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Effects of Computer Assisted Instructional Software on Senior Secondary School Students' Learning Outcomes in Volumetric Analysis in Ekiti State, Nigeria

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Abstract: ***This study investigated the effects of computer assisted instructional software on senior secondary school students' learning outcomes in volumetric analysis in Ekiti State, Nigeria. The purpose of the study was to investigate the effects of computer assisted instructional software and the influence of students' attitude on senior secondary school students' learning outcomes in volumetric analysis. The study adopted pre-test and post-test control group quasi- experimental research design of the survey type. The sample of this study was 108 senior secondary school II students in Ekiti State which was drawn out using multistage random sampling technique from a total population of 15,276 senior secondary school II students in Ekiti State, Nigeria. Three research instruments were; Students' Attitudinal Scale towards Volumetric Analysis (SASVA), Students' Volumetric Analysis Practical Test (SVAPT) and Computer Assisted instructional Software (CAIS)which were used to collect relevant data from the respondents. Face and content validity of the instruments were ascertained by experts in Computer Science with high experience in software programming, Science Education and Test, Measurement and Evaluation. Corrections made were properly incorporated into the instruments to make the final and corrected version. Test-retest method was used to establish the reliability of SVAPT as administered to 20 students outside the normal sample with interval of two weeks and co-efficient correlation value of 0.85.Cronbach's Alpha was used to determine the internal consistency of the items in SASVA and CAIS and the Co-efficient values obtained were 0.73 and 0.87 for SASVA and CAIS respectively which is high enough to make the instruments reliable. Data collected were analyzed using t-test for hypothesis one and Analysis of Co-variance (ANCOVA) for hypotheses two and three at 0.05 level of significance. The result showed that students' performance in computer assisted instructional software group at post-test was found to be significantly better than that of the control group. The findings also revealed that computer assisted instructional software is highly sensitive to students' attitude. Based on the findings of the study, it was concluded that computer assisted instructional software improved students' achievement in Volumetric Analysis. It was therefore recommended that this new instructional strategy should be introduced to the teaching of Chemistry and Volumetric Analysis.***

Keywords: Volumetric Analysis, Chemistry, Computer Assisted instructional Software, Learning Outcomes and Students' Attitude

1. Introduction

It is widely believed that the socio-economic and technological development of a nation is a function of her level of education which is itself a function of the nature of her curriculum implemented in schools. This could be the main reason why developed countries of the world achieved their eminence by hard work. Japan, which is one of the leading countries in the production of electronics and automobiles, attached a lot of importance to education sector (Cambell, 2011).

The product of science and technology has contributed significantly to the development of a nation. Through the application of science, scientific knowledgeable professionals have been able to invent equipment and machines used in industries and homes. In addition to this, science and technology has helped in ease stress brought by the movement of goods and services from one place to another, by inventing easy transportation equipment like automobiles, aircrafts among others. Furthermore, science and technology has helped in the area of medicine, communication, food production, electricity, good road and lots more. It is incontrovertible to say that science and technology play important roles in the development of any nation.

Science education deals with sharing of science content and process with individuals who are not considered traditionally to be members of the scientific community. Science education in Nigeria concentrates on the teaching of science concepts, method of teaching, and addressing misconceptions held by learners regarding science concepts (Aina, 2013). Science Education is one of the foundation upon which the bulk of present day technological breakthrough is built. Without science education, developments in science and technology as well as advances in information communication and technology would have not been possible.

At the level of secondary school in Nigeria education system, science is presented to students as specific science subjects. These include Basic Science, Physics, Chemistry, Biology, Mathematics and Agricultural Science. The chemical science permeates all the branches of science, and makes use of chemical principles.

