

Effects of Using Computer as Tutor and Tool on Secondary School Students' Academic Achievement in Chemistry

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Abstract

The study investigated the effects of using computer as tutor and tool on academic achievement of senior secondary school students in chemistry. The study was guided by one research question and one hypothesis. The population for the study comprised all the public secondary schools in Imo State. A sample of one hundred and twenty-nine (129) chemistry SS2 students gotten from three schools was involved in the study. Pre-test post-test quasi experimental research design was adopted for the study. A validated researcher-made instrument named Chemistry Achievement Test (CAT) with reliability of 0.72 was used for data collection. Research question was answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used in testing the hypothesis at .05 level of significant. Findings showed that students who were taught with computer both as tool and as tutor achieved better than those taught with lecture method but using computer as tool increased students' achievement in chemistry more than using computer as tutor. Recommendations were made which among others include that the chemistry teachers should use the computer as a tool in the classroom to enhance achievement of students since it has been found to be more effective than using it as tutor.

Keywords: Computer Assisted Instruction, Computer as tool and tutor, Chemistry, Students' achievement

Introduction

Chemistry is one of the compulsory science subjects for whoever wants to study science and technology courses in tertiary institutions. It is the natural basis of technology disciplines and natural sciences. Thorty (2008) noted that Chemistry has been identified as a very important school subject and its importance in scientific and technological development of any nation cannot be overemphasized. Chemistry has helped in the development of modern technology through the application of its principles to modern inventions (Asiyai, 2015). Chemistry is a core science that deals with the composition, properties and uses of matter. Abubakar and Ashiru (2010) stated that Chemistry is a science subject that deals with the study of the compositions and structures of matter. Obodo (2005) observed that life on earth depends on chemistry, chemicals and chemical products, not only from the cradle, but also to the grave. All that exist is chemistry. The study of chemistry is very important to mankind because chemistry is capable of explaining natural phenomena and everyday occurrence.

Chemistry as one of the main science courses that aid the transformation and development of nations has continually played very important roles in the production of many technologies, ranging from the life-saving pharmaceuticals to computers and other information technologies. Chemistry is regarded as a 'central science' because of the central role it plays in the successful study of science-based courses, such as medicine, pharmacy, biochemistry, engineering, agriculture and so many others and this underlines the importance and need to study it (Ibe, 2017). Okorie (2014) noted that chemistry and its impact on lives of

individuals will continue to grow, and probably even at a faster rate in the 21st century, as a number of innovative secondary school chemistry curricula have emerged across the globe since the turn of the 21st century.

In spite of the importance of chemistry in science and technological development, students' academic performance in the subject at Senior School Certificate Examination (SSCE) has been consistently poor (Giginna, 2013). In support of this statement Ibe (2012) noted that against the backdrop of the importance of chemistry in the home, society and industry coupled with the fact that it is a requirement for students' admissions into higher education in the physical sciences and science-related disciplines, it is very surprising that students do not show much seriousness in the subject as the learning outcomes have been worrisome. Ibe, (2017) observed that some of the reasons for the poor performance of students in chemistry can be linked to students' poor academic background. The students' poor academic background could be as a result of inappropriate teaching methods used by the teachers, unavailability and inappropriate use of adequate instructional materials in teaching and learning chemistry, lack of qualified teachers teaching chemistry, phobia and lack of interest on the part of the students, inadequacy of funds to carry out practical's.

Chemistry is said to be effectively taught and learnt when the students' academic achievement are on the positive side. In spite of the prime position chemistry occupies in our educational system and previous efforts made by researchers to enhance academic achievement, students' performance in chemistry is still low (Okorie, 2014). Despite the fact that the National Policy on Education has given chemistry education an enhanced status in Nigeria, it is still faced with numerous problems (Ibe, 2012). These problems threaten the realization of the goals of chemistry education in Nigeria. Ulunna (2000) and Nnadi (2004) have reported that students' performances in Chemistry in West African Senior School Certificate Examination (WASSCE) and National Examination Council (NECO) have been poor. This is because of some difficult concepts in chemistry. Some of these concepts perceived to be difficult in chemistry are electrochemistry, Periodic Table, Ionic Equilibria, Rate of Chemical Reactions, Chemical Bonding, Mole Concept and Thermodynamics (WAEC Chief Examiner's Reports; 2012 - 2018; Demirioglu & Yadigaroglu, 2013 & Ibe, 2017).

