Source	SS	df	MS	F _{cal}	F _{table}
Pre-test	1012.578	1	1012.578	35.608	3.84
Group	1742.069	1	1742.069	61.261	3.00
Error	6739.556	237	28.437		
Corrected Total	9689.183	239			
Total	135456.000	240			

P<0.05

Table 1 shows that F_{cal} (61.261) is greater than F_{table} (3.00) at a 0.05 level of significance. The null hypothesis is rejected. This implies that there is a significant difference in the mean achievement scores of students exposed to the use of CAI and the group not exposed after treatment in Chemistry.

In order to determine the effectiveness of the treatment, Multiple Classification Analysis (MCA) was used. The result is presented in Table 2.

Table 2: Multiple Classification Analysis (MCA)
of students' achievement in Chemistry after treatment

Grand Mean= 58.36					
Variable + Category	N	Unadjusted Deviation	Eta ²	Adjusted for Independent + Covariate	Beta
CAI	146	2.28	.30	2.16	-.35
Control	94	-3.54		-3.35	
Multiple	0.101				
Multiple R ²	0.010				

Table 2 shows that students exposed to CAI had higher adjusted mean score of 25.05 (22.89+2.16) than those in the control group who had an adjusted mean score of 19.54 (22.89+(-3.35)) in Chemistry. This implies that the use of CAI enhances students' achievement in Chemistry. The treatment accounted for 30% (Eta²=0.30) of the observed variance in students' achievement.

H₀₂: There is no significant difference in the retention mean scores of the group exposed to CAI and the group not exposed in Chemistry.

Retention means scores of the group exposed to CAI and the group not exposed in Chemistry were computed and subsequently subjected to statistical analysis involving a t-test at a 0.05 level of significance. The result is presented in Table 3.

Table 3: t-test showing the retention mean scores of students in CAI and control group

Group	N	Mean	SD	df	t _{cal}	t _{tab}
CAI	146	21.50	4.81	238	15.705*	1.960
Control	94	11.97	4.22			

P<0.05

The result in Table 3 reveals that $t_{ca}(15.705)$ is greater than $t_{table}(1.960)$ at a 0.05 level of significance. The null hypothesis is rejected. This implies that there is significant difference in the retention mean scores of the group exposed to CAI and the group not exposed in Chemistry.

H₀₃: There is no significant difference in the retention mean scores of male and female students that were exposed to the use of CAI.

In order to test the hypothesis, retention mean scores of male and female students that were exposed to the use of CAI were obtained and subsequently compared for statistical significance using a t-test at a 0.05 level of significance. The result is presented in Table 4.

Table 4: t-test showing the retention mean scores of students in CAI group by gender

Group	N	Mean	SD	df	t_{cal}	t_{tab}
Male	69	21.10	4.91	144	0.947	1.960
Female	77	21.86	4.73			

$P < 0.05$

Table 4 shows that t_{ca} (0.947) is less than t_{table} (1.960). The null hypothesis is not rejected. This implies that there is no significant difference in the retention mean scores of male and female students that were exposed to the use of CAI in Chemistry.

6. Discussion

The findings of this study show that there was an improvement in the performance of students resulting from their exposure to Computer-Assisted Instruction (CAI). This implies that the introduction of CAI to the experimental group made them to perform better than the control group that was not exposed to CAI. This is in agreement with the assertions of Erinosh (2008), Omoniyi (2006), Neboh (2009), Uduosoro (2002), Udeji (2007) and Kareem (2015) who were of the opinion that innovative teaching method such as CAI improved students' achievement and retention. Also, Olakanmiet al. (2016) study also corroborated this, while Ndukwe (2000), Sungur and Tekkaya (2003), Nnadi (2001) and Eze (2002) were not in agreement with this, they found out that there was no significant difference in the students' mean achievement scores when they were comparing two different methods of teaching on students' achievement. More so, there is a significant difference in the retention mean scores of the students exposed to CAI and those not exposed in which the experimental group retain better than their counterpart in the control group. This is also in concordance with the findings of Farrant as cited by Neboh (2009), Erinosh (2008), Udeji (2007), Kareem (2015) and Olakanmi et al. (2016) who found out that CAI make students achieve better and retain better what they were taught but the findings of Nnadi (2001), Eze (2002) and Sungur and Tekkaya (2003) who revealed that there is no significant difference in the achievement and retention of students in both the experimental and control group.

Findings from this study further revealed that there are no significant differences between the retention mean scores of male and female students that were exposed to CAI. This is not in agreement with Eriba and Sesugh (2006), Suleman et al. (2017) who were of the opinion that male students achieved and even retain what they learn better than their female counterparts but it is in support of the findings of Iloputaife (2001) and Eze (2001) who revealed that there is no significant difference in the achievement and retention of male and female students in Physics, while Olakanmi et al. (2016) found out that female achieved better than their male counterparts.

7. Conclusions

Based on the findings of this study, it could be concluded that the use of innovative teaching techniques like Computer-Assisted Instruction (CAI) in teaching Chemistry is an effective method that enhances better achievement of secondary school students in Chemistry. As effective as the method is, it is not gender biased. The individualization, self-pacing and interactive nature, as well as the incorporation of questions and feedback in the CAI process, made it impart better students' learning of, achievement and retention in Chemistry.

7.1 Recommendations

Based on the findings in this study, the following recommendations are made:

- 1) The potential of Computer-Assisted Instruction (CAI) should be utilized to enhance better achievement and retention of students in Chemistry.
- 2) There should be regular training and re-training of Chemistry teachers on the use of computers so as to improve the method of teaching the subject.
- 3) Government should establish a CAI promotion department to plan, organize and coordinate efforts to develop and utilize CAI softwares.

Conflict of Interest Statement

The author declares no conflict of interest.

About the Author

Dr. Stella K. Ekundayo is a lecturer in the Federal University Oye-Ekiti, Nigeria, with a PhD in Science Education (Chemistry option) and has keen research interest in the use of Information and Communications Technology and Computer Assisted Instructions in the teaching and learning of Chemistry. Orcid: orcid.org/0000-0002-3937-9252

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