Chemistry is one of the compulsory science subjects in the nation's 6-3-3-4 educational system and it has a special place in the school curriculum. It is the heart or nucleus of science at central to the study of many science and technology related courses in the tertiary institutions such as medicine pharmacy agriculture nursing and biochemistry. Chemistry as a science subject is meant to help learners acquire knowledge about the nature of chemicals (e.g. facts, concepts and principles), processes and attitudes and then equip them with skills of a professional chemist. The objective of Chemistry according to the National Policy on Education (FRN, 2014) include: adequate laboratory and field skills in chemistry, meaningful and relevant knowledge and functional science attitudes.

According to Abrahams and Millar, 2017; Chemistry practical is an essential feature or part of secondary school chemistry education (Abrahams and Millar, 2017), hence the reason for assigning a high proportion of chemistry lessons in the time table for practical with the assumption that it could lead to distinctive attainments and students' performance. They reported that such approach is generally effective in getting students to do things with objects and materials, as students see it as relatively effective in developing their conceptual understanding of the associated scientific ideas and concepts.

Most chemistry educators regard practical chemistry as very important for various reasons which include motivation, concept learning and the development of skills and appropriate scientific attitudes. Chemistry practical seems to be significantly bordered in totality or largely focused on Voluntary Analysis which is also known as quantitative analysis.

Volumetric analysis was first introduced by Jean Baptiste Andre Dumas, a French chemist Schneegans (2003). He used it to determine the composition of nitrogen combined with other elements in organic compounds. Volumetric analysis is defined as the quantitative analysis of an unknown chemical solution by determining the amount of reagent of known concentration necessary to effect a reaction in a known volume of the solution (Webster's New World College Dictionary). Much quantitative analysis (that is, analyzing the amount of substance present) is performed using reactions between two substances in solution. The volume and concentration of one solution is known and a titration method is used to find the exact volume of the second solution necessary to react completely with the first. It could be possible for the second solution's concentration to be obtained through the equation.

Volumetric analysis looks a better and faster technique, especially if the substances involved are acids and bases. They can be titrated against one another for better quantitative results. Volumetric analysis is used in high school, college and university chemistry laboratories to determine concentrations of unknown substances.

Despite the utilitarian value of Chemistry in science and technological advancement and teachers' position in the realization of these objectives. Reports of several studies revealed that most concepts in chemistry are indeed difficult to learn by most students (Fatokun, 2014). Lack of practical activities in Chemistry has resulted in poor manipulation and observation skills (Adepoju, 2002), Chemistry teaching and learning have continually received criticisms from the society as a result of poor performance of Nigeria students in science subjects relative to their counterparts in other countries (Adepoju,2002).A similar under achievement in sciences is further reported by shelter Right initiative where Nigeria trail behind other West African countries in science subjects such as Chemistry in the recent years (Olubusuyi, 2010).

Recently, the results of Senior Secondary School Certificate Examination (SSCE) conducted by the West African Examination Council (WAEC) shows that more than 60% of the Nigeria students performed below average in Chemistry which is determined by the performance in its practical (Federal Ministry of Education, 2019).The conventional method of teaching students in the laboratory seems to be insufficient enough as the performance of students in volumetric analysis remains not encouraging or dwindling.

In spite of the possible effect of different instructional strategies of teaching science practical, researchers such as Abiona (2000), Linder (2014) and Oniya, (2019) have been able to clamor for more innovative and latest instructional strategies to teach practical in science education.

The use of computer to provide instruction is known as Computer Assisted instruction (CAI) which is a form of software that is used to educate or instruct students. It can be helpful especially in allowing learners' individualized, repetitive, or similar instruction in science practical as well as activities for learning a range of skills instead of using textbook and familiar strategy in teaching in the laboratory.

Assisted instruction (CAI) incorporates a broad variety of computer technologies that help in the teaching and learning process (Nazimuddin, 2014). CAI divides content into 'frames' in which students can master the content sequentially at a convenient time. Information or instructional will be displayed on the monitor with the demonstration of the practical steps in solving problem in Volumetric Analysis either in the class or laboratory and the students will be required to respond to the information sequentially in order to guide students' level of understanding after assessing the feedback. If the student's answer or response is right, the student's proceeds, and if it is wrong, similar problem will be presented to the students until correct answer is given before going to the next level (Jesse, 2012).