In order to simplify difficult concepts in chemistry, chemistry teachers should devise means of assisting students in learning it. Assisting students to learn is the ultimate goal of any instructional activity in education. In fostering learning in the classroom, according to Amadi and Ibekwe (2009), teachers should bring the learners to close contact with the curriculum contents, using appropriate method and materials. Methods play a vital role in ensuring effective, interesting and stimulating learning and as such inappropriate teaching methods may hinder learning. Teaching methods therefore, appear to contribute significantly to the problem of low achievement among secondary school chemistry students. There are as many methods and techniques of teaching as there are different views of the nature of science. A teacher's approach to teaching will therefore generally reflect his view of the subject or how he was taught himself (STAN 2015). However, for effective teaching and learning, the teacher can begin by avoiding two mistakes. The first is to stop assuming that a method of teaching is a fixed formula that should be employed rigidly for effective teaching and learning. The second is to stop assuming that a given method of teaching will be suitable to the characteristics of all his learners. Both mistakes usually lead to undesirable results, for if teaching method is mismatched with learners' characteristics, a destructive collision is inevitable (Bruce and Marsha as cited in Ibe, 2017). Ojo (2015) inferred that a good science teacher should see scientific method as a necessary condition in the resolution of scientific problems emphasizing that appropriate methods such as discovery, enquiry, demonstration and project, if judiciously employed by the teacher will lead to the acquisition of those skills

which are the bedrock of scientific method. Oriaifor (2014) suggested that in seeking solution to the problems of underachievement of students, effort should be made towards finding answers to the problems of teaching method applied in chemistry.

Educationists seem to agree that there is no best method of teaching and that the best method, however, is that which involves the learner in a number of meaningful activities, where the teacher does not do it all alone (Ezeani, 2014). In support of this Ukegbu, (2013) opined that in choosing methods or techniques for teaching, teachers should consider the methods or techniques that will meaningfully engage the students in a lot of activities. One of such techniques is the use of computer technology in the classroom (Okorie, 2014). The application of computer technology in the classroom is known as Computer Assisted Instruction (CAI), Computer Based Instruction (CBI), Computer Assisted Learning (CAL), or e-learning. According to Gana (2013), CAI is student centered and can help students in concretizing the abstract aspect of any subject in senior secondary school. Therefore, there is need to employ the use of computer in the classroom that will give room for the teacher to re-strategize, redefine and make the classroom more interactive. Okorie (2014), opined that computer can be used in teaching chemistry in two ways namely; as a tutor and as a tool. As a tutor, the computer performs the teaching role. The students are tutored by the computer to increase their skills and knowledge. In the tutor classification, the computer has the information to be learnt and controls the learning environment. Within the tutor classification, there are five modes: drill and practice, animations, tutorials, simulations and games. The tutorial mode is probably one of the most common ones within CAI and was used in this study. In the tutorial mode the computer presents the information and guides the learner through the computer system.

Computer is used as a tool when it serves as an instructional material to the teacher. Okorie (2014) noted that computer is a sophisticated tool that is performing tasks that should augment human performance. PowerPoint application software is one of the softwares that applies computer as a tool and can be employed in the classroom as instructional material for effective classroom instruction. Microsoft PowerPoint (MPP), according to Gana (2013) is a powerful tool used to create a professional looking presentations and slide shows. The programme is used in business and classrooms as well as effective tool for training purposes. It is one of the powerful tools in classroom teaching and learning. PowerPoint is a presentation software that allows the presenter or user to create slides, notes and show colour, text and image with simple animation. Ibe (2017) observed that MPP product can incorporate text, video, animation and uses graphical approach to presentations in the form of slide shows. In this current study, PowerPoint was used as computer tool to explain, illustrate, and elucidate teaching points in the classroom.

