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RESEARCH ARTICLE

RELATIVE EFFECTIVENESS OF COMPUTER ASSISTED INSTRUCTION AND CLASSROOM DEMONSTRATION TECHNIQUE IN IMPROVING STUDENTS' PERFORMANCE IN PRACTICAL CHEMISTRY IN SECONDARY SCHOOLS ONDO STATE, NIGERIA

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ABSTRACT

The study examined the relative effectiveness of Computer Assisted Instruction (CAI) and Classroom Demonstration Technique (CDT) on the performance of students in acid/basetitration under volumetric analysis aspect of the O' level practical Chemistry. A pre-test, post-test control group design was used for the study. A sample of 123 SSS II Chemistry students from three secondary schools in their intact classes in Akure South Local Government Area of Ondo State were used for the study. The three classes were assigned to treatment and control groups. The first group comprising 46 students were taught using Computer Assisted Instruction (CAI), the second group comprising 42 students were taught using the Classroom Demonstration Technique (CDT), while the control group comprising 35 students were taught using the conventional lecture methods (LM). A pre-test was administered before treatment, and after four weeks of instruction, a post-test was administered..Data obtained were analyzed using one way Analysis of Variance and t-test. The results showed that there was a significant difference in the performance of students taught CAI and those taught with CDT ($t = 4.95$, $p < 0.05$). Also a significant difference existed in the performance of students that were exposed to CDT and those exposed to LM ($t = 13.80$, $p < 0.05$). There was also a significant difference in the effectiveness of CAI in improving students' performance in practical Chemistry ($F(2,120) = 92.58$, $p < 0.05$). It was therefore concluded that CAI was very effective in teaching acid/base titration in practical Chemistry.

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INTRODUCTION

Chemistry is an important science subject and as such it was named "the central science" by Brown and Lemay in 1977 because it is a servicing subject to other natural sciences like Physics, Biology, Agricultural Science and other science professional courses such as medicine, pharmacy and engineering. Exploitation of the principle of Chemistry has given humanity most of the important things human enjoyed today such as manufacturing of drugs, synthetic fibres used for clothes and synthetic plastics and rubbers in various applications, manufacturing of agricultural products such as fertilizers, pesticides and herbicides. Among the list are chemical and petrochemical industries, water purification and treatment. However, despite the importance of Chemistry to national development and its requirement for many science courses at the university, secondary school students have not been performing well in it in the Senior Secondary Certificate Examination (SSCE) over the years. Table I summarizes the enrolment and performance of students in the West African School Certificate Examination May/June 2008-2012. From this result, it was revealed that the average of students' performance at credit level from year 2008to 2012was 46.10% which is not up to the expected standard, of 80-90%. This is probably attributed to students' poor performance in chemistry in West African School Certificate (WASCE) as practical work constituted about 40% the total work. Also, absence of power of observation on the part of the students, inability to read the meniscus and record data accurately, inability to transfer learnt theoretical concepts to practical issues, students' study habit , poor teaching methods, abstract nature of science concepts, lack of qualified teachers, poor infrastructure, inadequate laboratory facilities, teacher-centered instruction, non-availability and utilization of instructional materials, inability to take the candidate through practical sessions in the laboratory as recorded by Adeyegbe, 1997;Bajah 2000; Orimogunje, Oloruntegbe and Alam, 2010; Bamidele and Oloyede, 2013 were some of the factors responsible for students' poor performance in chemistry as shown in Table I. Practical work in chemistry laboratory has been identified as central to the effective performance of student in chemistry in WASCE. Chemistry as a physical science can be taught and learned most effectively if its teaching involves hands-on and mind-on. It should beactivity-centered and student-centered, rather than lecture method or "chalk and talk" method which is teacher–centered.