Computer Assisted instructional (CAI) is interactive and can demonstrate a content in order to make students study conveniently, at any time even at home so far the students will be having software on their laptop.It provides instant feedback, develops students' competency in solving a problem, makes learning to be inviting to the students and enhance efficient teaching and learning.

Beside the use of inadequate instructional strategies by teachers in teaching and learning, which is a factor of students' performance? Some researchers such as; Carlson

2007, Jegede (2012) identified that learners' characteristics can affect achievement in science. Considering that the present study is also interested in how a learner could be empowered to improve on his learning outcomes in volumetric analysis in Chemistry, it is most likely that alterable motivational variable such as the learner's attitude may also influence learning outcomes in the subject.

Students' attitude plays a key role in the course of teaching and learning. The way Chemistry teacher teaches Volumetric Analysis usually makes the topic to be on abstract to the students even if they are taught in the laboratory. And this contributes to a large extent to the development of positive attitude towards the topic in the subject. Attitude is developed from learning experiences encountered by the learners. Most teachers don't know that mode of their conduct and the process adopted during teaching could directly or indirectly influence the attitude of students' towards the topic. A positive attitude towards volumetric analysis in chemistry presents a good emotional disposition towards the subject and in the same manner; a negative attitude towards the topic reflects a negative emotional disposition which directly affects learning outcomes in the topic.

1.1 Purpose of the Study

The purpose of the study is to;

a) Investigate the effects of computer assisted instructional on senior secondary school students' learning outcomes in volumetric analysis.
b) Determine the influence of students' attitude on senior secondary school students' learning outcomes in volumetric analysis.

1.2 Research Hypotheses

Three research hypotheses were postulated in this study.

1) There is no significant difference in the pre-test mean scores of the experimental and control groups.
2) There is no significant difference between the pre-test mean scores and the post-test mean scores of the students in the experimental and control groups.
3) There is no significant difference in students' attitude towards Volumetric Analysis in the experimental and control groups before and after treatment.

1.3 Research Design

The study design was pre-test and post-test control group quasi- experimental research of survey type.

1.4 Population

The target population of the study comprised all 12,576 senior secondary school ll (SSSll) students in Ekiti State, Nigeria.

1.5 Sample and Sampling Technique

The sample of this study was 108 SSSII students in Ekiti State. The multistage sampling procedure was used to select the sample. Stage one involved the selection of two Local Government Areas from each of the three Senatorial Districts in Ekiti State using simple random sampling technique. The second stage involved the use of purposive sampling technique to select a School from each Local Government Area selected in the State, putting into consideration public schools with computer laboratory and stand by electricity. This was followed by the use of students in an intact class of an arm randomly selected from each school to be considered.

1.6 Research Instruments

This study made use of three research instruments which were; Students' Attitudinal Scale towards Volumetric Analysis (SASVA), Students' Volumetric Analysis Practical Test (SVAPT) and Computer Assisted instructional Software (CAIS).

SASTVA: This is a questionnaire with 25 items prepared by the researcher to x-ray attitude of students towards Volumetric Analysis in Chemistry. The instrument was prepared using four Likert type scales which will be scored as follows: Strongly Agree (SA) – 4 points, Agree (A) – 3 points, Disagree (D)2 points and Strongly Disagree (SD) 1 points.

SVAPT: This consisted of 4 theory items to assess the performance of students inVolumetric Analysis.

CAIS: This was an adjunct instructional and interactive package which consist of six lessons structured in units, each unit lasted for 40 minutes. It is developed by the researcher with the assistance of programme developer.

1.7 Validity of the Instruments

Face and content validity of the instruments were ascertained by experts in Computer Science with high experience in software programming, Science Education, Test, Measurement and Evaluation. Corrections made were properly incorporated into the instrument to make it the final and corrected version.

