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## EDITORIAL COMMENT

The UNIZIK Journal of STM Education publishes reports of empirical research in Science, Technology; Engineering and Mathematics (STEM) Education as well as related studies in education generally. The publication is a medium of communicating well researched works for the science community as a forum for communication and cooperation among STEM teachers and students, policy makers, educators and other educational practitioners across the globe.

This fifth edition of the journal contains eleven (11) articles that have passed through peer-review by professionals. The opinions expressed are not necessarily those of the editorial board but of individual authors. These papers are very informative, educative and instructive and I therefore invite the readers to enjoy reading the contributions.

The Editorial board of UNIZIK Journal of STM Education appreciates those Who subscribe to the journal, reviewers and the consulting editors for their contributions.

**Prof. Abigail M. Osuafor**
Editor-in-Chief

## CONTENTS

# EFFECT OF COMPUTER GRAPHICS INSTRUCTIONAL MODE ON MALE AND FEMALE SECONDARY SCHOOL STUDENTS' INTEREST AND ACHIEVEMENT IN GENETICS IN ANAMBRA STATE OF NIGERIA

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**Abstract**
*There is a perceived trend of poor academic achievement and retention of students in genetics in Nigerian Secondary schools today. This situation has been attributed to many factors one of which is poor method of teaching. It is against this background that this study determined the effects of computer graphics instructional mode on secondary school male and female students' interest and achievement in genetics. Four hypotheses were tested at 0.05 level of significance. The research design was quasi – experimental. Two groups (one experimental and one control) made up of 135 senior secondary one (SS1) students were drawn from a population of 2,608 SSI students. Purposive and simple random sampling were used to select three public secondary schools from Aguata Education Zone of Anambra State. Two instruments were used for data collection namely- Genetics Interest Scale (GIS) and Genetics Achievement Test (GAT). Three experts validated the instruments. The instruments were trial tested and the GIS gave a reliability coefficient of 0.85 while the GAT gave a reliability coefficient of 0.89. Before treatment was given, the students were pretested with the GIS and GAT. After five weeks of teaching they were post-tested with GIS and GAT though the items were reshuffled to make the instrument look different from the pretest. Analysis of Co-variance (ANCOVA) was used to test the null hypotheses. The findings indicated that computer graphics instructional mode had significant effect on the mean interest and achievement scores of students in genetics. Based on the findings, it was recommended among others that biology teachers should adopt computer graphics in the teaching of genetics in order to enhance the interest and performance of students in genetics. Government and education authorities should sponsor biology teachers to workshops and seminars to learn how to improve their teaching skills using computer graphics.*
**Keywords:** Computer graphics instructional mode, interest, genetics

## Introduction

The 21st century is characterized by advancement in science and technology. No nation of the world will attain its zenith in technological development without giving proper attention to the teaching and learning of science. Biology is a branch of science that deals with life. Biology has many topics some of which are abstract and difficult for students to understand. Nzelum (2010) identified genetics, homeostasis,

evolution, nervous co-ordination, ecology, cellular respiration among others as difficult topics in secondary school biology curriculum. In addition, Cimer (2012) noted that there are five topics in biology that are most difficult which are matter cycles, endocrine system and hormones, respiration, cell division, genetics and evolution.

Genetics is an important aspect of biology that deals with heredity and variation. Umeh (2010) defined genetics as the science that deals with questions and answers on inheritance. An understanding of genetics is necessary for the diagnosis, prevention and treatment of hereditary diseases, the breeding of plants and animals and the development of industrial processes through the use of micro-organisms. Genetics can be called a science of potentials since it deals with the transfer of information from parents to offspring. Genetics gives answers to such problems as incompatibility of blood groups, hereditary diseases like sickle cell anaemia, leukemia and others. Thus, the study of genetics gives students the opportunity to explain most naturally occurring phenomenon like birth of twins, sex determination, crops and livestock failures which were hitherto explained through superstition.

Despite the importance of genetics to man, it is one aspect of biology that most teachers find difficult to teach and students find it difficult to learn because of its abstract nature. This is because it deals with inheritance of traits that can be visibly seen but the explanation is not always clearly understood. As a result, students perform poorly in genetics in both internal and external examinations. The method used by teachers in teaching genetics has been blamed for poor interest, achievement of knowledge by the students. Studies have shown that secondary school students are exhibiting low interest in genetics (Esiobu, 2015). This low interest of students has resulted in poor achievement in examination questions on genetics. Ibitoye and Fape (2017) held that poor achievement in biology could be traced to poor usage of instructional resources for biology teaching and learning, poor state of infrastructural facilities, large class size, poor teaching method, use of faulty assessment practices and inadequacy of quality. Anyaegbunam (2012) indicated that many science teachers prefer the conventional method of teaching and shy away from innovative, activity-oriented, learner-centered methods or strategies.

Computer graphics has been found effective in the teaching and learning of arts subjects like Christian Religious Knowledge. Computer graphics is the creation, storage and manipulation of drawings and pictures with the aid of computer system (Adekoya & Adekoya, 2002). Computer graphics offer the potential to increase the challenges and curiosity of tasks, as well as encourage students to be creative and use their imaginations.

Interest is an important variable in the teaching and learning of biology. This is because when one student becomes interested in an activity, one is likely to be more

deeply involved in that activity. Interest, according to Imoko and Agwagah (2006) is a subjective feeling of concentration or persisting tendency to pay attention and enjoy some activities or content. It can also be regarded as the condition of being eager to know or learn about something. Okigbo and Okeke (2011) held that though some children may be intellectually and physically capable of learning, they may never learn until their interest is stimulated.

Achievement is the act or process of finishing something successfully. Achievement is used synonymously with success. According to Ezeh (2009) achievement could be referred to as something very good or difficult which was carried out successfully. Despite the fact that various methods such as discovery, guided inquiry and expository method among others have also been in use, the Chief Examiner's annual reports and comments in biology shows that students' performance in biology have not improved appreciably (WAEC, 2019).Thus this study is geared towards finding out if Computer Graphics Instructional modes can enhance students' interest and achievement in genetics.

Gender constitutes the characteristics that distinguish the male from the female. Nworgu (2015) saw it as certain characteristics of men and women which are culturally and socially determined. Those that are biologically determined are regarded as sex. Gender influence on achievement is still inconclusive. Hence gender will be considered as an intervening variable in this study. Gender is the different socio-cultural stereotyped roles and responsibilities expected of men and women. According to Eze (2008), gender is parallel and socially unequal division into masculinity and femininity. Biases and misconceptions about women and science is that science is a male enterprise and this has remained the main focus of concern among science educators. In Nigeria, gender bias is still prevalent. It has persisted even within the science classroom. The issues of gender have generated a lot of concern for science educators in achievement. For instance, Anagbogu and Ezeliora (2007) found that females achieved better than males in science subjects while Kost, Pollock and Finkelstein (2009) found that males achieved better in science. Okoli and Okoli (2014) found that there is no statistically significant difference in the mean achievement scores of male and female students in biology. Thus, there is no consensus as to whether gender influences achievement, interest and retention in science or not. The present study therefore, is challenged with the dearth of research studies on the effect of computer graphics instructional mode in secondary school male and female students' interest and achievement in genetics in Anambra State, Nigeria.

**Statement of Problem**

Despite the importance of biology, available statistics from the West African Examination Council (WAEC, 2015 - 2019) recorded very poor performance at SSC examinations. Poor achievement in biology has been blamed on a number of factors

such as ineffective instructional strategies adopted by biology teachers and difficulty in understanding some topics in genetics. Cimer (2012) noted that there are five topics in biology that are most difficult which are matter cycles, endocrine system and hormones, respiration, cell division, genetics and evolution.

Students' poor achievement in genetics is because the topics are complex and deals with inheritance of traits that can be visibly seen but the explanation as to how the process takes place is always abstract. Consequently, students find it difficult to comprehend and retain what they were taught. To understand and perform well in genetics students must be made to be interested in the learning of the concepts. Research reports on the status of science in schools in Nigeria showed that science classroom activities are still dominated by teacher–centered method (conventional method) which have been found to be ineffective in promoting science learning at primary and secondary levels (Cimer, 2012).

Despite the fact that various methods such as discovery, guided inquiry and expository method among others have also been in use, the WAEC Chief Examiner's annual reports and comments on biology still show that students' performance in biology have not improved appreciably (WAEC, 2019). There is therefore, the need to find out if Computer Graphics Instructional modes can enhance students' interest and achievement in genetics. The study also would consider the influence of gender on students' interest and achievement in genetics.

**Purpose of the Study**

The main purpose of this study was to determine the effects of computer graphics and computer animation on students' interest and achievement in the learning of genetics. Specifically, the study determined the:

(1) difference in the mean interest rating scores of male and female students taught genetics using computer graphics and those taught using conventional method.
(2) difference in the mean achievement scores of male and female students taught genetics using computer graphics and those taught using conventional method.
(3) interaction effects of gender and method (computer graphics and conventional method) on students' mean interest scores in genetics.
(4) interaction effects of gender and method (computer graphics and conventional method) on students' mean achievement scores in genetics.

**Hypotheses**

1. There is no significant difference between the mean interest rating scores of male and female students taught genetics using computer graphics and that of those taught using conventional method.

2. .There is no significant difference between the mean achievement scores of male and female students taught genetics using computer graphics and that of those taught using conventional method.
3. There is no significant interaction between gender and the use of computer graphics and conventional method on students' mean interest rating scores in genetics.
4. There is no significant interaction between gender and the use of computer graphics and conventional method on students' mean achievement scores in genetics.

**Methodology**

The study adopted quasi–experimental design. Specifically, the study adopted a non-randomized pre-test, post-test, control group design. The area of this study was Aguata Education Zone of Anambra State. Aguata Education Zone consisted of three Local Government Areas namely: Aguata, Orumba South and Orumba North. Aguata Education zone has two tertiary institutions and 43 co-education secondary schools. The people of the area are predominantly farmers and traders. The population of the study was all the Senior Secondary year one (SS1) biology students in the 43 government owned co-educational secondary schools numbering 2,183 SSI students in Aguata Education Zone of Anambra State. The population was made up of 1,080 males and 1,103 females. Purposive and simple random sampling techniques were used to get a sample size of 135 SS1 students.

Two instruments were used for data collection, namely: Genetics Interest Scale (GIS) and Genetics Achievement Test (GAT).The GIS is a 20- item interest scale developed by the researcher with a 4- point Scale response options. The students indicated their extent of agreement or disagreement on the twenty statements (10 positive and 10 negative), The GAT was used for the pre-test and post- test. The selection of the items was based on a well-planned test- blue print to ensure even coverage of the content. The reliability of the instruments (GIS and GAT) was established through trial testing in the schools not used for the study but have homogenous environment with the schools used. Cronbach Alpha was used in determining the coefficient of the GIS and 0.85 was obtained while Kuder Richardson formula 20 (K-R 20) was used in determining the reliability coefficient of GAT and 0.87 was obtained. The research questions were answered using mean and standard deviation while the hypotheses were tested at 0.05 level of significance using ANCOVA.

**Research Procedure**

The regular teachers in the schools were employed as research assistants. They were given adequate orientation on the use of the instructional strategies and were given the lesson plans. The same topics were given to the experimental and control groups. The only difference was that the experimental group was taught using computer

graphics instructional mode while the control group was taught using conventional method. Before the treatment, the research subjects in the two groups were given pre GIS and pre GAT. After the pretest, teachers commenced the treatment and after five weeks, the post GIS and the post GAT were given. The post GAT had the same test items as the pre GAT but the items were rearranged. Data on the students' GIS and GAT from the two groups were recorded and used to answer the research questions and test the hypotheses.

## RESULTS

### Hypotheses Testing

**Hypothesis 1:** There is no significant difference between the mean interest rating scores of male and female students taught genetics using computer graphics and those taught using conventional method.

**Table 1: Summary of ANCOVA Test of Difference Between the Mean Interest Rating Scores of Students' Taught Genetics Using Computer Graphics and Those Taught Using Conventional Method**

| Source | SS | Df | MS | F | P-value | Decision |
|---|---|---|---|---|---|---|
| Corrected Model | 37.103[a] | 4 | 9.276 | 83.902 | .000 | |
| Intercept | 1.856 | 1 | 1.856 | 16.788 | .000 | |
| Pretest_Interest | 32.385 | 1 | 32.385 | 292.929 | .000 | |
| Method | 2.531 | 1 | 2.531 | 22.894 | .000 | *S |
| Gender | .145 | 1 | .145 | 1.310 | .256 | **NS |
| Method * Gender | .181 | 1 | .181 | 1.638 | .204 | NS |
| Error | 9.176 | 83 | .111 | | | |
| Total | 853.350 | 88 | | | | |

*Significant **Not Significant

In Table 1, the analysis shows that there is a significant difference in mean interest scores of male and female students taught genetics using computer graphics and those taught using conventional method, $F(1,83) = .256 P<0.05$. However, there is no significant difference between the male and female students taught genetics in both the computer graphics and conventional method groups. Therefore, the null hypothesis which posited no significant difference between the two groups is upheld.

**Hypothesis 2:** There is no significant difference between the mean achievement scores of male and female students taught genetics using computer graphics and those taught using conventional method

**Table 2: Summary of ANCOVA Test of Difference Between the Mean Achievement Scores of Students' Taught Genetics Using Computer Graphics and Those Taught Using Conventional Method.**

| Source | SS | Df | MS | F | P-value | Decision |
|---|---|---|---|---|---|---|
| Corrected Model | 4358.758[a] | 4 | 1089.690 | 31.510 | .000 | |
| Intercept | 6857.611 | 1 | 6857.611 | 198.298 | .000 | |
| Pretest_Achievement | 1409.941 | 1 | 1409.941 | 40.771 | .000 | |
| Method | 2639.476 | 1 | 2639.476 | 76.324 | .000 | S |
| Gender | 7.326 | 1 | 7.326 | .212 | .647 | NS |
| Method * Gender | 30.966 | 1 | 30.966 | .895 | .347 | NS |
| Error | 2870.333 | 83 | 34.582 | | | |
| Total | 315448.000 | 88 | | | | |
| Corrected Total | 7229.091 | 87 | | | | |

As shown in Table 2, there is a significant difference in the mean achievement scores of students taught genetics using computer graphics and those taught using conventional method, F(1,83) = .647*P*<0.05. However, there is no significant difference in the mean achievement scores of both male and female students taught genetics in both the computer graphics and conventional method groups. The null hypothesis of no significant difference between the two groups was upheld.