The attempt to take care of poor achievement of students in chemistry inspired some researchers to use computer technology in the classroom. Okorie (2014) carried out a research on effects of instructional package on secondary school students' achievement and interest in chemical bonding. The study revealed that the group taught using computer package performed better than those taught using lecture method. The researcher adduced reasons for the significant achievement of the people taught with computer package over the lecture method to include the fact that learning through visual resources like the computer is the key to acquisition of knowledge. When a student is instructed verbally, there is the tendency to forget. Knowledge that is visualized aids remembrance. This supports the findings of Kareem, as cited in Nsofor and Akpomedaye (2012) who stated that instructional materials of which computer is included help teachers to teach more effectively and also enable the students to learn more efficiently. This is also in agreement with Okwo and Illiya (2004), Okwo and Ottubah (2007); Nwachukwu and Nwosu (2007). In all these studies involving the use of computer technology in the classroom, none has compared the

effectiveness of using computer as a tutor and as a tool in teaching chemistry. It is therefore pertinent to compare the two modes for effective classroom instructions, hence, the focal point for this study.

Statement of the Problem

Chemistry education plays a significant role in scientific, technological and national development. However, there is ample evidence in literature that students' achievement in the subject is very poor. The poor achievements in chemistry may be as a result of teachers' use of ineffective teacher-centred methods which make students passive in the teaching/learning process. The use of teacher-centred methods may be due to large class size and teachers' inability to use some of the innovative learner-centred techniques for effective learning of chemistry. These current classroom situations is characterized with the inability of students to actively participate in the teaching and learning process which advertently affect effective learning of chemistry concepts. The students are mostly passive in the classrooms where these teacher-centred methods are employed. These results to the inability of the students to internalize, remember easily, transfer what is learnt to new situations and hence achieve poorly.

Researchers have recommended that teachers should adopt learner-centred methods that will actively involve the students in the teaching/learning process. One of the learner-centred methods that can engage students actively in the classroom is the use of computer technology. It is assumed that the use of active learning method like use of computer will provide students with more efficient thinking and problem solving skills as well as cooperative working habit and skills. The use of computer in teaching could be as a tutor or tool. These modes have been identified as the various modes of using computer in the classroom but the mode that is more effective is yet to be identified which calls for this study. Researchers have also used computer both as tutor and tool but none has to the best of the knowledge of the researchers compared the modes to identify the one that is more effective in teaching and learning of chemistry. In this study therefore, the researchers sought to find out if using computer as a tutor and tool would have effect on senior secondary school students' achievement in chemistry in Imo State.

Purpose of the Study

The main purpose of this study was to determine the effects of using computer as tutor and tool on the academic achievement among senior secondary school chemistry students. Specifically, the study sought to determine the mean achievement scores of students taught chemistry with computer as tutor, computer as a tool and lecture method.

Research Question

The study was guided by the research question below:

What are the mean achievement scores of students taught chemistry with computer as tutor, computer as a tool and lecture method?

Hypothesis

The hypothesis was tested at $\alpha = 0.05$ significance in the study:

There is no significant difference in the mean achievement scores of students taught chemistry with computer as tutor, computer as a tool and lecture method.

Methods

This study adopted quasi-experimental research design. Specifically, a pre-test, post-test non-equivalent control design was used for the study. The study was carried out in Obowo Local Government Area within Okigwe Education Zone II, Imo State, Nigeria. The population for the study comprised all the public Secondary Schools in Imo State.