1.8 Reliability of the Instruments

The method of test-retest was used to establish the reliability of SVAPT as administered to 20 students outside the normal sample for the period of two weeks. The test showed no ambiguity in the instrument with the co-efficient correlation value of 0.85.Cronbach's Alpha was used to determine the internal consistency of the items in SASVA and CAIS after they have been administered to 25 students outside the sample of the study. Co-efficient values obtained were 0.73 and 0.87 for SASVA and CAIS respectively which is high enough to make the instruments reliable.

1.9 Experimental Procedures

The pre-treatment stage

At the pre-treatment stage, the researcher visited the selected schools with letter of introduction to obtain permission from the principals and the Chemistry teachers to use their

schools' laboratories and students with training of the teachers as research assistance.

Treatment stage
On the first day of the treatment, the SASVA and SVAPT were administered as pre-test to the students. This was followed by series of lessons designed for the study; the research assistance made use of CAIS during teaching in experimental group while normal way of teaching was allowed in control group.

Post-treatment stage
At the post-treatment stage, the SASVA and SVAPT were re-arranged and administered to the students as posttest by the research assistants.

Data Analysis
The data obtained was analyzed using t-test for hypothesis one while Analysis of Covariance (ANCOVA) statistics was used to analyses hypotheses two and three. Multiple Classification Analysis (MCA) was used to determine and explanation the sources of the observed significant main effects. Each hypothesis was tested at 0.05 level of significant.

2. Results and Discussion

Hypothesis 1: There is no significant difference in the pre-test mean scores of the experimental and control groups.

Table 1: t-test analysis of the pre-test mean scores of the students in Computer Assisted Instructional Software (CAIS) and Conventional groups

Group	N	Mean	SD	df	T	p
CAIS	52	28.97	2.34			
Conventional	56	28.81	2.73	106	0.337	0.737

p> 0.05

Table 1 shows that the t value of 0.337 is not significant because the p value (0.737) > 0.05. It implies that the null hypothesis is accepted. Hence, there is no significant difference in the performance of students in the two groups which proves the homogeneity of all the students used in the study at the pre-treatment stage.

Hypothesis 2
There is no significant difference between the pre-test mean scores and the post-test mean scores of the students in the experimental and control groups.

Table 2: Analysis of Covariance (ANCOVA) for pre-test and post-test Mean Scores of students in Experimental and Control Groups

Source	Sum of Square	Df	Mean Square	F	Sig.
Corrected Model	25800.597[a]	2	12900.299	714.834*	.000
Intercept	3636.150	1	3636.150	201.487*	.000
Pre-test	2.045	1	2.045	.113	.737
Groups	25786.000	1	25786.000	1428.856*	.000
Error	1894.894	105	18.047		
Total	477522.512	108			
Corrected Total	27695.492	107			

a. R Squared = 0.932 (Adjusted R Squared = 0.930) *p< 0.05

Table 2 revealed that F-value is 1428.856 (p=0.000 < 0.05). This implies that the null hypothesis is not accepted. By this, there was significant difference in the performance mean scores of students in experimental and control groups before and after the treatment. In order to find out the more probable effective strategy, Multiple Classification Analysis (MCA) was carried out. The result is hereby presented in table 3.

Table 3: Multiple Classification Analysis (MCA) of Students' Performance in Volumetric Analysis by Treatment

Grand Mean = 64.54					
Variable + Category	N	Unadjusted Dev'n	Eta^2	Adjusted for Independent + Covariate	Beta
Experimental (CAIS)	52	16.04		15.98	
Control	56	-14.9	.81	-14.96	.11
Multiple R 0.965 Multiple R^2 0.932					

The result in table 3 shows the Multiple Classification Analysis (MCA) of Students' Performance in Volumetric Analysis by Treatment. This reveals that with a ground mean of 64.54, students in the experimental group that were exposed to CAIS had higher adjusted mean score of 80.58 (64.54 + 16.04) than their counterparts in the control group with adjusted mean score of 49.64 (64.54 + (-14.9)). This shows that CAIS was more effective in teaching Volumetric Analysis more than the conventional method of learning.