**Hypothesis 3:** There is no significant interaction effect of students' gender and method (computer graphics and conventional method) on students' interest in genetics. As revealed in Table 1, there is no significant interaction of gender and method on students' mean interest scores in genetics, *F(1,83)*= .204, *P<0.05*. The null hypothesis is therefore not rejected.

**Hypothesis 4:** There is no significant interaction effect of students' gender and method (computer graphics and conventional method) on students' achievement in genetics. As shown in Table 2, there is no significant interaction of gender and method on students' mean achievement scores in genetics, *F(1,83)*= .347, *P<0.05*. The null hypothesis is therefore not rejected.

**Discussion**

The combined effects of computer graphics and gender on students' interest in genetics studied was obtained by comparing the mean interest scores of male and

female students taught with computer graphics and conventional method. The ANCOVA result in table 1 $F(1,83) = .256$, $p < 0.05$ showed that there was no significant difference between the mean interest rating scores of male and female students taught genetics using computer graphics and those taught using conventional method. This means that both male and female students tended to have interest in genetics when taught using computer graphics and conventional method. The result is in line with Okoli, Akuezuilo and Okoli (2015), Ugwuadu (2011) and Egbunonu (2012) who all found out from their respective studies that gender has no effect on students' interest. However, the finding is contrary to Iweka's (2006) who found out that the interaction effect of instructional technique and gender on students' interest was significant.

The combined effects computer graphics and gender on students' achievement in genetics was obtained by comparing the mean achievement scores of male and female students taught with computer graphics and those taught with conventional method. Table 2 shows that there was no significant difference in the mean achievement scores of students taught genetics using computer graphics and those taught using conventional method where $F(1,83) = .647$, $p > 0.05$. This means that both male and female students tended to have almost the same achievement scores in genetics when taught using computer graphics and conventional method. The implication is that the relative efficacy of the instructional strategies was consistent across gender levels.

Gender as a main factor is not significant on students' achievement in genetics. Consequently, the null hypothesis of no significant difference between pre-test and post- test mean achievement scores of male and female students taught genetics using computer graphics and conventional method was accepted.

This means that both male and female students tended to have increase in achievement in genetics when taught using computer graphics and conventional method. These findings are in line with the studies of Falode et al (2016); Okoli and Okoli (2014) and Egbunonu (2012) who agreed that once equal educational and learning experiences are provided for both male and female students, achievement will be even for both sexes.

The interaction effect of method (computer graphics and conventional method) and gender on students' overall cognitive interest in Table 1 was not significant in genetics $F(1,83) = .204$, $p > 0.05$. The null hypothesis of no significant difference between the interaction effect of students' gender and method on students' achievement in genetics was therefore accepted. This implies that the relative efficacy of the instructional mode was consistent across gender level. The present study is in line with the findings of Okoli & Okoli (2014), Egbunonu (2012) which

revealed that the interaction effects of instructional technique and gender on students' achievement was not significant.

The interaction effect of method (computer graphics and conventional method) and gender on students' overall cognitive achievement in Table 2 was not significant in genetics $F(1,83) = .347$, $p > 0.05$. The null hypothesis of no significant difference between the interaction effect of students' gender and method on students' achievement in genetics was therefore accepted. This implies that the relative efficacy of the instructional mode was consistent across gender levels. The present study is in line with the findings of Okoli and Okoli (2014) and Egbunonu (2012) which revealed that the interaction effects of instructional technique and gender on students' achievement was not significant.

**Conclusion:**

On the basis of the findings, it was established that there was a significant difference in the mean interest and achievement scores of male and female students taught genetics using computer graphics and those taught using conventional method. However, there was no significant difference in the mean interest and achievement scores of both male female and students taught genetics in both computer graphics and conventional method. Also there was no significant interaction effect in the mean interest and achievement scores between the two groups

**Recommendations**

Based on the findings of this study, the following recommendations are proffered:

1. Teachers, especially those teaching biology should always adopt the computer graphics instructional mode that will enable them to cater for the diverse learning styles of students in their classrooms and hence, captivate their interest and improve their achievement in genetics.
2. Teacher education prorgrammes should include computer graphics instructional mode in biology method course content. This will ensure that the biology teachers are adequately trained on how to use computer graphics instructional mode in the teaching and learning of genetics
3. Ministries of Education, both state and Federal should organize workshops and seminars and sponsor teachers to attend in-service courses on how to use computer graphics instructional mode to improve their teaching skills which are found by this study to be effective in promoting students' interest and achievement
4. Biology teachers should pay attention to the issue of gender–related differences in the classroom. Such gender–related differences which are known not to be innate could be minimized if not eliminated through curricular restructuring or use of appropriate teaching techniques such as computer graphics instructional mode.

5. Students should be encouraged to be serious to embrace this activity-oriented and student- centered approach which will enable them carry out independent or group work such as assignment and project given to them by the biology teachers and also make their instructions authentic by relating what they have learnt to their personal experiences or real world situation.

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# JUNIOR SECONDARY SCHOOL STUDENTS' EVALUATION OF THEIR BASIC SCIENCE TEACHERS' INSTRUCTIONAL EFFECTIVENESS IN AWKA SOUTH

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**Abstract**
*The study investigated junior secondary school students' evaluation of their Basic Science teachers' instructional effectiveness. Three research questions guided the study. The study made use of the survey research design. The research was done in Awka South Local Government Area of Anambra State. The sample of the study constituted of 300 J.S.S. 2 students. The instrument titled Teachers Instructional Effectiveness Evaluation Questionnaire (TIEEQ), adapted from the NUC rubric for students' evaluation of teachers in the tertiary institutions was used for data collection. A reliability coefficient of 0.85 using Cronbach alpha was obtained for the instrument. The Mean was used in answering the research questions. The major findings from the study showed that students were in agreement that their Basic Science teachers were effective in the areas of lesson organization and planning, teacher-student interaction and the use of instructional materials which were covered by the study. It was recommended among other things that school authorities should use students' evaluation of teaching for evaluating teachers' teaching effectiveness.*
**Keywords:** Basic Science, teachers' effectiveness, students' evaluation,

## Introduction

Formal education in Nigeria was introduced by the foreign missionaries in 1842 (Omiko, 2016). The curriculum at this period emphasized majorly on three things; arithmetic, writing and reading. This system of formal education proceeded further into pre-primary, primary, post-primary and the tertiary levels. High quality teaching at each of these levels has been widely acknowledged to be the most important factor influencing sustainable education. The post-primary level, also known as the secondary level is the one in which students choose subjects that would help build their career path. The secondary education is considered the pivot around which the development of a nation's economy revolves; it is the engine room that provides input resources into the nation's economy and tertiary education system (Omoniyi, 2014). A focus on standards in secondary schools is timing and a wise attempt in identifying the direction at which the nation is heading, and determining whether a nation is on course towards realizing her dreams in running secondary schools, or whether she needs to return to the drawing board. When one gets it right at the secondary education level, they are likely to get it right at the tertiary level; and part

of the team that will not proceed to the tertiary level can become useful and productive members of the society (Joshua, 2004). The secondary level of education is basically divided into the junior secondary school (J.S.S) level and the senior secondary school (S.S.S) level, and it is at the J.S.S level that Basic Science is taught as a subject.

Basic Science according to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2001) is defined as an approach to the teaching of science which involves the expression and the presentation of science concepts and principles as a fundamental unit of scientific thought, in order to avoid undue stress in the distinction between the various scientific fields. Omiko (2015) defined Basic Science as the study which involves the study of elementary biology, anatomy, earth/solar system, ecology, genetics, chemistry and physics as a single science subject in the Junior Secondary School. It offers the basic training in scientific skills required for human survival, sustainable development and societal transformation (FRN, 2008). Basic science studies also involve bringing together traditionally separate science subjects so that students grasp a more authentic understanding of science.

The change from the 6-3-3-4 system of education introduced in Nigeria in 1980 by the Federal Government to the 9-3-4 system introduced in the year 2008 and the review of the 9-3-4 system of education done in the year 2012 by the Federal Government saw the change in the name and scope of Integrated Science to Basic Science and then to Basic Science and Technology. According to the Nigerian Educational Research and Development Council (NERDC, 2012), the objectives of Basic Science and Technology should be directed at enabling students who are exposed in it, to acquire the following:

1. Develop interest in science and technology
2. Acquire basic knowledge and skills in science and technology
3. Apply scientific and technological knowledge and skills to contemporary societal needs
4. Take advantage of the numerous career opportunities provided by Science and technology
5. Become prepared for further studies in science and technology
6. Avoid drug abuse and related vices and
7. Be safety and security conscious.

To achieve these objectives, effectiveness in the instructional delivery of Basic Science lessons is very crucial. To ensure effective teaching in general and particularly in Basic Science, teachers' instructional delivery are often reviewed through a process of evaluation. Ifamuyiwa (2006) sees evaluation as the process of gathering valuable information on attainment of educational objectives, analyzing and fashioning those information to aid judgement on the effectiveness of teaching

or an educational programme. The process of evaluation involves two dimensions; gathering of data and using the gathered data to make judgements or take decisions according to specific standards. Evaluation according to Moyinoluwa (2014) can be both formative (occurring during the process of teaching) and summative (occurring at the end of the implementation of an instructional programme). Evaluation of teaching can be done by the teachers themselves, and it is called self-evaluation, or by their colleagues, which is called peer evaluation or by their superiors, which is called hierarchical evaluation or better still, it can be done by their subordinates which in this case are the students and this is called students' evaluation. Literature according to Vevere and Kozlins (2011) have shown the importance of students' evaluation of their teachers' instructional practices, as an important factor that causes the teachers to improve on their teaching.

Students' evaluation of their teachers' instructional effectiveness, is one among the approaches of teacher evaluation. This approach implies that students are taught by a teacher and are made to express their opinions and feelings concerning the effectiveness of the teacher's instructional processes and behaviours over a period of time, and the extent to which they have benefitted from those processes/behaviours. The use of students' ratings in teacher evaluation is predicated according to Joshua (2004) on the following assumptions;

1. the student knows when they have been motivated to learn
2. it is the student whose behaviour(s) is to be changed
3. student ratings constitute feedback to the teacher
4. student recognition may promote or motivate good teaching

Paulsene (2002) opined that students' evaluation of a teacher's teaching plays dominant role in the operational definition of what constitute effective teaching as the students themselves are seen as being in a better position than any significant others to say how they have been affected by any teaching process. Research done by Socha (2009) has also proven that students' evaluation of their teachers' instructional effectiveness is a valid and a reliable source of data for teacher evaluation. It is important for students to regularly evaluate their teachers' instructional practices as it is a form of feedback to the school authority to know how to promote or to judge which teacher is in need of requisite training and whether they should be retrained.

The rubric for students' evaluation of teachers developed by the Nigerian University Commission (NUC) to be used in Nigerian universities covered the following aspects: good organization and planning, teacher-student interaction, clarity, effective communication, grading, flexibility of approaches towards teaching, rating of supplementary/instructional materials, teachers' supportive attitude, and overall ratings. This study will however concentrate on teachers' lesson organization and planning, teacher-student interaction and the use of instructional materials since

according to Cashin (2003) students are in a better position to evaluate their teachers in these aspects. Though students' evaluation of teaching effectiveness is being used as an important source of data for teacher evaluation by many nations of the world, Nigeria is only introducing its usage in her institutions of higher learning, leaving out the foundational education levels of which the secondary school level is part of. The study sought to determine junior secondary school students' evaluation of their Basic Science teachers' instructional effectiveness in Awka South Local Government Area of Anambra State. The study specifically sought to determine:

1. the junior secondary school students' mean evaluation scores of their Basic Science teachers' lesson organization and planning.
2. the junior secondary school students' mean evaluation scores of their Basic Science teacher-student interaction.
3. the junior secondary school students' mean evaluation scores of their Basic Science teachers' use of instructional materials.

**Research Questions**

Three research questions guided the study:

1. What are the Junior Secondary School students' mean evaluation scores of their Basic Science teachers' lesson organization and planning?
2. What are the Junior Secondary School students' mean evaluation scores of their Basic Science teacher-student interaction?
3. What are the Junior Secondary School students' mean evaluation score of their Basic Science teachers' use of instructional materials?

**Methodology**

The study adopted the survey research design. This type of design (Anikweze, 2013) involves a detailed and critical examination of a topic or situation with a view of finding out what is and how it is. The target population of the study comprised of all the 2615 J.S.S. 2 students in the 15 government owned co-educational secondary schools in Awka South LGA of Anambra State. The choice of J.S.S. 2 was based on the fact that the students have been exposed to learning Basic Science at least for 1 year. They are expected to have attained certain level of intellectual ability to be able to answer raised questions on teachers' instructional effectiveness. Simple random sampling technique was used in constituting a sample of 300 J.S.S. 2 students.

The instrument titled "Teachers' Instructional Effectiveness Evaluation Questionnaire (TIEEQ)" adapted from the NUC rubric for students' evaluation of teachers was used for collecting data. The TIEEQ was developed with a four-point rating scale of strongly agree (SA), agree (A), disagree (D) and strongly disagree (SD). The instrument was validated and found reliable at a reliability index of 0.85 using Cronbach alpha technique. Copies of the instrument were administered to the

respondents with the help of three research assistants. In answering the research questions, any mean with cut-off point of 2.50 and above was taken to be agreed while any mean less than 2.50 were taken as disagreed.

**Results and Discussion**

The results of the research based on the research questions are summarized thus.

**Research Question One:** What are the junior secondary school students' mean evaluation scores of their Basic Science teachers' lesson organization and planning?