A sample of one hundred and twenty nine (129) SS2 students gotten from three schools in the zone was involved in the study. Purposive sampling technique was used to select three schools in the area of the study. The three schools were selected because they were better equipped with ICT facilities than other schools in the area. The researcher considered the issue of gender and that was why co-educational secondary schools where boys and girls study together under the same learning environment were used. Simple random sampling technique was used to obtain the schools that formed the experimental groups and control group. After the randomization the following intact classes were used for the experiment: Lecture Method (Control Group – 45 students), Tutor Group (43 students) and Tool Group (41 students).

An instrument titled Chemistry Achievement Test (CAT) was used to collect data. The CAT contained questions on Periodic Table which was the chemistry content taught during the study. The topic gave 50 multiple choice chemistry achievement test items. The 50 multiple choice questions which was adapted from WAEC and NECO examinations covered the units/topics that were taught as shown in the table of specification below.

Sub-topics	Levels of Cognition on Achievement						Total 100%
	LLCS		HLCS				
	Re 16%	Un 18%	App 24%	An 16%	Eva 14%	Cre 12%	
Periodic Law and Periodicity of the Elements	1	1	2	2	1	1	8
Blocks of elements – metals, non-metals, metalloids and transition metals	1	2	2	1	1	1	8
Families of elements – groups I – VIII	1	2	2	1	1	1	8
Properties: Changes in sizes down and across the groups and periods	2	2	2	1	1	1	9
Diagonal relationships	1	1	2	2	2	1	9
Ionization energy, electron affinity down the group and across the periods.	2	1	2	1	1	1	8
Total	8	9	12	8	7	6	50

Key

LLCS	=	Lower Level Cognition Skill
HLCS	=	Higher Level Cognition Skill
Re	=	Remembering level
Un	=	Understanding level
App	=	Applying level
An	=	Analyzing level
Eva	=	Evaluating level
Cre	=	Creating level

The 50 multiple choice questions have 4 options (A - D) and each correctly answered question was awarded two marks. Incorrect answers attracted no mark. The instrument was face validated by experts in chemistry education and measurement and evaluation. Kuder-Richardson Twenty (K-R₂₀) formula was used to determine the reliability coefficient of the CAT as 0.72 after a pilot study involving thirty (30) chemistry SS2 students outside the study area. The study lasted for six weeks; the first week was used for the administration of the instrument (pre-test) while the actual study lasted for four weeks. The last week was used for the administration of the CAT (post-test). Mean and standard deviation was used in answering the research question while the analysis of covariance (ANCOVA) was used in testing the hypothesis at an alpha level of 0.05. This implied that any p value that is less than

0.05 is significant and therefore the hypothesis was rejected. Any p values that is equal to or greater than 0.05 is not significant and therefore the hypothesis was not rejected.

Results

Research Question:

Table 1: The mean achievement scores of students taught with computer as tutor, computer as a tool and lecture method.

Variables	N	Pre-Test Mean	Post-Test Mean	Gain Score	SD of Pre-Test	SD of Post-Test
Tutor Group	43	37.07	67.53	30.46	14.25	14.23
Tool Group	41	36.49	78.83	42.34	13.88	10.13
Lecture Method	45	37.91	53.78	15.87	17.62	14.47

Result from table 1 shows that the pre-test and post-test mean scores of students who were taught chemistry with computer as tutor are 37.07 and 67.53 respectively with gain score of 30.46. Also, table 1 shows that the pre-test and post-test mean scores of students who were taught chemistry with computer as tool are 36.49 and 78.83 respectively with gain score of 42.34. Similarly, pre-test and post-test mean scores of students taught with lecture method are 37.91 and 53.78 respectively with gain score of 15.87.

Hypothesis

Table 2: Analysis of covariance on the mean achievement scores of students taught with computer as a tutor, computer as a tool and lecture method.

Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	13595.057 ^a	3	4531.686	26.000	.000	.384
Intercept	79308.355	1	79308.355	455.015	.000	.784
Pretest	37.012	1	37.012	.212	.646	.002
Technique	13592.467	2	6796.233	38.992	.000	.384
Error	21787.268	125	174.298			
Total	602864.000	129				
Corrected Total	35382.326	128				

a. R Squared = .384 (Adjusted R Squared = .369)

Table 2 shows that the F-ratio is 38.992 with 2 degree of freedom. However, since the associated alpha level of .000 is less than the alpha level of .05 ($p > 0.05$), the null hypothesis is not accepted. This implies that there is a significant difference in the mean achievement scores of students taught chemistry with computer as tutor, computer as tool and conventional instructional strategy.

Table 3: Post Hoc Tests (Scheffe Test)

(I) Technique	(J) Technique	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Tutor	Tool	-11.2944*	2.79642	.000	-18.2235	-4.3653
	Conventional	13.7571*	2.73205	.000	6.9875	20.5267
Tool	Tutor	11.2944*	2.79642	.000	4.3653	18.2235
	Conventional	25.0515*	2.76592	.000	18.1979	31.9050
Conventional	Tutor	-13.7571*	2.73205	.000	-20.5267	-6.9875

Tool	-25.0515*	2.76592	.000	-31.9050	-18.1979
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Based on observed means.

The error term is Mean Square (Error) = 164.126

*The mean difference is significant at the .05 level

In order to determine the direction of the finding a post hoc analysis was carried out. Table 3 shows the relationship between the three groups. The level of significance between tutor group and tool group is .000, this shows that there is a significant difference in the mean achievement scores of students taught chemistry with computer as tutor and those taught with computer as tool since .000 is lower than the alpha level of .05. More so, there is a significant difference in the mean achievement scores of students taught chemistry with computer as tutor and those taught with lecture method since the associated significant value is .000 which is lower than the alpha level of .05. The mean achievement scores of students taught with computer as tool and those taught with lecture method differ significantly since the significant level is also .000 which is lower than the alpha level of .05.

Discussions

Results showed that students who were taught with both computers as tool and as tutor performed significantly better than students taught without computer. Results also showed that students taught with computer as a tool had higher mean than students taught with computer as tutor and it is significant. The reason for the “tool group” achieving better than the “tutor group” is because no matter the type of instrument that one interact with, it cannot be compared with human being whom you can ask questions, watch his/her countenance and feel his presence (Ukegbu, 2013). This study is in agreement with that of Ibe (2017) who stated that the computer cannot replace the teacher in the classroom. It then implies that teachers’ place cannot be replaced but teachers should use various technologies to augment their teachings.

This study is in support of Okorie (2014) who stated that using computer in teaching takes care of poor method of teaching and poor textbooks that are available to teachers. The outcome of the finding is very instructive to both teachers and administrators. It then implies that the use of ICT facilities especially computer should be further explored and harnessed for effective teaching and learning. In this regard, the teachers need to prepare in both technical knowhow and materials that should facilitate the use of computer in teaching of chemistry if the poor achievement of students recorded in recent times is to be averted.

Conclusion

The study has shown that the use of computer in classroom instruction has significant effect on students’ achievement in chemistry. The study has also shown that the use of computer both as tool and as tutor were more effective in increasing students’ achievement than the conventional method but using computer as a tool increased students’ achievement in chemistry more than using computer as tutor.

Recommendations

Based on the findings of this study the following recommendations are made:

1. Chemistry teachers should use the computer as a tool in the classroom to enhance achievement of students since its more effective than using it as tutor.
2. Seminars and workshops should be organized by State and Federal ministries of education and professional bodies like Science Teachers Association of Nigeria (STAN) and Nigeria Educational Research and Development Council (NERDC)

where teachers will be taught various ways of using computer for effective classroom instructions.

- Parents should be encouraged to provide computers for their children to use at home after school periods. This will enable students to practice what they have learnt in school and also discourage them from engaging in nefarious activities after school hours. The practice will enhance their interest and lead to improved achievement.

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