Table 1. Trends of Performance of Chemistry Students in the West African Senior School Certificate Examination May/June 2008-2012

Year	Total Entry	Total Examined	Total Absent	Number and percentage with grades		
				Credit 1-6	Pass 7 & 8	Fail 9
2008	468291	456993 (97.58%)	11298 (2.41%)	198621 (43.46%)	121139 (26.50%)	116892 (25.57%)
2009	478235	468546 (97.97%)	9689 (2.03%	204725 (43.69%)	114697 (23.41%)	110260 (25.39%)
2010	568291	565643 (97.50%)	11930 (2.50%)	236059 (50.70%)	109944 (23.61%)	98165 (26.08%)
2011	575757	565692 (98.25%)	10065 (1.75%)	280250 (49.54%)	151627 (26.80%)	129102 (22.82%)
2012	641622	627302 (97.77%)	14320 (2.23%)	270570 (43.13%)	192773 (30.73%)	148344 (23.65%)

Source: West African Examination Council, Nigeria

In line with this, the secondary school curriculum recommends the use of discovery or inquiry approach of teaching to Chemistry which is basically on practical work in the laboratory. Laboratory experiences are so important that the examination bodies like National Examination Council (NECO) and West African Examination Council (WAEC) assessed learners' competency in the practical aspect of the subject separately as part of the final year examination in secondary schools. Since learning Chemistry does not involve only learning of concepts and facts but also learning how to examine concepts and facts in the laboratory, there is the need to have a well-equipped science laboratory which is very vital to the teaching of Chemistry. The objectives of secondary school Chemistry curriculum are to equip students with meaningful and relevant knowledge in the subject; to develop reasonable and functional scientific attitude; provide adequate laboratory and field skills and ability to apply scientific knowledge to everyday life (FGN,2004). It could be inferred from the objectives of secondary school Chemistry curriculum that practical activities are very essential to effective learning of Chemistry. All aspects of Chemistry teaching requires the practical demonstration to enable the students see the facts about the various concepts in it and also to develop scientific attitudes in the students. However, science teachers are faced with challenges of poorly equipped science laboratories. Owolabi (2003) suggested that an individualized approach of laboratory teaching, in which students can understand and learn Chemistry better with the required exposure to the practical trainings in the absence of real and well equipped laboratory be introduced to schools by using the latest interest-getting device instructional resources capable of enhancing performance, retention and interest of the students in the subject. One of such approaches, according to Adegoke (2010), Chuang (1999), Mayer, Dow, and Mayer (2003), Moreno and Mayer (2000) involves multimedia presentations of explanations in visual and verbal formats such as presenting a computer-generated animation synchronized with narration or on-screen text. The instructional resources of interest to the researcher in this study include, Computer Assisted Instruction (CAI) and Classroom Demonstration Technique (CDT).

In Nigerian secondary schools the most common method employed by Chemistry teachers is teacher centered and is referred to as Classroom Ddemonstration Techniques which involves the students sitting, listening and watching the teacher deliver the theoretical concept after which the teacher demonstrates the practical aspect to the students to see. Sometimes the students surround the teacher to seeclearly and this method may not be too good enough for science practical experiments especially when dealing with hazardous reactions which may explode. The Computer Assisted Instruction can be used to teach students repeatedly till they gain mastery of the concept taught. Ofili (2003), Oloyede and Bamidele (2003) and Okworo (2008) have found out that Computer Assisted Instruction helps to stimulate learning and enrich the class with materials that may be lacking in real laboratory setting. According to them, the media makes learning more permanent and offer experiences which promote self-activity on the part of the students. Also, nothing absolutely new is ever learnt effectively with one exposure. Repetition helps to reinforce and extend learning and to make the learned information more enduring (Thorndike, 1932). Computer Assisted Instruction allows repetitive viewing; the learner can view repeatedly until the concept being taught is well understood. In Computer Assisted Instruction (CAI), practical sessions are delivered using Microsoft power point containing text, art, images audio and photos. The visual device (projector) is used to present power point slides. With the use of the visual device, students can take better note with the ability to discern what information the teacher displays is most useful to them. Additionally, the students can ask the teacher to repeat a slide if they missed information. Hence students no longer have to crowd around the teacher demonstrating the titration experiment. Based on the implication in literature, CAI have been found to be a satisfactory approach that enhanced students' performance and retention ability in many other subjects. However, there is the need to find out how successful it will be when applied to practical Chemistry.