**Table 1: Mean evaluation scores of junior secondary school students on their Basic Science teachers' lesson organization and planning.**

| S/N | ITEMS | N | MEAN | REMARK |
|---|---|---|---|---|
| | My Basic Science teacher; | | | |
| 1 | Plans each class carefully | 300 | 3.60 | Agree |
| 2 | Organizes each lesson well enough to ensure maximum learning | 300 | 3.59 | Agree |
| 3 | Is time conscious and does not waste teaching time on less important things | 300 | 3.40 | Agree |
| 4 | Delivers instruction in a way as to carry slow learners along | 300 | 3.34 | Agree |
| 5 | Provides enough time for students to take notes | 300 | 3.30 | Agree |

N= Number of respondents

The results of research question one as presented in table 1 indicates that the students agreed that their Basic Science teacher plans each class carefully, organizes each lesson well enough to ensure maximum learning, is time conscious and does not waste teaching time on less important things, delivers instruction in a way as to carry slow learners along and provides enough time for students to take notes. In other words, these students agreed that their Basic Science teacher's lesson organization and planning was good and it encouraged them to do better in class.

**Research Question Two:** What are the junior secondary school students' mean evaluation scores of their Basic Science teacher-student interaction?

**Table 2: Mean evaluation scores of junior secondary school students on their Basic Science teacher-student interaction.**

| S/N | ITEMS | N | MEAN | REMARK |
|---|---|---|---|---|
| | My Basic Science teacher; | | | |
| 1 | Encourages the students to ask questions | 300 | 3.67 | Agree |
| 2 | Treats students with respect and regard for | 300 | 3.21 | Agree |

| | | | | |
|---|---|---|---|---|
| | dignity | | | |
| 3 | Seems willing to offer individual help to students | 300 | 3.05 | Agree |
| 4 | Motivates us to work hard and achieve | 300 | 3.58 | Agree |
| 5 | Encourages the students to contribute in the class | 300 | 3.13 | Agree |

N= Number of respondents

The result of research question two as shown in table 2 shows that there was an agreement by the students on their Basic Science teacher-student interaction in the area of encouraging them to ask questions, treating them with respect and regard for dignity, willingness in offering individual help to students, motivating them to work hard and achieve and encouraging them to contribute in classroom discussion and all these in overall help increase their interest in the subject.

**Research Question Three:** What are the junior secondary school students' mean evaluation score of their Basic Science teachers' use of instructional materials?

**Table 3: Mean evaluation scores of junior secondary school students on their Basic Science teachers' use of instructional materials.**

| S/N | ITEMS | N | MEAN | REMARK |
|---|---|---|---|---|
| | My Basic Science teacher; | | | |
| 1 | Uses recommended textbooks for teaching | 300 | 2.89 | Agree |
| 2 | Uses charts and diagrams to explain topics to us | 300 | 3.14 | Agree |
| 3 | Uses models in explaining concepts to us | 300 | 2.56 | Agree |
| 4 | Uses real life objects such as oranges, pawpaw to teach life-oriented topics | 300 | 2.22 | Disagree |
| 5 | Uses durable instructional materials that are re-useable | 300 | 2.65 | Agree |

N= Number of respondents

The result obtained from research question three as seen in table 5 indicates that the students used for the study, agreed that their Basic Science teachers use recommended textbooks, improvised and durable instructional materials that guarantees effective learning but disagreed on their Basic Science teachers' use of real life objects in teaching life-oriented concepts.

**Conclusion**

The study thus concludes that the Basic Science teachers' instructional delivery is effective, commendable and positive as far as the students are concerned especially in the aspect of the Basic Science teachers' lesson organization and planning, teacher-student interaction and the use of instructional materials.

**Recommendations**

The following recommendations were made based on the findings from the study;

1. Teachers should keep up the good work as the study has shown that their teaching methods and classroom behaviours influence the students positively.
2. Lessons should be made more fascinating since the students were of the opinion that the stimuli provided by the teachers prompt positive responses from the students.
3. Teachers should use life objects in teaching the students life-oriented concepts for better and easier comprehension.
4. Secondary school authorities should be serious in the use of students' evaluation in evaluating teachers' teaching.
5. Interpretations of scores from students' evaluation of teaching should serve as one of the criteria to guide employers of labour in the secondary schools in deciding whether or not a person's employment would be confirmed.
6. In order to avoid abuse of and cruelty associated with students' evaluation of teaching, the feedback obtained would be better used initially for formative purposes which would benefit both the students and their teachers especially in the area of knowledge transfer.

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# SELF-EFFICACY AND MOTIVATION AS CORRELATES OF SECONDARY SCHOOL STUDENTS'ACADEMIC ACHIEVEMENT IN PHYSICS

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**Abstract**
*The study was carried out on Self-efficacy and Motivation as correlates of secondary school students' academic achievement in Physics in Enugu state.. Three research questions and three null hypotheses were used to guide the study. The researchers adopted a correlation survey design. The sample comprises of 384 SSII physics students which were drawn from 12 out of 25 government owned secondary schools in Enugu Education Zone of Enugu State using a multi-stage sampling technique. Physics Self- Efficacy Questionnaire (PSEQ) and Physics Motivation Questionnaire (PMQ) were used for data collection. The PSEQ consists of 20 items measured in 5-point Likert scale format and adapted from Sawtelle (2011) while the PMQ also consists of 20 items measured in 5-point Likert scale format and adapted from Mubeen and Reid (2014). Pearson Product Moment Correlation and Regression analysis were used to answer and test the research questions and hypotheses respectively. The findings of the study indicated that self-efficacy was not a significant factor on students' academic achievement in physics, while motivation was a significant factor on students' academic achievement in physics. The findings also revealed that there was a low positive relationship between self-efficacy and motivation on students' academic achievement in Physics. Motivation was of great influence on students' academic achievement in Physics while self-efficacy had no significant influence on academic achievement in Physics. Based on the findings, it was recommended that; Teacher education programmes should train teachers on ways to improve their students' motivation, both state and federal governments should organize workshops and seminars and sponsor teachers to attend in-service courses on how to improve their teaching skills in order to enhance their students' achievement.*
**Keywords:** Self-efficacy, motivation, academic achievement.

## Introduction

Education is described as the development of desirable qualities in people. This is why the basic principle of education in Nigeria is equipping every citizen with knowledge, skills, attitudes and values as to enable one to derive maximum benefits from one's membership in a society, live a fulfilling life and contribute to the development and welfare of the society. In the spirit of promoting basic education

and 'education for all' there was a plan to provide every child with nine year schooling up to the junior secondary school level (World Data on Education, 2010).

Education helps an individual to achieve knowledge, skills, values and attitudes and be able to translate it into benefit, leading to a fulfilled life and equally contributing to the welfare of their community (Pahalson& Habila, 2014). Education therefore is a change agent that transforms an individual or society from primitive way of life of the Dark Age to modern society of today which is full of scientific and technological inventions. Hence, the valuable roles of science and technology cannot be overemphasized.

Science and technology study is the study of how social, political and cultural values affect scientific research and technological innovation, and how these, in turn affect society, politics and culture. Science and technology is quite a broad category and it covers everything from studying the stars and the planets to studying molecules and viruses. Beginning with the Greeks and Hipparchus and Galileo and today, man continues to learn more and more about the world. In technology, you will find many things that make life easy today. This includes medical advances like magnetic resonance imaging machines, portable computing devices and flat screen televisions.

Science which is a branch of study and part of education is as old as man. Since the inception of science, emphasis has been laid on the study and improvement of science because of its impact on the technology of nations. Its valuable role cannot be over emphasized in the societal world. According to Ezema (2011), science is an ever expanding dynamic subject involving the study of natural phenomenon and matter. It is a systematic enterprise that builds and organizes knowledge in the form of testable explanation and predictions about the universe. The introduction of science into Nigeria's post primary institution according to Ebeh (2009) started as early as 1878. It was taught as "general science" before with some basic ideas of Chemistry, Biology and Physics. The general sciences were suitable for least science oriented students who cannot pursue science beyond O'level stage. Later, there was introduction of core science subjects which emerged from the general science. The core subjects are Biology, Chemistry and Physics.

Physics which is a branch of science is one of the core science subjects taught at the senior secondary school level of the Nigeria education system and is highly needed for technological breakthrough. It is a branch of science that deals with energy and matter and their interactions. It is sometimes referred to as the science of measurement and its knowledge has contributed greatly to the production of instruments and devices of tremendous benefits to the human race (Sani, 2012). The knowledge of physics is usually required to pursue courses like Astronomy, Geology, Medicine, Pharmacy, Engineering among others. Udoh (2012) established that learning of physics offers the students an opportunity to think critically, reason

analytically and acquire the spirit of enquiry. This is why he asserted that: physics is crucial for effective living in the modern age of science and technology. Given its application in industry and many other professions, it is necessary that every student is given an opportunity to acquire some of its concepts, principles and skills.

Despite the importance of physics as a subject, it is widely recognized that the teaching and learning of physics has been fraught with challenges such as low enrolment both in secondary schools and in tertiary institutions in Nigeria (Ojediran, 2016). Among the causes of low enrolment of students offering physics in schools include poor science and mathematics background of students at the junior secondary level of education, poorly equipped physics laboratory, inadequate motivation of teachers and students, poor remuneration, inappropriate teaching strategies employed by the teachers, insufficient number of qualified physics teachers, lack of proper orientation to the students, lack of indigenous textbooks (NERDC, 2009; Jegede & Adedayo, 2013; Sani, 2012).

These factors have equally added to decline in performance of students who enrolled for physics at the Senior Secondary Certificate Examination (SSCE). This is evident in the West African Examination Council (WAEC) results between 2011 and 2016. A total of 165,604 candidates, representing 31.28% who sat for the 2016 WAEC in Nigeria, obtained credits and above in physics when compared to what was obtained in the same examination in 2015, 29.27%, 2014, 29.17%, 2013, 38.81%, 2012, 26.80% and 2011, 32.64%. This shows that performance in Physics not only fluctuates but also declines with years. The problem of low enrolment of students in physics class and poor performance of physics students in SSCE had been in part attributed to students' attitudes towards the subject and students' misconceptions that Physics and most science subjects are difficult (Mekonnen, 2014). Affective factors such as anxiety, attitudes, interests, values, preferences, self-esteem, locus of control, motivation and self-efficacy influence students learning behavior and affect their final academic achievement in their coursework. In this study, focus is on self-efficacy and motivation.

Self-efficacy is the beliefs in one's capabilities to organize and execute the courses of action required for producing a given attainment. It refers not to the actual abilities of someone to perform certain tasks but rather to their self-perception of being able to perform certain tasks under given conditions. The importance of self-efficacy appears to depend on its ability to affect human's choices and behaviours. Indeed, Bandura (2006) supported that self-efficacy plays a key role in the development of human achievements and motivations. Bandura's work strongly supports the motion that human behaviours, their motivations as well as the outcome of their actions (success or failure) are the product of their self-efficacy. Thus, the way people think, feel, act and motivate themselves is affected by self-efficacy. Researchers studying self-efficacy suggest that people lacking in self-efficacy have

problems with motivating themselves to carryout tasks. When students have the impression that they will not be able to complete a certain task they will not make an effort to fulfill it and they will easily quit.

Academic self-efficacy includes various learning and teaching processes. Jamali, Noroozi and Tahmasobi (2012) referred to academic self-efficacy as students' perceptions of their competence to do their class work. Academic self-efficacy refers to individuals' convictions that they can successfully perform given academic tasks at designated levels, which also includes the beliefs about the capabilities to achieve the tasks in certain academic fields. This belief is closely linked to self-concept which is a general self-descriptive belief that incorporates many forms of self-knowledge and self-evaluative feelings.

Motivation on the other hand, is an inner drive that directs a student's behaviour towards the fulfillment of a goal. Motivation is a goal-directed behaviour and indicates the willingness of the students to exert high levels of effort toward achieving goals. Motivation influences how and why people learn as well as their academic achievement. Research opinions have suggested the validity of self-efficacy as a predictor of student's motivation and learning. To perceive the relationship between self-efficacy and motivation, self-efficacy is observed to be a major ingredient in motivation (Bandura, 2006). Self in this context is seen as cognitive structure that provides references mechanisms and a set of sub-functions for perception, evaluation and regulation of behaviour.

Therefore, it is important to determine the variables that influence students' achievement in physics; and this study now explored self-efficacy and motivation as correlates of secondary school students' academic achievement in Physics.

**Statement of the Problem**

The development in technology in Nigeria is poor and this contributes immensely to the state of underdevelopment in Nigeria (Adedayo & Jegede, 2013). There is need to redress and bring about a worthwhile growth in technology. Given that physics is one of the major subjects meant to provide the basic developments needed in technology, its effective learning should be put into consideration by adopting different strategies that will promote learning.

Majority of the students in the secondary schools in Nigeria perceive physics as a difficult subject. The cause of the negative perception of students towards physics was identified to include the fear of the mathematical skills involved, poor teacher-students relationship, students' un-readiness to study, preconceived bad information that physics is a difficult subject and poor method of teaching. This impression greatly affects students' readiness, interest, motivation and self-efficacy to the study of physics. If the situation is left unchecked, the performance of the students

academically will be affected negatively and this becomes a problem. There is the need therefore, to examine the relationship between some affective factors like self-concept and motivation and students' academic achievement in Physics.

**Research Questions**

The following research questions guided the study;

1. What is the relationship between students' self-efficacy and their academic achievement in physics?
2. What is the relationship between students' motivation and their academic achievement in physics?
3. What is the joint influence of self-efficacy and motivation on students' academic achievement in physics?

**Hypotheses**

The study tested the following null hypotheses:

1. There is no significant relationship between students' self-efficacy and their academic achievement in physics.
2. The relationship between students' motivation and their academic achievement in physics was not significant.
3. There is no significant correlation among students' self- efficacy, motivation and their academic achievement in physics.

**METHOD**

The correlation survey design was used in this study. The correlation survey studies according to Nworgu (2015) seek to establish what relationship exists between two or more variables. The study was conducted in Enugu Education Zone of Enugu State. There are 25 public senior secondary schools in the zone. The population of the study was made up of the entire Senior Secondary two (SSII) Physics Students totaling 1,911 students in the 25 government owned secondary schools within Enugu Education Zone.