Hypothesis 3
There is no significant difference in students' attitude towards Volumetric Analysis in the experimental and control groups before and after treatment.

Table 4: Analysis of Covariance (ANCOVA) for Pre-attitude and Post- attitude of Students in the two Groups

Source	Sum of Square	df	Mean Square	F	Sig.
Corrected Model	5548.831[a]	2	2774.416	314.565*	.000
Intercept	365.227	1	365.227	41.410*	.000
Pre-test	.589	1	.589	.067	.737
Groups	5531.692	1	5531.692	627.186*	.000
Error	926.085	105	8.820		
Total	437019.000	108			
Corrected Total	6474.917	107			

a. R Squared = .857 (Adjusted R Squared = 0.854) *p< 0.05

Table 4 shows that F-value is 627.186 (p=0.000<0.05). This implies that the null hypothesis is not accepted. It means that there was significant difference in students' attitude towards Volumetric Analysis in each of the groups before and after treatment. To find out more probable significant strategy, Multiple Classification Analysis (MCA) was carried out and the result is hereby presented in table 5 below.

Table 5: Multiple Classification Analysis (MCA) of Students' Attitude towards Volumetric Analysis by Treatment

Grand Mean = 63.14					
Variable + Category	N	Unadjusted Dev'n	Eta^2	Adjusted for Independent + Covariate	Beta
Experimental (CAIS)	52	7.44	.74	7.39	.09
Control	56	-6.91		-6.95	
Multiple R 0.923 Multiple R^2 0.857					

The result in table 5 shows the Multiple Classification Analysis (MCA) of Students' Attitude towards Volumetric Analysis by Treatment. This reveals that with a ground mean of 63.14, students in the experimental group that were exposed to CAIS had higher adjusted mean score of 70.58 (63.14 + 7.44) than their counterparts in the control group with adjusted mean score of 56.23 (63.14 + (-6.91)). This shows that CAIS was more effective strategy in increasing positive attitude towards Volumetric Analysis than the conventional method of learning.

3. Discussion

The finding of this study shows that there is no significant difference in the performance of students in the two groups. This established the homogeneity of the sampled groups. In another words, the base line knowledge of the students participating in the two groups for the study are equivalent. Thus, any significant difference seen later would be attributed to the specific treatment used rather than chance.

The study also showed that there was significant difference in the performance mean scores of students in experimental and control groups before and after the treatment. It was also discovered that there was better improvement in the performance of students exposed to CAIS than that of conventional group. This study is in agreement with the findings of Oniya and Adefila (2020) who stated that new innovational strategies will improve students' performance better than those in conventional class. The finding is in concordance with the finding of Kareem (2015), Nduati (2015), and Jegede (2012) who concluded that students who used CAIS-based instructional scored higher than students without computers in science.

The study also pointed out that there was significant difference in students' attitude towards Volumetric Analysis in each of the groups before and after treatment. Students in CAIS class exhibit better positive attitude to learning of volumetric Analysis than those in conventional class. This implies that CAIS makes Volumetric Analysis class to be more inviting and interesting to the students. The findings is in consonance with those of Nduati (2015) and Tyagi (2014) who in separate studies concluded that CAIS makes a positive change in students' attitude toward Chemistry.

4. Conclusion

From the findings of this study, it is concluded that students' exposure to Computer Assisted instructional Software (CAIS) resulted to a significant increase in academic performance of students also that the strategy improve the attitude of students towards teaching and learning.

5. Recommendation

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

1) Conventional method presently in the use by Basic Science teachers should be improved on upon, modified or replaced with an activity-based teaching strategy.
2) The use of Computer Assisted instructional Software (CAIS) should be encouraged in teaching science practical especially Volumetric Analysis in Chemistry in secondary schools in order to enhance their performance and improve their attitude.
3) Government should ensure that there is an equipped computer laboratory in each of the Secondary schools for effective adoption of Computer Assisted instructional Software (CAIS) by the science teachers.

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