Theoretical Framework

The Theoretical Frameworks for this study is based on constructivism. John Dewey is one of the founding fathers of constructivism who emphasized the place of experience in education; while Piaget cognitive constructivist articulated mechanisms by which knowledge is internalized by learner. He suggested that through process of accommodation and assimilation, individuals construct new knowledge from their experience and incorporate such with already existing framework while social constructism, Vygotsky suggested that knowledge is first constructed in a social context and then appropriated by individuals. Constructive approach to learning brings about another sense to the teaching and learning experience in schools. Students learnt how to learn by giving them the training using Computer Assisted Instructions. Papert (1980) was an early critic of traditional approaches to teaching and learning that emphasize isolated skills. He advocateda less structured environment that would let students use computers to learn, think and solve problems. The use of computing technology as part of the practice is crucial since it provides the key of association with the younger generation.

Demonstration method

Theoretical framework

Demonstration method is a method that is suitable for most categories of learners. According to Smith (1998), demonstration must be used in a manner that suits the needs of the normal students and hearing impaired. It is a method of teaching used to communicate an idea with the aid of visuals such as flip charts, posters, and PowerPoint. It is a process of teaching someone how to make or do something in a step-by-step process. It is very useful in teaching large class where there is inadequate laboratory materials and equipment. It is also seen as a method in teaching learning process. It is an act of showing something by proof or evidence (Behaviorism).

Statement of the problem

The teaching of practical Chemistry in On do State secondary schools is faced with challenges such as overcrowded classes, inadequate science laboratory equipment and chemicals coupled with teachers' negative attitude towards organizing practical classes (Jegede, 2007; Gambari, 2010; Edomwonyi-Out and Avaa, 2011; Adetunji, Oloyede, Bamidele and Bada, 2012) and using effective teaching methods. Several suggestions such as the use of cooperative learning strategy, inquiry method and concept mapping have been made by researchers (Agboola and Oloyede, 2007**;** Aluko and Olorundare, 2012; Bamidele, Adetunji, Awodele and Irinoye, 2013) to salvage this unsatisfactory state of affairs. Unfortunately the situations till persists. Effective teaching and learning have been obtained through Computer Assisted Instruction in different subject areas with relative success. Not every teacher in Nigeria is aware of the use of Computer Assisted Instructional package for the purpose of teaching particularly in Chemistry practical learning settings. However, in Akure South Local Government Area of Ondo State, not much is known in relation to the use of Computer Assisted Instruction for teaching practical Chemistry. Thus, much remain to be empirically studied on the effect of Computer Assisted Instruction in teaching practical Chemistry, hence this study.

Purpose of the Study

The purpose of the study is to find out the relative effectiveness of Computer Assisted Instruction (CAI) and Classroom Demonstration Techniques (CDT) in teaching acid base titration in volumetric aspect of practical Chemistry.

The specific objectives of this study are to:

1. Determine the relative effectiveness of Computer Assisted Iinstruction (CAI) and Classroom Demonstration Technique (CDT) in improving students'performance in acid/base titration,
2. Compare the performance of students when exposed to Classroom Demonstration Technique (CDT) and Lecture Method (LM) after treatment; and
3. Determine the relative effectiveness of Computer Assisted Instruction (CAI), Classroom Demonstration Technique (CDT) and Lecture Method (LM) in enhancing students performance in acid/base titration after treatment.

Research Hypotheses

The following research hypotheses were tested based on the objectives of the study:

1. There is no significant difference in the performance of students taught acid/base titration using Computer Assisted Instruction (CAI) and Classroom Demonstration Technique (CDT).
2. There is no significant difference in the performance of students exposed to acid/base titration using Classroom Demonstration Technique (CDT) and those taught using Lecture Method (LM).
3. There is no significant difference in the performance of students exposed to acid/base titration using CAI, CDT and LM after treatment.

MATERIALS AND METHODS

The study adopted the pre-test post-test control group design. There are three groups for the study, two experimental groups and one control group. The design is represented as:

O_1 X_1 O_2
O_3 X_2 O_4
O_5 C O_6

Where

O_1, O_3 and O_5 represent pre-test
O_2, O_4 and O_6 represent post-test
X_1 – treatment 1 (exposed to Computer Assisted Instruction (CAI))
X_2 – treatment 2 (exposed to Classroom Demonstration Technique (CDT))
C – Lecture Method (LM) (control group)

Sample

The population for this study comprised all Senior Secondary School two (SSS II) students offering Chemistry in public secondary schools in Ondo State. The sample for this study consisted of one hundred and twenty three (123) SSS II chemistry students from each of the three randomly selected secondary schools in Akure South Local Government Area of Ondo State. The three classes were randomly assigned to treatment and control groups.