The sample comprises of 384 SSII physics students' who were drawn from 12 out of 25 government owned schools in Enugu Education Zone, using the multi-stage sampling technique. Two (2) instruments were used for data collection. These are: Self-Efficacy Questionnaire (SEQ) and Physics Achievement Motivation Questionnaire (PAMQ). The self-efficacy questionnaire developed by Sawtelle (2011) was adapted to determine students' self-efficacy in Physics. This instrument consists of 20 items. Participant's responses were measured using 5-point Likert scale ranging from "strongly agree" to "strongly disagree". The Physics achievement motivation questionnaire (PAMQ) developed by Mubeen and Reid (2014) was adapted to determine students' achievement motivation in physics. This instrument consists of 20 items. Participant's responses were measured using 5- point Likert

scale ranging from "strongly agree" to "strongly disagree". Students' cumulative annual results of the 2017/2018 session were also used.

The instruments were validated by experts and a reliability coefficient was established to be 0.91 for Physics Self- Efficacy Questionnaire and 0.89 for Physics Achievement Motivation Questionnaire. The researcher with the aid of research assistants which were subject teachers in the sampled schools distributed the instruments to the respondents. After the students have filled the instruments, their names were used to obtain their results. Pearson product moment correlation and regression analysis were used to answer the research questions while the hypotheses were tested at 0.05 level of significance by comparing the computed correlation index against the critical values for appropriate decision. Any correlation coefficient r=+ or - 0.3 shows a low relationship while above 0.3 shows high relationship. Null hypothesis was rejected when p-value is less than (<) 0.05, otherwise it was not rejected.

**Results**

**Research Question 1:** What is the relationship between students' self-efficacy and their academic achievement in physics?

**Table 1:**
**Correlation of Students' Self-efficacy and Achievement in Physics**

| **Predictor** | **N** | **Achievement in physics r** | **Self-efficacy r** | **Remark** |
|---|---|---|---|---|
| **Self-efficacy** | **384** | **0.074** | **1.00** | **low positive Relationship** |
| Sig. (1-tailed) | | 0.073 | | |

Table 1 shows the relationship between students' Physics self-efficacy and achievement, which indicated a low positive Pearson's coefficient of 0.074. This means that as students Physics self-efficacy goes up, their Physics achievement also increases. However, the strength of this positive relationship between the variables is weak since 0.074 is less than 0.3 showing a weak positive relationship.

**Hypothesis 1:** There is no significant relationship between secondary school students' self-efficacy and their academic achievement in physics.

The data on Table 1 also showed that the positive correlation that existed between Physics students' self-efficacy and their achievement was not significant, since the

p-value of 0.073 obtained was greater than 0.05 level of significance in which the hypothesis was stated.

**Research Question 2:** What is the relationship between students' motivation and their academic achievement in physics?

**Table 2:**
**Correlation of Students' Motivation and Academic Achievement in Physics**

| **Predictor** | **N** | **Achievement in physics r** | **motivation r** | **Remark** |
|---|---|---|---|---|
| **Self-efficacy** | **384** | **0.182** | **1.00** | **low positive Relationship** |
| Sig. (1-tailed) | | 0.001 | | |

Table 2 shows the relationship between students Physics motivation and achievement, which indicated a low positive Pearson's coefficient of 0.182. This means that as students Physics motivation goes up, the value of their Physics achievement also increases. However, the strength of this positive relationship between the variables is weak since 0.182 is less than 0.3 which shows weak positive relationship.

**Hypothesis 2:** The relationship between students' motivation and their academic achievement in physics was not significant.

The data on Table 2 also showed that the positive correlation that existed between physics students' motivation and their achievement was significant, since the p-value of 0.001 obtained was less than 0.05 level of significance in which the hypothesis was stated.

**Research Question 3:** What is the joint influence of self-efficacy and motivation on students' academic achievement in physics?

**Table 3:**
**Regression Analysis of Students Self-efficacy, Motivation and Achievement in Physics**

| **Predictors** | **b** | **SEb** | **β** | **t** | **Sig.** |
|---|---|---|---|---|---|
| Constant | 31.375 | 5.497 | | 5.798 | .000 |
| Self-efficacy | .060 | .050 | .061 | 1.200 | .231 |
| Motivation | .205 | .058 | .177 | 3.519 | .000 |

Table 3 shows the combined relationship between physics self-efficacy, motivation and academic achievement. From the table, both predictors have positive b-values

0.060 (self-efficacy) and 0.205 (motivation) indicating positive relationships. So as students' self-efficacy increases, achievement increases and as physics motivation increases, achievement also increases. Physics motivation showed a stronger positive relationship with achievement than self-efficacy.

**Hypothesis 3:** There is no significant correlation among secondary school students' self-efficacy, motivation and their academic achievement in physics.

The data on Table 3 also showed that the positive relationship between self-efficacy achievement (self-efficacy, $t(381) = 1.200$; $p = 0.231$) was not significant since the p-value of 0.231 obtained was greater than 0.05. While, the positive relationship between motivation and achievement (motivation, $t(381) = 3.519$; $p = 0.001$) was significant since the p-value of 0.001 obtained was less than 0.05.

**Discussion**

Self-efficacy was not a significant factor on students' achievement in physics since the p-value of 0.073 obtained is greater than 0.05. The result showed that self-efficacy had positive correlation with students' achievement but the positive relationship had no significant direct effect on achievement. This finding contradicted the result findings of Ghazanfar and Akram (2014), Screenivasulu (2015) and Deniz and Hatice (2016), whose results revealed significant influence of self-efficacy on achievement of students. Their findings proved that improvement of students' physics self-efficacy increases their tendency toward meaningful learning.

Motivation was a significant factor on students achievement in physics since the p-value of 0.001 obtained was less than 0.05. This means that motivation is positively correlated and significantly influences students' achievement in physics. This finding is in agreement with those of Chow and Seng Yong (2013) and Deniz and Hatice (2016), whose findings revealed that there is a significant influence of motivation on achievement.

The combined relationship between self-efficacy and motivation on students' achievement in physics proved that both self-efficacy and motivation had positive influence on students' achievement. This positive impact on students' academic achievement was significant for motivation and not significant in the case of self-efficacy. This result is partly in agreement with the findings of Sahile (2014) and Deniz and Hatice (2016) which revealed that motivation and self-efficacy were significant predictors of students' academic achievement.

**Conclusion**

The study had shown that there was a low positive relationship between self-efficacy and motivation on students' academic achievement in Physics. Motivation was of

greater influence on students' academic achievement in Physics while self-efficacy had no significant influence on academic achievement in Physics.

**Recommendations**

Based on the findings of this study, the following recommendations are put forward.

1. Teacher education programmes should include training of teachers on ways of improving their students' achievement motivation by adopting different teaching strategies and skills.
2. Ministries of education, both state and federal should organize workshops and seminars and sponsor teachers to attend in service courses on how to improve their teaching skills in order to enhance their students' achievement motivation, thereby effectively promoting students' academic achievement.
3. Teachers' training centers and supervision departments at schools should put in more efforts in helping teachers' perceive the importance of using activities and procedures that improve students' achievement motivation both intrinsically and extrinsically.

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# LEVEL OF ACQUISITION OF LABORATORY MANAGERIAL SKILLS BY BASIC SCIENCE TEACHERS IN SECONDARY SCHOOLS IN ANAMBRA STATE

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**ABSTRACT**
*The study investigated the level of acquisition of laboratory managerial skills by basic sciences teachers in secondary schools in Anambra Stae. Two research questions guided the study while two hypotheses were tested at 0.05 level of significance. The design of the study was descriptive survey design. The population of the study comprised of 298 basic science teachers from Aguata, Awka, Nnewi, Ogidi, Onitsha and Otuocha zones. The entire population was studied without sampling due to its manageable size. The instrument for data collection was a researcher-developed instrument tagged Acquisition of Laboratory Managerial Skills Questionnaire (ALMSQ). The instrument was validated by two experts and the reliability of the instrument was established using Cronbach alpha which yielded reliability co-efficient of 0.90. The research questions were analyzed using mean while the null hypotheses were tested using t-test and ANOVA. The findings of the study revealed that basic science teachers had high level of acquisition of laboratory managerial skills; teaching experience had significant contributions to basic science teachers' level of acquisition of laboratory skills, and that their academic qualifications had no significant effect. Based on the findings, the study recommended that since the basic science teachers in secondary schools have high level of acquisition of laboratory managerial skills, Government, Education Managers and Administrators in Nigeria should create a unit in the Ministry of Education to handle issues that will promote and sustain the basic science teachers' applications of these skills for effective teaching and enhancement of students' achievement in basic science.*
**Keywords:** Laboratory Managerial Skills, Basic Science Teachers, Basic Science

## Introduction

It is becoming increasingly apparent that the economically developed countries of the world achieved their position of eminence by dint of hard work based on a scientific approach to life endeavours. Since its inception in Nigeria, science education has brought a dramatic development in the area of education, science and technology as well as contributing immensely to the growth of the nation's economy. Science education is the scholarly and practical discipline concerned with the teaching, learning and assessment of science content, science process as well as nature of science (Obialor, 2018). No nation can afford to neglect science education

at any level of education and hope to thrive in any field of human endeavour. Science education is imperative for useful living in any society. It is at the centre for producing resources necessary for socio-economic, scientific and technological development needed for advancement of any nation (Osuafor & Okonkwo, 2013), Nigeria inclusive

In Nigeria, science education is taught at all levels of the educational system from pre-primary through primary and secondary school to tertiary levels. Science education in primary schools is taught as a component of basic science and technology (Federal Ministry of Education, 2007). At the junior secondary school level, science education is taught as basic science (Federal Ministry of Education, 2007). At the senior secondary school level, science education is taught as chemistry, biology and physics, although, students are not expected to offer all three of them but at least one (Afemikhe, Imobehai & Ogbuanya, 2015), except those with the aim of advancing in science related fields at the tertiary institutions. The Universal Basic Education has coined basic science in place of the earlier known integrated science to cater for both practical and theoretical aspects of science at primary and junior secondary schools in Nigeria (Otarigho&Oruese, 2013).

Basic Science is an introductory course to the study of the sciences in the senior secondary school (Omiko, 2016). Ukpabi in Omiko (2015) defined Basic Science as a science in differentiated form which stresses the fundamentals of science. Basic science involves the study of elementary biology, anatomy, earth/solar system, ecology, genetics, chemistry and physics as a single science subject in the Junior Secondary school. It offers the basic training in scientific skills required for human survival, sustainable development and societal transformation. Basic science studies also involve bringing together traditionally separate science subjects so that students grasp a more understanding of science and one of the guiding principles of the National Science Education Standards (NSES) is simply science for all students. It is in realization of this fact that the Federal Republic of Nigeria in the National Policy on Education (FRN, 2013) stated that secondary education should among other things equip students to live effectively in our modern age of science and technology.

It is a basic fact that the development of science and technology requires not only resources but effective use of such resources. These resources are found in the laboratories. Ufondu (2011) observed that laboratory is an indispensable organ of the school but many Basic Science teachers are not doing well in their level of acquisition of laboratory management skills such as in laboratory equipment procurement, storage and safety and maintenance practices. Ezeano and Ezeudo (2013) argued that proper management of student's prerequisite skills in the laboratory will lead to acquisition of a higher skill or easier understanding of the required skills. Management pattern of practical work in science laboratory can

ensure sequential move from basic practical skills to fundamental science skills needed in future career. Hruz (2019) asserted that effective laboratory management is a learned skill which involves regular meetings and delegating responsibility. Management of science laboratory therefore means the running and controlling of materials and human resources (Ezeano& Ezeudo, 2013).

According to Eze and Akubue (2007), it is expected of science teachers to possess laboratory management skills after graduation. It is necessary, therefore, that science teachers should employ such laboratory skills as maintenance of equipment, ordering, stocking and storage of equipment and chemicals, and also safety precautions. These skills when properly applied will help to improve the quality of teaching and learning of science subjects in the secondary schools. Nevertheless, since skills are not innate attributes but must be acquired externally. The level of acquisition of managerial skills by science teachers determines how much impact they will have on the students. Osuafor and Ezeobi (2017) discovered that laboratories in Secondary School in Awka South Local Government of Anambra State are not properly organized and managed by the concerned staff or teachers. Nevertheless, teaching experience and qualification may likely be factors contributing to the level of acquisition of managerial skills by science teachers.

Experienced teachers are considered to be more able to concentrate on the most appropriate way to teach particular topics to students who differ in their abilities, prior knowledge and backgrounds. They believe that teacher's attendance of in-service training is one of the indicators of experience. In addition, the more the teachers know about students, the better the teachers can connect with them and the more likely they will be able to benefit from the teacher's experience in reconstructing their world. Teaching qualification on the other hand, is the number of academic and professional degrees that enables a person to become a registered teacher in primary or secondary school. Such qualifications include but are not limited to, the Postgraduate Certificate in Education (PGCE), Professional Diploma in Education (PDE), Bachelor of Education (B.Ed.) and Nigeria Certificate in Education (NCE). Based on these facts,one may wonder if the basic science teachers had the qualification and experience needed for effective laboratory management of the Basic Science laboratories. This study therefore aims at investigating the level of acquisition of laboratory managerial skills by Basic Science teachers in Anambra State.

**Purpose of the study**

The purpose of this study was to investigate the level of acquisition of laboratory managerial skills by basic science teachers in Anambra State. Specifically, the study accessed: objectives:

1. The level of acquisition of laboratory managerial skills of basic science teachers based on their teaching experience;

2. The level of acquisition of laboratory managerial skills of basic science teachers based on their qualifications.

**Research Questions**

The following research questions guided the study

1. What is the level of acquisition of laboratory managerial skills of basic science teachers based on their teaching experience?
2. What is the level of acquisition of laboratory managerial skills of basic science teacher based on their qualifications?

**Hypotheses**

The following null hypotheses were formulated and tested at 0.05 level of significance

1. There is no significant difference in the level of acquisition of laboratory managerial skills among basic science teachers in Junior Secondary Schools, based on their years of teaching experience.
2. There is no significant difference in the level of acquisition of laboratory managerial skills among basic science teachers in Secondary Schools based on their qualifications.

**Method**

The design for the study was descriptive survey design. According to Nworgu (2015), descriptive survey design is one in which a group of people or items is studied by collecting and analyzing data from only a few people or items considered to be representative of the entire study. The population for this study consisted of all the 298 basic science teachers in all the 261 public secondary schools in the six education zone in Anambra State. Sampling was not done because the entire population of the basic science teachers (298) was deemed not to be too large; therefore all the basic science teachers in all the 261public secondary schools in the six education zone formed the sample for the study. The instrument for data collection was tagged "Acquisition of Laboratory Managerial Skills Questionnaire (ALMSQ)". The instrument was divided into two sections, A and B. Section A consists of personal characteristics of the teachers while section B contains 26 items that were used to elicit information on the level of acquisition of laboratory managerial skills by Basic Science teachers. The instrument used was developed through information from literature and was subjected to face validation by two experts, one from department of science education, Nnamdi Azikiwe University, Awka and one experienced secondary school basic science teacher. The reliability of the instrument was determined using Cronbach alpha method which yielded internal consistency value of 0.90. The researchers administered the copies of the questionnaire personally to the 298 basic science teachers and all the copies were collected after completion. Data collected were analyzed using mean to answer the research questions and t-test and ANOVA to test the hypotheses at 0.05 level of

significance. Mean scores of 2.50 and above indicates high level of acquisition of laboratory managerial skills while mean scores below 2.50 indicates low level of acquisition of laboratory managerial skills. Also, a hypothesis is rejected when the P-value is less than (<) 0.05, otherwise, it is not rejected.

## Results

### Research Question one

What is the level of acquisition of laboratory managerial skills of basic science teachers based on their teaching experience?

**Table 3: Mean ratings on the level of acquisition of laboratory managerial skills of basic science teachers based on their experience.**

| | Laboratory Managerial Skills | 0-5 (n=108) | | | 6 Years and above (n=153) | | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Remark | Mean | SD | Remark |
| 1 | Procuring needed and relevant laboratory materials/ equipment | 3.35 | .70 | High | 3.14 | .91 | High |
| 2. | Ensuring priority placement on items that are ordered | 3.09 | .85 | High | 3.11 | .89 | High |
| 3 | Procuring from knowledgeable laboratory equipment suppliers | 3.16 | .82 | High | 2.99 | .94 | High |
| 4. | Ensuring that the needed chemicals and equipment ordered for are supplied | 3.30 | .90 | High | 3.12 | 1.07 | High |
| 5 | Matching the cost of materials with their qualities | 3.06 | .88 | High | 2.89 | .94 | High |
| 6 | Checking for and rejecting fake laboratory equipment and chemicals | 3.33 | .98 | High | 2.95 | 1.13 | High |
| 7 | Labeling of reagents boldly | 3.34 | .86 | High | 3.15 | .97 | High |
| 8 | Separating chemicals that can react with each other | 3.25 | .88 | High | 3.25 | .98 | High |
| 9 | Making provision and using stock record book(s) | 3.07 | .89 | High | 2.96 | .93 | High |
| 10 | Frequently checking the production and expiry dates of chemicals | 3.42 | .86 | High | 3.08 | 1.03 | High |
| 11 | Storing chemicals that are susceptible to photolysis in dark colored bottles | 2.90 | .96 | High | 2.93 | 1.03 | High |
| 12 | Preventing glass ware breakages by not storing them in nest pattern | 3.09 | .92 | High | 3.04 | .98 | High |
| 13 | Recording damages and breakages properly | 3.26 | .87 | High | 3.09 | 1.03 | High |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 14 | Carefully recording and stocking of used-up chemicals | 3.33 | .84 | High | 3.03 | .98. | High |
| 15 | Isolating radioactive, toxic, inflammable and carcinogenic | 3.13 | .86 | High | 3.08 | .99 | High |
| 16 | Using warning symbols or signs where and when necessary | 3.17 | 1.04 | High | 3.14 | .99 | High |
| 17 | Making laboratory store assessable to only chemistry teachers and laboratory assistant | 3.28 | .81 | High | 3.13 | .96 | High |
| 18 | Ensuring the drainages are functional | 3.01 | .96 | High | 2.85 | 1.09 | High |
| 19 | Inspecting apparatus, equipment and electrical appliances before allowing students to use them | 3.27 | .88 | High | 3.26 | .97 | High |
| 20 | Ensuring that used laboratory equipment are washed and packed | 3.45 | .90 | High | 3.28 | .98 | High |
| 21 | Preventing and amending leakages of water and gas | 3.23 | .92 | High | 3.10 | 1.03 | High |
| 22 | Repairing equipment with minor problems like leaking burette, blocked pipette | 3.13 | .91 | High | 2.88 | 1.08 | High |
| 23 | Taking care of students who may swallow base, spill acid on their bodies and floor | 3.21 | .90 | High | 3.26 | 1.01 | High |
| 24 | Ensuring that students wear lab coats and use their napkins | 3.56 | .84 | High | 3.18 | 1.11 | High |
| 25 | Using fume cub-board where necessary and applicable | 3.17 | .88 | High | 2.94 | 1.10 | High |
| 26 | Making sure that students wash their hands after every practical before leaving | 3.45 | .89 | High | 3.24 | 1.07 | High |
| | **Mean of means** | **3.23** | **.88** | **High** | **3.08** | **1.00** | **High** |

The analysis on Table 3 shows the overall mean and standard deviation score of 3.23 and .88 for teachers with 0-5 years of experience and 3.08 and 1.00 for those with 6 years and above experience. These mean scores are all above cut-off point of 2.5 indicating that both teachers with 0-5 years of experience and those with 6 years and above experience have high level of acquisition of laboratory managerial skills. The item by item analysis shows that the mean rating for teachers with 0-5 years of experience ranged from 2.90 to 3.56 while that of those with 6 years and above years of experience ranged from 2.85 to 3.28.

**Research Question Two**

What is the level of acquisition of laboratory managerial skills of basic science teachers based on their academic qualification?

**Table 4: Mean ratings on the level of acquisition of laboratory managerial skills of male and female basic science teachers in secondary schools.**

| | | NCE(n=39) | | OND(n=16) | | HND(n=74) | | B.SC(n=132) | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Mean** | **Remark** | **Mean** | **Remark** | **Mean** | **Remark** | **Mean** | **Remark** |
| 1 | Procuring needed and relevant laboratory materials/ equipment | 3.13 | High | 3.13 | High | 3.41 | High | 3.16 | High |
| 2. | Ensuring priority placement on items that are ordered | 3.23 | High | 3.06 | High | 3.15 | High | 3.05 | High |
| 3 | Procuring from knowledgeable laboratory equipment suppliers | 2.97 | High | 2.81 | High | 3.16 | High | 3.05 | High |
| 4. | Ensuring that the needed chemicals and equipment ordered for are supplied | 3.26 | High | 3.13 | High | 3.34 | High | 3.10 | High |
| 5 | Matching the cost of materials with their qualities | 3.18 | High | 3.00 | High | 2.95 | High | 2.89 | High |
| 6 | Checking for and rejecting fake laboratory equipment and chemicals | 3.15 | High | 2.69 | High | 3.19 | High | 3.10 | High |
| 7 | Labeling of reagents boldly | 3.18 | High | 2.75 | High | 3.35 | High | 3.23 | High |
| 8 | Separating chemicals that can react with each other | 3.26 | High | 3.31 | High | 3.20 | High | 3.26 | High |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9 | Making provision and using stock record book(s) | 3.31 | High | 3.06 | High | 3.09 | High | 2.86 | High |
| 10 | Frequently checking the production and expiry dates of chemicals | 3.28 | High | 3.06 | High | 3.20 | High | 3.23 | High |
| 11 | Storing chemicals that are susceptible to photolysis in dark colored bottles. | 2.97 | High | 2.87 | High | 3.03 | High | 2.84 | High |
| 12 | Preventing glass ware breakages by not storing them in nest pattern | 3.10 | High | 2.94 | High | 3.15 | High | 3.02 | High |
| 13 | Recording damages and breakages properly | 2.95 | High | 3.44 | High | 3.16 | High | 3.19 | High |
| 14 | Carefully recording and stocking of used-up chemicals | 3.10 | High | 2.94 | High | 3.34 | High | 3.09 | High |
| 15 | Isolating radioactive, toxic, inflammable and carcinogenic | 3.31 | High | 3.13 | High | 3.14 | High | 3.02 | High |
| 16 | Using warning symbols or signs where and when necessary | 3.13 | High | 3.13 | High | 3.34 | High | 3.05 | High |
| 17 | Making laboratory store assessable to only chemistry teachers and laboratory assistant | 3.26 | High | 3.06 | High | 3.12 | High | 3.23 | High |
| 18 | Ensuring the drainages are functional | 3.03 | High | 2.69 | High | 3.07 | High | 2.83 | High |
| 19 | Inspecting apparatus, equipment and electrical | 3.21 | High | 3.06 | High | 3.31 | High | 3.29 | High |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | appliances before allowing students to use them | | | | | | | | |
| 20 | Ensuring that used laboratory equipment are washed and packed | 3.38 | High | 3.31 | High | 3.38 | High | 3.33 | High |
| 21 | Preventing and amending leakages of water and gas | 3.31 | High | 3.19 | High | 3.26 | High | 3.05 | High |
| 22 | Repairing equipment with minor problems like leaking burette, blocked pipette | 2.92 | High | 3.06 | High | 2.97 | High | 3.00 | High |
| 23 | Taking care of students who may swallow base, spill acid on their bodies and floor | 3.26 | High | 3.44 | High | 3.24 | High | 3.20 | High |
| 24 | Ensuring that students wear lab coats and use their napkins | 2.92 | High | 3.44 | High | 3.51 | High | 3.34 | High |
| 25 | Using fume cub-board where necessary and applicable | 3.10 | High | 2.94 | High | 3.09 | High | 2.99 | High |
| 26 | Making sure that students wash their hands after every practical before leaving | 3.33 | High | 3.75 | High | 3.47 | High | 3.19 | High |
| | **Mean of means** | **3.16** | **High** | **3.09** | **High** | **3.22** | **High** | **3.10** | **High** |

The analysis in above Table 4 shows the overall mean scores of 3.16, 3.09, 3.22 and 3.10 for teachers with NCE, OND, HND and B.Sc qualifications. These mean scores are all above the cut-off point of 2.50 indicating that teachers with NCE, OND, HND and B.Sc qualifications have high level of acquisition of laboratory managerial skills. The item by item analysis shows that the respondents' mean rating ranged

from 2.92 to 3.38 for those with NCE qualification, 2.69 to 3.75 for those with OND, 2.95 to 3.51 for those with HND and from 2.84 to 3.34 for those with B.Sc.

**Hypotheses**

**Hypotheses one**

There is no significant difference in the level of acquisition of laboratory managerial skills among basic science teachers in secondary schools based on their years of teaching experience.

**Table 5: t-test Comparison of Basic Science Teachers' Level of Acquisition of Laboratory Managerial Skills by Teaching Experience.**

| Source of variation | N | Mean | SD | df | t-cal | *P*-value | Decision |
|---|---|---|---|---|---|---|---|
| 0-5 Years | 106 | 3.23 | 0.40 | 259 | 2.39 | .018 | Sig |
| 6 Years and Above | 155 | 3.08 | 0.57 | | | | |

Table 5 shows that the mean score for teachers with 0-5 years of teaching experience ($\bar{x}$ =3.23, SD=0.40) is greater than that of those with 6 years and above teaching experience ( $\bar{x}$=3.08, SD=0.57). P-value of 0.018 is less than 0.05. This shows that there is significant difference in the level of acquisition of laboratory managerial skills of basic science teachers in junior secondary schools based on their years of teaching experience. The null hypothesis of no significant difference between the two groups was therefore rejected.

**Hypotheses two**

There is no significant difference in the level of acquisition of laboratory managerial skills among basic science teachers in secondary schools based on their qualification.

**Table 6: Analysis of variance on the level of acquisition of laboratory managerial skills among basic science teachers in secondary schools based on their qualification**

| | Sum of Squares | df | Mean Square | F | P-value |
|---|---|---|---|---|---|
| Between Groups | .709 | 3 | .236 | .908 | .438 |
| Within Groups | 66.823 | 257 | .260 | | |
| Total | 67.532 | 260 | | | |

As shows in Table 6, F-ratio (df: 3/257) is .908 and p-value (.438) is greater than the stipulated 0.05 level of significance. It was therefore decided that there is no

signification difference in the level of acquisition of laboratory managerial skills among basic science teachers in secondary schools based on their qualification. The null hypothesis was therefore not rejected.

**Discussion of the findings**

The findings of this study revealed that teachers with 0-5 years of experience and those with 6 years and above have a high level of laboratory managerial skills with teachers with 0-5 years of experience showing higher acquisition of laboratory managerial skills. This finding is in line with the recent findings reported by Bello (2015) who found that teachers' ability to use laboratory equipment in teaching biology practical work depend on their years of experience. However, the finding is in contrast to Ezenwabachili (2016) who reported that the teachers' years of experience did not account for the pedagogical content knowledge level of biology teachers. Again, the finding of this study disagrees with Sarpong and Apaak (2016) who reported that no significant relationship exists between teaching experience and their Pedagogical content knowledge. The t- test analysis revealed that teaching experience has significant contribution on basic science teachers' laboratory managerial skills. The significance contribution of teaching experience in explaining teachers' laboratory managerial skills may be linked to effective teaching. Just as Obialor and Osuafor (2019) opined that effective teaching is the teacher doing the right thing in the teaching process so that at the end of teaching events, he/she can truly say that the goals and objectives of the lessons have been achieved implying that the students for whom the lesson was planned have learnt. Again it may be possible that teachers with 6 years and above experience may be taking certain things for granted while those with 0-5 years are still very enthusiastic.