Instrument

One instrument was used to collect data for this study. The instrument is tagged Chemistry Practical Achievement Test (CPAT) which was used as pre-test and post-test to determine the effect of the treatment on students' performance. This consisted 20 item multiple choice test with four options A, B, C and D. The twenty items practical test comprised questions on relevant apparatus, indicators, titration experimental procedures, calculation of concentration, molar mass and number of mole of substances. The difficulty index of the items ranges from 0.25 to 0.75. The reliability coefficient of the test was determined using Kuder Richardson formula 21(KR-21) and found to be 0.80 indicating that the instrument is reliable.

Instructional Packages

The instructional packages used for this research was Computer Mediated Instructional packages. Analysis, Design, Development, Implementation and Evaluation (ADDIE) instructional design model was adapted to develop the package. It consisted of one topic acid base titration subdivided into four lessons.. The practical aspect (titration) was downloaded from the internet while the theory (calculation) aspect was developed by the researchers and a programmer.

Instructional Package for Computer Assisted Instruction (CAI)

Step1: Teacher asks the students questions on what was taught last- students were asked to balance equations. e.g.

$$\underset{\text{Acid}}{NaOH} + \underset{\text{Base}}{HCl} \longrightarrow \underset{\text{Salt}}{NaCl} + \underset{\text{Water}}{H_2O}$$ (Neutralization reaction)

Step II: Teacher introduces the topic titration to the students by defining titration as a process by which a measured volume of a solution is added to a reaction mixture until some observable property has changed. It is a common technique used for measuring amounts of acid-base titration. It is an experimental procedure used to determine the unknown concentration of an acid or base by precisely neutralizes it with an acid.

Procedure:

- Choose the titrant
- Choose the titrate
- Select the normality of the titrate
- Choose the volume of the liquid to be pipette out
- Select the indicator

Step III: The research assistant sets up the projector containing the computer assisted instructional package presentation slides. The teacher paused the computer assisted instructional package at interval to explain to the students the calculations involving mole ratio, molar concentration and mass concentration. Students are to pay attention and jot down key points seen or heard while watching the instructional package.

Step IV: Students are given some exercises involving titration to solve.

For example: Calculate the concentration of 25cm^3 NaOH solution if 35cm^3 of1.25m HCl is needed to titrate to the equivalent point.

Answer: In this equation, the mole ratio of NaOH (base) and HCl (acid) is as determined by the equation

$M_{acid} \times V_{acid} = M_{base} \times V_{base}$
M_{acid}= molarity of the acid
V_{acid}= volume of the acid
M_{base}= molarity of the base
V_{base} = volume of the base
$NaOH + HCl \longrightarrow NaCl + H_2O$

In this equation, the mole ratio of NaOH (base) and HCl (acid) is 1:1 as determined by the balanced chemical equation. The equivalence point is where the moles of titrant and analyte in the reaction are equal.

$M_{acid} \times V_{acid} = M_{base} \times V_{base}$
$1.25 \times 35 = M_{base} \times 25$
$1.75 = M_{base}$

Step V: Teacher evaluate the lesson by giving the students more exercise on how to calculate the molar mass of the following compounds NaOH, NaCl and $MgCO_3$

Data collection and analysis: At the pre-treatment stage, during the first week of the study, pre-test was administered to the participating students in each school. This was followed by assigning the schools into groups. Experimental group I was the Computer Assisted Instruction group, they were taught titration using Computer Assisted Instructional package connected to a projector to deliver the practical lesson. Experimental group II students were exposed to acid/base titration using Classroom Demonstration Technique. The students watched the teacher as she demonstrates and explained using the usual laboratory demonstrations. The third group was taught using the conventional Lecture Method. The actual teaching took three weeks after which the post test was administered. Each session lasted for 45 minutes. At the post-treatment stage which was the last week of the experiment, CPAT was administered to both the experimental and control groups as post-test. Data collected were analyzed using the mean, t-test and One-Way Analysis of Variance (ANOVA).