In terms of the teachers' laboratory managerial skills and their qualifications, this study find out that teachers with NCE, OND, HND and B.SC qualifications have high level of acquisition of laboratory managerial skills. This suggested that other factors other than basic science teachers' qualification may have resulted to their high level of acquisition of managerial skills and not just their qualifications. This position agrees with the findings reported by Muhammed (2016) which showed that there are other factors identified as contributing to high level of laboratory managerial skills other than qualification. Hence, the professional training may have given rise to non- significant difference found in laboratory managerial skills in relation to basic science teachers' qualifications.

**Conclusion**

Based on the findings of the study, it was concluded that there was significance difference in the level of acquisition of laboratory managerial skill among basic science teachers based on their years of teaching experience but there was no significant difference in their acquisition of laboratory managerial skills on the bases of academic qualification. Therefore, basic science teachers' acquisition of

laboratory managerial skills could depend on their years of experience but not on their qualifications.

**Recommendations**

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

1) Since the basic science teachers in secondary schools have high level of acquisition of laboratory managerial practice skills, Government, Education Managers and Administrators in Nigeria should create a unit in Ministry of Education to handle issues that will promote and sustain the basic science teachers' applications of these skills for effective teaching and enhancement of students' achievement in basic science.
2) Government and Administrators of Education should consider, incorporating Acquisition of Laboratory Managerial Skills into their interview schedule for employment of teachers as the Laboratory is the hub of Science Education.

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# COMPERATIVE EFFECTIVENESS OF ANALOGY AND CONCEPT MAPS INSTRUCTIONAL STRATEGIES ON SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN CHEMISTRY IN ANAMBRA STATE

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**Abstract**
*This research was an effort to determine the relative effectiveness of analogy and concept maps instructional strategies on senior secondary two (SS2) students academic achievement in chemistry in Njikoka/Dunukofia Local Government Area (LGA) of Anambra State. The study was guided by three research questions and three null hypothesis tested at 0.05 alpha level. The study adopted a non equivalent pretest posttest control group quasi-experimental design involving two treatment groups. The sample comprised 55 SS2 students that offer chemistry who were drawn from two co-educational schools out of the 11 co-educational secondary schools using two-stage sampling procedure. The instrument for data collection was Chemistry Achievement Test (CAT). The CAT was validated by three experts and two secondary school chemistry teachers. The reliability coefficient of 0.79 was obtained using Kuder-Richardson formula (K-R 20). The CAT was administered as pretest for both experimental groups followed by a posttest after treatment was given using analogy and concept maps lesson plans. For data analysis, the pretest and posttest scores of the chemistry students were used. Analysis of the data using the Mean, S.D and ANCOVA showed among others that there was no significant difference between the mean achievement scores of chemistry students taught using analogy instructional strategy when compared with those taught with concept maps instructional strategy. This means that none of the strategies was superior to the other. The result of the study equally showed no significant difference between the mean achievement scores of male students when compared with that of their female counterparts for both strategies. Consequently, it was recommended that since both strategies showed no significant difference in their effectiveness on students' academic achievement in chemistry, teachers should adopt the use of both strategies in teaching of chemistry for enhanced achievement in the subject.*

**INTRODUCTION**

The global concern for the advancement in science and technology necessitates the need to improve the quality of science education in Nigeria. Undoubtedly, excellence in academic achievement demands high level of intelligence. Research has shown that the extent to which students utilize their cognitive abilities is important and may contribute to better academic achievement. The cognitive abilities of students refer to the way the students perceive, pay attention, remember, think and understand the concept being presented to them. It is used by the students in receiving information, comprehending it, retrieving it and using it to make decisions and solve problems (Dzulkifli & Alias, 2012).

In respect of the above facts, analogies are believed to help students' learning by visualization of abstract concepts and by helping to compare similarities of the students' motivation (Dilber &Duzgun 2008). Simply stated, analogy is a process of identifying similarities between two concepts; one is the "target concept" which is the actual topic to be taught to the students and another is the "analog concept" created by the teacher which is used as a basis for structural comparison. The analog concept enables him to explain the target concept to the students explicitly by comparing the similarities between the two concepts. This is because the analog concept is more familiar to the students than the target concept which has abstract nature. Analogy as an instructional strategy is now often considered by educators and researchers as a strategy to provide creative solutions (Paris & Glynn in Serkan, 2011). In terms of problem in the field of chemistry, Gongden (2016) recommended the use of analogies as strategies for teaching problem tasks in electrolysis to male students. According to Yildirim et al. (2013), it was emphasized that teachers need to employ strategies that help students concretize the events taking place in chemical equilibrium at three levels in the instructional process. One of these strategies is analogy.

In a continued effort by the teachers and those in educational sector to improve students' achievement in chemistry, it has been noted that the ability to apply knowledge requires a stable conceptual framework. One effective way of establishing a framework is to create "Concept Maps". Concept maps are diagrams in which various forms or lists of information are classified and their links are shown (Xiaojie, 2004). As Xiaojie emphasized, concept mapping strategy can serve as a key to teach a topic. According to Brinkerhoff and Booth (2013), concept maps are always used in conjunction with other teaching strategies.

Research studies, example Barbara, Sasa and Janez (2015), which relates to concept mapping, indicated that concept mapping had positive effects both on students' achievements as well as on their attitude. According to Remero, Cazorla and Buzon (2017), the use of concept maps provides series of advantages to students among which is promoting agility and skill in organizing concepts in a specific subject area

and they stated that empirical evidence exists which support that the introduction of concept maps promotes significant learning. Concept maps as a teaching strategy, is parallel with the movement from teacher to learner-centered method which has power to improve academic achievement (Sakiyo& Waziri, 2015). They reported that students taught using concept mapping strategy performed better than those taught using inquiry and lecture methods. Concept maps instructional strategy is an effective method of presenting science concept to the students to achieve meaningful learning (Udeani& Okafor, 2012).

Chemistry as a science subject is full of abstract and challenging concepts that are not easy to understand unless they are related to something from our everyday experiences. Students have continued to achieve poorly in chemistry in spite of provisions made by Federal and State Governments of Nigeria for effective teaching and learning of chemistry in schools. For instance, many researchers (Omoreogbe& Ewansiha, 2015; Gambari et al, 2016; Adenipekun, 2018) reported a decline in the performance level in SSCE Chemistry, a situation which is worrisome to the stake holders in the educational sector. Furthermore, use of adequate instructional strategies that would be able to relate most of the predominant abstract and challenging concepts in chemistry to something from students' everyday experiences is lacking. The usual rote learning that are passive still appears to dominate the more activity -based learning. Moreover, factors such as gender and inappropriate instructional strategies had been identified as affecting students' achievement in chemistry.

Historically, many studies bothering on academic achievement cannot be unconnected with gender. In many countries of the world, the educational provision for boys and girls was clearly differentiated (Sani, 2011). Explaining further, Sani added that this gender gap can equally be observed in science disciplines such as chemistry and physics. According to Gongden (2016), in his study, the result showed that male chemistry students benefited more in problem solving task involving electrolysis than female students when taught with analogy. However, Chawla (2013) discovered that male and female students in his experimental study did not differ in their achievements in chemistry. Therefore, as part of effort to meet the objectives of Nigerian Secondary School Chemistry Curriculum and improve the cognitive abilities of chemistry students, the researchers conceived the present investigation.

**Statement of Problem**

The abstract nature of chemistry concepts makes the subject difficult for students to understand resulting in poor academic achievements in schools. In a bid to ameliorate the poor academic achievement and increase the standard of education due to a decline in the performance level in SSCE chemistry, many researchers had identified analogy and concept maps as effective instructional strategies. Some

studies had also compared the effectiveness of analogy with other instructional strategies while others compared the effectiveness of concept maps with other strategies but no study had compared the effectiveness of analogy and concept maps instructional strategy in teaching chemistry. Also there was the need to identify whether gender was a factor in the way students respond to analogy and concept maps. It is against this background that the researchers investigated the relative effectiveness of analogy and concept maps instructional strategies on secondary school students' academic achievement in chemistry.

**Purpose of the Study**

The aim of this study was to determine the comparative effectiveness of analogy and concept maps instructional strategies on secondary school students' academic achievement in Chemistry in Njikoka/Dunukofia Local Government Area (LGA) of Anambra State. Specifically, the study aimed at determining the following:

1. The pretest and posttest mean achievement scores of students taught chemistry using analogy instructional strategy (AIS) and those taught chemistry using concept maps instructional strategies (CMIS).
2. The pretest and posttest mean achievement scores of male and female students taught chemistry using analogy instructional strategy (AIS).
3. The pretest and posttest mean achievement scores of male and female students taught chemistry using concept maps instructional strategy (CMIS).

**Scope of the Study**

The study considered only senior secondary two (SS2) students in Njikoka/Dunukofia LGA of Anambra State and was limited to the concept of "Rate of chemical Reaction". The study concentrated on the sub-topics: Reaction rate, calculations involving reaction rates, factors affecting rate of chemical reaction, collision theory as well as Exothermic and Endothermic reactions.

**Research Questions**

1. What are the pretest and posttest mean achievement scores of students taught chemistry using analogy instructional strategy (AIS) and those taught using concept maps instructional strategy (CMIS)?
2. What are the pretest and posttest mean achievement scores of male and female students taught chemistry using analogy instructional strategy (AIS)?
3. What are the pretest and posttest mean achievement scores of male and female students taught chemistry using concept maps instructional strategy (CMIS)?

**Hypotheses**

1. There is no significant difference between the pretest and posttest mean achievement scores of students taught chemistry using analogy instructional strategy and those taught using concept maps instructional strategy

2. There is no significant difference between the pretest and posttest mean achievement scores of male and female students taught chemistry using AIS
3. There is no significant difference between the pretest and posttest mean achievement scores of male and female students taught chemistry using CMIS

**Methodology**

This study adopted a quasi-experimental design. Specifically, a non- equivalent pretest posttest experimental group design was used. The study involved the use of two treatment groups. The design represented two levels of treatment "Analogy Instructional Strategy" and "Concept Maps Instructional Strategy"

| | | | |
|---|---|---|---|
| $E_1$ | $O_1$ | $X_1$ | $O_2$ |
| $E_2$ | $O_1$ | $X_2$ | $O_2$ |

**Figure 1:** Design of the Experiment

Where:

$O_1$= Pretest for $E_1$ and $E_2$

$O_2$= Posttest for $E_1$ and $E_2$

$X_1$ and $X_2$= Analogy and concept maps (treatments) given to groups $E_1$ and $E_2$.

The study was carried out in the selected secondary schools within Njikoka and Dunukofia Local Government Areas (LGAs) in Awka Education Zone of Anambra State, Nigeria. The study was conducted in these LGAs because it would help to improve the academic achievement of a good number of students at the end of the study. This study used SS2 students and the reason for this choice was because they had attained the required cognitive level to cope with the teaching strategies that were applied in the study. Equally this class of students was in the preparatory stage for senior school certificate examination (SSCE). The population comprised 483 SS2 students in the 19 senior secondary schools in Njikoka and Dunukofia LGAs of Awka Education Zone. Out of these 19 schools, 11 schools were co-educational comprising 263 SS2 chemistry students (159 male and 104 female). The sample size was 55 Chemistry students, comprising 32 male and 23 female students drawn from the two senior secondary schools selected out of the 11 co-educational schools in Njikoka and Dunukofia LGAs. The sampling was done using a two-stage sampling procedure (purposive and simple random sampling techniques). According to Nworgu (2015), the purposive sampling is relevant when specific elements which satisfy some predetermined criteria, based on researcher's judgment, are to be selected. The schools were purposively sampled because: (1) they recorded poor achievements in chemistry for the past years. (2) They were co-educational schools. In the second stage, simple random sampling was applied to assign the two schools to the two experimental groups.

The instrument that was used in this study for data collection was the Chemistry Achievement Test (CAT). The CAT consists of 30 multiple choice test items that were selected from past examination questions of West African Examination Council (WAEC) and National Examination Council (NECO). The CAT captured two major concepts: Rate of a chemical reaction covering rapid/slow reactions, its calculations, ways of measuring reaction rates as well as variation in rates and collision theory covering exothermic/endothermic reactions, activation energy, effective collision as well as factors affecting reaction rates. The CAT measured the key areas in the contents using a table of specification. The instrument was validated by three science educators and two experienced secondary school chemistry teachers. The reliability coefficient of 0.79 was obtained using Kuder Richardson formula (K-R20).

For the pretest, CAT on rate of chemical reaction was administered to the two experimental groups in the two sampled schools before treatment. The test was administered by the two trained chemistry teachers and their two assistants at the appropriate time allotted for the test. During the treatment using the analogy lesson plan, acid reaction with marble chip was represented in different concentrations as 2.0M acid, 1.5M, 1.0M and 0.5M of acid to differentiate their strength which in turn determines their rates of reaction. These acid concentrations were analogous to what was explained using athletes on track racing A, B, C and D ( 100 or 200 meters, 800 or 1500 meters, 8000 meters and marathon racing) for better understanding by the students.

For concept maps, students were introduced to the following general approach; Contextualization, Brainstorming phase and Layout phase to construct concept maps in relation to the chosen topic. In the final step, specific examples were given below concepts to solidify meaning. Students were told to make a concept map into a well-organized permanent form for their consumption. It should be of note that concepts maps are never finished but depend on the area you want your lesson to be buttressed more. In one of the tasks given to the students, a photocatalytic reaction between hydrogen and chlorine when carried out in a dimly lit room was presented by the following equation.

$$H2_{(g)} + Cl2_{(g)} \longrightarrow 2Hcl_{(g)} \; ; \; \Delta H = - x \; Kjmol^{-1}$$

**Question:**

Looking at this equation in the concept maps before you;

1. Identify the reactants and the product
2. Is the reaction an endothermic or an exothermic reaction?
3. List three other examples of reactions that can be affected by presence of light (photo catalytic reaction).

During the data collection, the pretest was only used to determine the students' initial group equivalence but posttest for the two treatment groups was

marked and the scores recorded accordingly. The data collected from the two groups were used for analysis based on the intended objectives of the research questions and hypotheses. The research questions were answered using mean and standard deviation while the hypotheses were tested with Analysis of Covariance (ANCOVA), at 0.05 alpha levels. This was because ANCOVA enabled the researchers to handle the error due to problem of non-equivalent groups.

**Results**

**Table 1:The pretest and posttest mean achievement scores of students taught chemistry in the two treatment groups.**

| **Instructional Strategy** | | **Pretest** | | **Posttest** | | |
|---|---|---|---|---|---|---|
| | N | Mean | SD | Mean | SD | Mean Gain |
| Analogy | 25 | 25.96 | 7.75 | 61.64 | 10.19 | 35.68 |
| Concept Maps | 30 | 26.23 | 7.43 | 60.90 | 8.58 | 34.67 |

The result in Table 1 showed the means and standard deviations in the pretest and posttest for both AIS and CMIS. The mean gain score of students taught chemistry using AIS was 35.68 which was slightly higher than that of CMIS (34.67).This means that Analogy group achieved slightly higher than concept maps group.

**Table 2: The pretest and posttest mean achievement scores of male and female students taught chemistry using Analogy Instructional Strategy (AIS).**

| **Instructional Strategy** | | | **Pretest** | | **Posttest** | | |
|---|---|---|---|---|---|---|---|
| | Gender | N | Mean | SD | Mean | SD | Mean Gain |
| Analogy | Male | 15 | 25.80 | 7.31 | 63.20 | 11.24 | 37.40 |
| | Female | 10 | 27.20 | 7.59 | 59.30 | 8.39 | 32.10 |

Table 2 presented the means and standard deviations in the pretest and posttest for both male and female in AIS group. The male students had a higher mean gain score of 37.40 as against 32.10 of the female students. This means that male students taught using analogy achieved better than their female counterparts. Therefore, AIS enhanced male students' achievement in chemistry more than their female counterparts.

**TABLE 3: The pretest and posttest mean achievement scores of male and female chemistry students taught chemistry using Concept Maps Instructional Strategy (CMIS).**

| Instructional Strategy | | Pretest | | | Posttest | | |
|---|---|---|---|---|---|---|---|
| | Gender | N | Mean | SD | Mean | SD | Mean Gain |
| | Male | 17 | 25.06 | 7.81 | 60.24 | 8.79 | 35.18 |
| Concept Maps | Female | 13 | 27.77 | 7.43 | 61.77 | 8.56 | 34.00 |

Table 3showed the means and standard deviations in the pretest and posttest for both male and female students in CMIS group. The male students had a higher mean gain score of 35.18 as against 34.00 of the female students. This means that male students taught using CMIS achieved better than their female counterparts. Therefore, CMIS enhanced male students' achievement in chemistry more than their female counterparts.

**Table 4:ANCOVA test of significant difference between mean achievement scores of students in the two groups.**

| Source | Type III Sum of Squares | Df | Mean Square | F.cal | Sig. |
|---|---|---|---|---|---|
| Corrected model | 3410.471[a] | 4 | 852.618 | 34.845 | .000 |
| Intercept | 4538.642 | 1 | 4538.642 | 185.484 | .000 |
| Pretest | 3294.410 | 1 | 3294.410 | 134.635 | .000 |
| Method | 6.157 | 1 | 6.157 | .252 | .618 |
| Gender | 103.794 | 1 | 103.794 | 4.242 | .045 |
| Method Gender | 29.737 | 1 | 29.737 | 1.215 | .276 |
| Error | 1223.456 | 50 | 24.469 | | |
| Total | 10878.000 | 55 | | | |
| Corrected Total | 8500.747 | 54 | | | |

a. R squared = .736 (Adjusted R squared = .715)

An examination of data from Table 4 showed that F(1,50) =0.252, P = 0.618. Since P= 0.618 was greater than 0.05 level of significance, the difference in mean was not significant. As a result, the null hypothesis of no significant difference was accepted. Therefore, the study upheld that there is no significant difference between the mean achievement scores of students taught chemistry using AIS and those taught using CMIS.

**Table 5:ANCOVA test of comparison of mean achievement scores of male and female students taught using AIS.**

| Source | Type III Sum of Squares | Df | Mean Square | F.cal | Sig. |
|---|---|---|---|---|---|
| Corrected model | 1174.591[a] | 2 | 887.296 | 27.143 | .000 |
| Intercept | 2153.907 | 1 | 2153.907 | 65.495 | .000 |
| Pretest | 1683.331 | 1 | 1683.331 | 51.495 | .000 |
| Gender | 112.532 | 1 | 112.532 | 3.442 | .077 |
| Error | 719.169 | 22 | 32.689 | | |
| Total | 97491.000 | 25 | | | |
| Corrected Total | 12493.760 | 24 | | | |

a. R squared = .712 (Adjusted R squared = .685)

An examination of data from Table 5 showed that F(1,22) = 3.442, P = 0.077 for effect of gender. Since P= 0.077 was greater than 0.05 level of significance, the difference in mean was not significant. As a result, the null hypothesis of no significant difference was accepted. Therefore, the study upheld that there is no significant difference between the mean achievement scores of male and female students of chemistry when taught using AIS.

**Table 6:ANCOVA test of comparison of mean achievement scores of male and female students taught using CMIS.**

| Source | Type III Sum of Squares | Df | Mean Square | F.cal | Sig. |
|---|---|---|---|---|---|
| Corrected model | 1630.970[a] | 2 | 815.485 | 27.785 | .000 |
| Intercept | 2382.705 | 1 | 2382.705 | 130.262 | .000 |
| Pretest | 1613.636 | 1 | 1613.636 | 94.147 | .000 |
| Gender | 10.870 | 1 | 10.870 | .620 | .451 |
| Error | 501.730 | 27 | | | |
| Total | 113397.000 | 30 | | | |
| Corrected Total | 2132.700 | 29 | | | |

a. R squared = .765 (Adjusted R squared = .747)

An examination of data from Table 6 above showed that F(1,27) = 0.620, P= 0.451 for the effect of gender. Since P = 0.451 was greater than 0.05 level of significance, the difference in mean was not significant. As a result the null hypothesis of no significant difference was accepted. Therefore, the study upheld that there is no significant difference between the mean achievement scores of male and female students of chemistry when taught using CMIS.

**Discussion**

The findings of the study showed that analogy is an effective instructional strategy as well as concept maps. The reason is because the mean achievement scores of AIS and CMIS showed no significant difference when compared. This means that both strategies were of equal effectiveness when teaching chemistry students. The above finding was supported by the finding from the study done by Yildrim et al. (2013), who found that analogy based instruction showed a significant difference when compare with the traditional method.

On the other hand, concept maps had proven to be effective since those in Analogy instructional strategy did not achieve higher than concept maps instructional strategy. The finding was in agreement with that of Udeani and Okafor (2012) who found out that the group taught using concept mapping instructional strategy performed significantly better than their expository group counterpart. Therefore, Concept map is an effective instructional strategy. It is of note that no study had compared the relative effectiveness of Analogy and Concept maps instructional strategies. Therefore, the study has shown that between Analogy and Concept maps, no strategy is better than the other in effectiveness. Both strategies are effective in teaching chemistry.

The findings of the study equally revealed that male students taught using analogy instructional strategy did not achieve significant higher than female counterpart. This reason is because the mean achievement scores of male and female students did not differ significantly. Therefore, gender should not be a factor when using analogy to teach chemistry students because neither male nor female achieved significantly better than the other. The finding agreed with that of Samara (2016), who discovered that there was no statistically significant difference in the achievement of male and female students taught using analogies. However, the finding disagreed with the study by Gongden (2016), who revealed that male students performed better than the female students in a chemistry problem solving test involving electrolysis when taught using analogy.

Furthermore, the findings of this study equally revealed that male students did not achieve significantly higher than their female counterparts when taught using concept maps. The reason is because the mean achievement scores of male and female students did not differ significantly. Therefore, gender should not be a factor when using concept maps instructional strategy to teach chemistry students because neither male nor female students achieved significantly better than the other. The finding was supported by that of Sakiyo and Waziri (2015) who revealed that there was no gender difference in students' academic achievement in Biology when taught using concept mapping. Study by Chawla (2013) equally showed that male and female students taught using concept mapping did not differ significantly in their achievement in chemistry.

**Conclusion**

This study had shown that both analogy and concept maps instructional strategies had significant effect on students' academic achievement in chemistry. On the other hand, the relative effectiveness of Analogy and Concept maps instructional strategies, when compared, had no significant difference on students' academic achievement in chemistry. It was also concluded that gender had no effect on academic achievement of chemistry students when Analogy and Concept map instructional strategies were used in teaching chemistry.

**Recommendations**

The following recommendations were made from the outcome of this study:

1. Since the use of Analogy and Concept map had enhanced students' achievement in chemistry, chemistry teachers should be encouraged to adopt them often in the classroom. In so doing, the cognitive ability of those students who do not perform well would be improved significantly.
2. Teachers should be using examples and illustrations that employ students' previous experience in explaining concepts being taught.
3. Learning should incorporate whole concepts, not isolated parts, so that students could see the links among concepts they have learnt, the ones they are learning and those they ought to learn. This would motivate them to learn efficiently.

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# EFFECTS OF PROBLEM-SOLVING INSTRUCTIONAL TECHNIQUE AND COGNITIVE STYLE ON SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN GENETICS IN ANAMBRA STATE

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**ABSTRACT**
*The study investigated the effect of problem-solving technique and cognitive style on students' academic achievement in genetics in Onitsha Education Zone. Four research questions guided the study while four hypotheses were tested at 0.05 level of significance. Quasi-experimental research design was adopted for the study. The population of the study consists of 5,397 Senior Secondary school students in the 20 co-educational secondary schools in 32 public Secondary Schools in Onitsha Education zone. A sample consisting of 120 (52 Male and 68 Females) SSII biology students from two schools was used for the study. Two instruments tagged Group Embedded Test (GEFT) and Genetics Achievements Test (GAT) were used to collect data for the study. Data were collected with a 40-item genetics achievement test and 20-item group embedded figure test. Kuder-Richardson (KR-20) reliability method was used to determine the reliability of the instrument. Mean was used to answer the research questions. The null hypotheses were tested at 0.05 level of significance using analysis of covariance (ANCOVA). Findings of the study revealed that students' with field independent and field dependent cognitive style taught genetics using problem-solving technique achieved higher than those taught using the expository method. Problem-solving technique had more effect on students' achievement in genetics than expository method. Gender was not a significant factor in determining students' achievement in genetics. Based on the findings of the study, it was recommended among others that teachers should use problem-solving technique as one of the instructional strategies for teaching biology since it has been found to be more effective in enhancing students' academic achievement in biology (genetics) than the expository methods.*
**Keywords:** Problem-solving, cognitive style, achievement, genetics

## Introduction

Science is the bedrock upon which the modern day technological breakthrough is built. Countries all over the world, especially the developing ones like Nigeria, are striving hard to develop technologically and scientifically. Nwagbo in Usman (2010) explained science as an intellectual activity carried out by humans, designed to discover information about the natural world in which we live and to discover the ways in which this information can be organized to benefit human race. According to Feynman (2011), science has become such an indispensable tool that no nation,

developed or developing, wishing to progress in socio-economic sphere will afford to relegate the learning of science in schools to the background.

Biology as defined by Ramalingam (2003), is one of the branches of science that involves the study of living things ranging from microscopic cellular molecules to the biosphere which encompasses the earth surface. Importance of biology includes helping individuals to understand the parts of his/her body and their functions; bringing into focus the need to maintain good health; promoting the individual for choice of careers; to inculcate in the individual scientific skills and attitudes in his approach to personal and societal problem; enabling one to question superstition due to sustained interest arising from comprehension of the cause of events, understanding and appreciating life (Maduabum, 2009). In spite of these enormous importance that biology provides, biology results in most certified examinations such as the Senior School Certificate Examination (SSCE) conducted by both the West African Examinations Council (WAEC) and the National Examinations Council (NECO) have not been satisfactory in Nigeria (Asika, 2009). Parents and government are in total agreement that their huge investment on education is not yielding the desired dividend and that students' achievement still remains poor.

According to Wikipedia (2010), achievement means a thing that somebody has done successfully especially using one's own effort and skills. Aniekwe (2006) also sees achievement as a test for the measurement and accomplishment of skills in various field of academic study. Academic achievement of students in biology is needed to erase the record of poor performance of students in external examinations. Government, teachers, parents and the general public are greatly worried about students' poor performance in biology. Most State Ministries of Education have taken additional steps in the recent times on school comparison to measure progress in solving the national crisis.

The education arm of the government and educators recently have shown concern about how well the students score in biology (Adeyemo, 2010). The observed decline in students' performance in SSCE Biology may not be unrelated to their perception of difficulties in comprehending certain areas of biology which are regarded as complex and abstract e.g. genetics. As a result, the students tend to dislike certain topics in biology hence the tendency to avoid such areas during examinations (Tamarin, 2007). This fact is supported by Amoebi (2007), who worked on the identification of difficult concepts in senior secondary biology curriculum in Anambra State. The researcher stressed that among the biology topics teachers and students find difficult were nervous system and hormonal coordination, basic ecology, genetics, evolution and energy transfer. The Anambra State WASSCE May/June (2018) statistical data on students' performance in biology also indicated poor performance in biology with particular reference to genetics questions which were poorly attempted by many students. This poor achievement of students in

biology shows that some of the students that enroll for biology in public examination, graduate without grasping the fundamentals of the subject. Research reports (Agba, 2004) have shown that most teachers prefer the use of conventional teaching methods in curriculum delivery. This invariably leads to poor achievement particularly in biology. It is being advocated that teachers should use varieties of innovative teaching methods such as problem-solving in delivering biology lessons to serve as intervention (Efe & Efe, 2011).