RESULTS

Testing of the Hypotheses

Hypothesis One: Hypothesis one states that there is no significant difference in the performance of students taught acid/base titrationusing Computer Assisted Instructions and Classroom Demonstration Technique. In testing this hypothesis, the post-test scores of students exposed to CAI were compared with the post-test scores of students exposed to CDT using t-test statistics as presented in Table 2. Result from Table 2 showed that, t = 4.95 and p = 0.019. This implies that a significant difference existed in the performance of the students taught acid/base titration using CAI and CDT. The null hypothesis is hereby rejected. The CAI group ($\bar{X}$ = 11.24) performed better than the CDT group ($\bar{X}$ = 8.05).

Hypothesis Two: Hypothesis two states that there is no significant difference in the performance of students exposed to acid/base titration using Classroom Demonstration Technique and the conventional Lecture Method. In testing this hypothesis, the post test scores of students exposed to CDT were compared with the post-test scores of students exposed to Lecture Method (LM) using t-test statistics is presented in Table 3. Result from table 3 showed that, p value is less than 0.05 at t = 13.80. This implies that, there was a significant difference in the performance of students taught acid base analysis using CDT and LM. The null hypothesis is hereby rejected. The CDT group ($\bar{X}$ = 15.35) performance is better than the LM group ($\bar{X}$= 8.05).

Hypothesis Three: Hypothesis three states that there is no significant difference in the post test of students exposed to acid/base titration using Computer Assisted Instruction, Classroom Demonstration Techniques and the conventional Lecture Method. In testing this hypothesis, the post-test scores in the students of the three groups were subjected to F- test. Result from table 4 showed $F_{(2,120)}$ = 92.58 and p = 0.00. Indicating that a significant difference existed in the post test scores of students taught acid/base titration using CAI, CDT and LM. The null hypothesis is hereby rejected.

Table 2. t-Test Analysis of the Performance of Students exposed to CAI and CDT Groups

Group	N	X	S.D.	df	t	*P*
CAI	46	11.24	3.17	86		
CDT	42	8.05	2.85		4.95*	0.029

P < 0.05

Table 3. t-test Analysis of Performance of Students exposed to CDT and LM Groups

Group	N	X	df	t	P
LM	35	8.05			
CDT	42	15.35	75	13.80*	0.013

P < 0.05

Table 4. Analysis of Variance of the three groups after Post Test

Source of variation	Sum of square	Df	Mean square	F	Sig
Between Groups	2364.54	2	1182.27		
Within Group	1532.73	120	12.77	92.58*	0.00
Total	3897.27	122			

DISCUSSION

The result of this study revealed that the use of Computer Assisted Instruction($\bar{X}$ = 11.24) and Classroom Demonstration Technique ($\bar{X}$ = 15.35) brings significant differences in the performance when compared with Lecture Method (conventional method) ($\bar{X}$ = 8.05). The Computer Assisted Instruction is effective due to its ability to captivate and hold the attention of the students with what was learnt. This instructional package provided the students the opportunity to revise and practice practical Chemistry in the presence/ absence of real and functional laboratory. It also gives the opportunity to repeat a slide if they missed any information. The result of the analysis of this study agreed with the findings of previous researchers Oloyede and Bamidele, (2003); Afolabi, (2006), Jasper, (1998); Yusuf and Afolabi, (2010) and Udousoro, (2000) who asserted that instructional media enhance students academic performance, aid retention of learnt concept and also enhance communication between learners and teachers.

Conclusion and Recommendation

The study concluded that Computer Mediated Instructional strategy can be used to enhance the performance of students in Chemistry especially the practical aspect. Since Computer Assisted Instruction could enhance the teaching / learning of practical Chemistry, Government and education stake holders should provide these facilities in schools and accord necessary attention to computer literacy by organizing seminars, workshops and in-service training for teachers to enable them acquire necessary skills. Also, teachers should be encouraged to update their knowledge about the development and proper use of relevant Computer Assisted Instructional package for effective teaching of chemistry in secondary school.

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