Genetics which is the focus of this study is the branch of biological science that studies the process or mechanism of heredity. It focuses on establishing the scientific basis for understanding of how characteristics or traits are being transferred from parents to their offspring from one generation to another. The scientific understanding of genetics principles had also lead to the application of genetics in industry. For instance, in modern times, genetic engineering is used to improve the quality of crops and domestic animals (Tamarin 2007). Another interesting application of genetics to solve problems is when deoxyribonucleic acid (DNA) is used in crime detection and establishing of paternity where there is dispute.

Cognitive styles are psychological constructs which describes individuals mode of information perception, organization and representation. Also Emmanuel (2003) stated that cognitive style is a continuum and there is actually no low or high end of it, however, at the extreme ends there are field-dependent and field-independent individuals. A Field independent (Fl) cognitive style learner is described as analytic, competitive, individualistic, task-oriented, internally referent, intrinsically motivated (self-study), self-structuring, detail oriented and visually perceptive, prefers individual project work and has poor social skills, while a field dependent (FD) cognitive style learner is described as global (holistic), group-oriented sensitive to social interactions and criticisms, externally motivated, externally referential, not visually perceptive, a non-verbal and passive learner who prefers external information and group projects (Hall, 2000).

Good-enough and Cox as cited by Onyekuru (2015) revealed that students who preferred a field-dependent learning style tend to perceive the world globally, found it difficult to solve problems, tend to favour the Specter approach to learning and would adopt the organization of information to be learned while students who preferred a field-independent learning style tended to view the world analytically, found it easier to solve-problem and are more likely to favour inquiry and independent study. They also tend to provide their own structure to facilitate learning.

The teaching of science in general and biology in particular in school enable students to acquire broad knowledge, skills and attitudes that would equip them to solve their personal and societal problems as they develop into adults. Problem-solving

techniques are used to inculcate these knowledge, skills and general disposition or attitudes which individuals need, to be able to identify and tackle observed or perceived problems in the environment with a view to finding solution to them. An individual with the requisite knowledge, skills and disposition to identify and solve a problem is said to be competent in that area of socio-economic life. The different subjects which they are taught in the school are intended to equip them with different kinds of knowledge, skills and dispositions for problem recognition, identification and solving within the environment. It is therefore important to investigate the effects of problem-solving teaching technique on students' achievement in genetics.

**Purpose of the study**

The main purpose of this study was to determine the effect of problem solving technique and cognitive style on students' achievement in biology. Specifically, this study sought to determine the effect of problem solving technique on:

1. The mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught with expository method.
2. The mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught with expository method.

**Research Questions**

The following research questions guided the study

1. What are the mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught with expository method?
2. What are the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught with expository method?

**Hypotheses**

The following null hypotheses were formulated and tested at 0.05 level of significance.

1. There is no significant difference in the mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught with expository method.
2. There is no significant difference in the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught with expository method.

**Method**

The study adopted the quasi-experimental research design. Specifically, the study adopted a non-randomized pretest-posttest control group design. The population of

the study comprised of 5,397 SSII students in the 20 co-educational schools in 32 public secondary schools in Onitsha Education Zone. The sample consisted of 120 SSII biology students, which include 52 male and 68 female students drawn from two schools out of 5,397 in the 20 co-educational of 32 public schools in the Onitsha South Local Government area. Onitsha South Local Government Area was sampled from Onitsha Education Zone. Two instruments were employed for data collection. These are the Group Embedded Figure Test (GEFT) and Genetics Achievement Test (GAT).

The GAT and GEFT instruments were subjected to face and content validation by two experts. One experts was from Science Education department and one from measurement and evaluation in the department of Educational Foundations, all of Nnamdi Azikiwe University, Awka.Kudar-Richardson (KR-20) was used to calculate the reliability of the scores gotten from the test. This method was used because it is best suited in checking the internal consistency of tests with dichotomous choices. A reliability coefficient of 0.73 was obtained. Two pieces of papers were drawn randomly from a hat containing names of all the thirty-two secondary schools in Onitsha education zone. The two pieces of papers picked out represented the two secondary schools selected for the study. The researcher then organized 2 weeks briefing exercise two days per week) for the biology teachers in the schools participating in the study. These teachers served as the research assistants. The research assistants must have taught for 5 years and must have a Bachelor of Science in Education (B.Sc.Ed) inBiology. One of the research assistants taught the experimental group while the other taught the control group so as to avoid teacher bias. The lesson plan and how to use the problem-solving instructional technique in the classroom lessons as well as the general requirements of the research was thoroughly explained to the experimental group teacher. The control group teacher on the other hand only received information about the general requirements of the research since students in the control group where taught with the usual expository method. Then a pretest was administered to the students using Group Embedded figure Test (GEFT) and Genetics Achievement Test (GAT) in both intact groups respectively with the aid of the research assistants before beginning of the treatment. The pretest indicated the level of performance of students before the manipulation of experimental variables. Both groups received the same content area of instructional material using the same length of time. Problem-solving instructional steps used by Alan (2013) which includes defining the problem, planning a solution, solving the individual part which involves sketches, diagram and grouping, putting it all together and evaluation were used in treating the experimental group. The control group was taught using the expository method. Teaching lasted for four weeks, each school where taught once a week with each lesson lasting for ninety minutes. A reshuffled GAT and GEFT was administered as post-test to students of both group (experimental and control) after treatment.The hypotheses were tested at 0.05 level of significance using analysis covariance

(ANCOVA). The decision rule was to reject the null hypothesis when it is less than 0.05, and to uphold the null hypothesis when it is greater than 0.05 level of significance.

**Research Question 1**
What are the mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught with expository method?

**Table 1: Pretest and posttest mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught with expository method.**

| Source of Variation | N | Pre-test Mean SD | Post-test Mean SD | Gain in mean | Remark |
|---|---|---|---|---|---|
| Problem-solving (FI) | 33 | 35 | 54.5 | 19.5 | Effective |
| Expository method (FI) | 34 | 35.02 | 37.05 | 2.03 | |

Results in Table 1 show that the field independent group taught genetics using problem solving technique had a pretest mean of 35 and a posttest mean of 54.5. The difference between the pretest and posttest mean was 19.5. The field independent group taught genetics using expository lecture method had a pretest means of 35.02 and a posttest mean of 37.05. The difference between the pretest and posttest means was 2.03. However, for each of the groups, the posttest means were greater than the pretest means with the group taught using problem solving teaching method having a higher mean gain. This is an indication that students' with field independent cognitive style taught genetics using problem-solving technique achieves higher than those taught using the expository method.

**Research Question 2**
What are the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught with conventional lecture method?

**Table 2: Pretest and posttest mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught with expository method.**

| Source of Variation | N | Pre-test Mean SD | Post-test Mean SD | Gain in mean | Remark |
|---|---|---|---|---|---|
| Problem-solving (FD) | 27 | 18.07 | 36.7 | 18.6 | Effective |
| Expository method (FD) | 26 | 14.6 | 17.4 | 2.8 | |

Results in Table 2 show that the field dependent group taught genetics using problem solving technique had a pretest mean of 18.07 and a posttest mean of 36.7. The difference between the pretest and posttest mean was 18.6. The field dependent group taught genetics using expository method had a pretest means of 14.6 and a posttest mean of 17.4. The difference between the pretest and posttest means was 2.8. However, for each of the groups, the posttest means were greater than the pretest means with the group taught using problem solving teaching method having a higher mean gain. This is an indication that students' with field dependent cognitive style taught genetics using problem-solving technique achieves higher than those taught using the expository method.

**Null hypothesis 1**

There will be no significant difference in the mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught with expository method.

**Table 3: ANCOVA of the significant difference in the mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught using expository method**

| Source | SS | DF | MS | F | Sig | Remark |
|---|---|---|---|---|---|---|
| Corrected Model | 5339.356[a] | 2 | 2669.678 | | | |
| Intercept | 403.307 | 1 | 403.307 | | | |
| FI pretest | 236.376 | 1 | 236.376 | | | |
| GROUP | 5112.610 | 1 | 5112.610 | 425.083 | .000 | Sig |
| Error | 769.749 | 64 | 12.027 | | | |
| Total | 145773.000 | 67 | | | | |
| Corrected Total | 6109.104 | 66 | | | | |

Result in table 3 shows that with respect to the students with field independent cognitive style groups taught genetics using problem solving teaching method and those taught using expository method, an F-ratio of 425.083 was obtained with associated probability value of .000. Since the associated probability value of 0.01 was less than 0.05 set as level of significance, the null hypothesis (H01) which stated that there will be no significant difference in the mean achievement scores of students with field independent cognitive style taught genetics using problem-solving teaching method and those taught using expository method is rejected. Thus, inference drawn therefore is that there was a significant difference in the mean achievement scores of students with field independent cognitive style taught

genetics using problem-solving teaching method and those taught using expository method.

**Null hypothesis 2**
There will be no significant difference in the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught with expository method.

**Table 4: ANCOVA of the significant difference in the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught using expository method**

| Source | SS | DF | MS | F | Sig | Remark |
|---|---|---|---|---|---|---|
| Corrected Model | 5702.857[a] | 2 | 2851.428 | | | |
| Intercept | 1952.361 | 1 | 1952.361 | | | |
| FD pretest | 779.021 | 1 | 779.021 | | | |
| GROUP | 3602.699 | 1 | 3602.699 | 221.037 | .000 | Sig. |
| Error | 814.955 | 50 | 16.299 | | | |
| Total | 5860.000 | 53 | | | | |
| Corrected Total | 6517.811 | 52 | | | | |

Result in table 4 shows that with respect to the students with field dependent cognitive style groups taught genetics using problem solving teaching method and those taught using expository method, an F-ratio of 221.037 was obtained with associated probability value of .000. Since the associated probability value of 0.00 was less than 0.05 set as level of significance, the null hypothesis (H02) which stated that there will be no significant difference in the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving teaching method and those taught using expository method is rejected. Thus, inference drawn therefore is that there was a significant difference in the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving teaching method and those taught using expository method.

**Discussion**
From the analysis, the following findings were made: Students' with field independent cognitive style taught genetics using problem-solving technique achieves higher than those taught using the expository method. Similarly, students' with field dependent cognitive style taught genetics using problem-solving technique achieves higher than those taught using the expository method.
These findings are similar to Agba (2004) who found out that cognitive styles of the students significantly influenced performance in the test of problem-solving in

genetics. The finding is also in line with that ofSafyanu, Maruta and Olarinoye (2016) that also found out that the cognitive styles of field dependence, field-independence and field neutral were significantly related to achievement in science process skills. The study revealed that no significant difference existed between the male and female students in both experimental and control group taught using problem – solving instructional technique.

**Conclusion**

Based on the findings of the study, it is concluded that problem-solving technique enhances better achievement of students with field independent and field dependent cognitive style than expository method.

**Recommendations**

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

1. Professional development for secondary school teachers should include training in the identification and characteristics of individual cognitive styles and strategies that will also meet the educational needs of students with different cognitive styles.
2. The study also recommends that teachers should use problem solving techniques as one of the instructional strategies for teaching biology since it has been found to be effective in enhancing students' academic achievement in genetics.

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# IMPACT OF GENERATIVE LEARNING MODEL ON ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS IN CHEMISTRY IN ONITSHA EDUCATION ZONE OF ANAMBRA STATE, NIGERIA

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**ABSTRACT**
*The study investigated the impact of generative learning model on academic achievement of secondary school students in chemistry in Onitsha education zone. The study adopted a quasi-experimental, design specifically; a non-equivalent control group. A sample of Ninety eight (98) Senior Secondary One (SS1) students was used for the study. 50 students were used in experimental group and 48 students in control group. A total of 98 students (67 males and 31 females) constituted the sample for the study. The instrument used was Chemistry Achievement Test (CAT) which was validated by two experts. The reliability coefficient using Kudder-Richardson formula 20 (KR-20) was 0.81. Mean and standard deviation were used to answer the research questions while ANCOVA was used to test the hypothesis at 0.05 level of significance. The study revealed that students taught chemistry using Generative Learning Model (GLM) instructional strategy had higher mean academic achievement score than students taught using conventional method. There is a significant difference between the mean academic achievement scores of experimental group (GLM) and control group (conventional method) in favour of experimental group with higher mean academic achievement score. The high academic achievement shown by the experimental group may have been the impact of the exploration and elaboration phases of the generative learning model. These phases are interesting on their own, in the sense that, this phase encourages individual students to explore ideas and apply what they have learnt. The findings of this study reveal that male and female students taught chemistry with generative learning model instructional strategy have almost equal mean academic achievement scores. The findings also show that there is no significant difference due to gender on chemistry students' mean academic achievement scores of students taught with GLM. Based on these findings, it was recommended among others that Chemistry teachers should incorporate generative learning model as one of the instructional strategy used in teaching concepts in chemistry.*
**Keywords:** Generative learning model, academic achievement, chemistry

## Introduction

Science has penetrated every branch of modern life. It brings about the noise of machines, cars, mills and factories which wakes us up every day in the morning. The food we eat, the clothes we wear, the book and paper we read, all have one thing or

the other to do with the application of science. It was in recognition of the importance of science that Nigerian Government has continued to make serious effort towards providing her citizens with qualitative and quantitative science education programmes. In addition, looking at the modernization that takes place every day, the world work force requires people who could have acquired the necessary attitude and skill of science and technology. That is why Nzewi (2011) stated that, science and technological education are regarded as a vehicle for economic and social development in a country and the acceleration and sustainable development depend on the quality of scientists produced from science education. This implies that our nation's advancement in science depends to a large extent on its strong science education programmes.

Science education is the field of study which is concerned with sharing science contents and processes with individuals not traditionally considered part of the scientific community, thereby producing a scientific literate society (Offiah &Igboekwu, 2010). Science education can be seen as a process of teaching and training especially in school to improve one's knowledge about one's environment and develop one's skill for systematic inquiry. It is important to note that science education and its application in technology are one of the most powerful instruments which can enable all members of the society to face the dynamic nature of science and modernization of today. Science education has many branches which include chemistry education.

Chemistry is a branch of science that studies the properties, composition, and structures of matter together with the associated changes as well as how such changes impact on the welfare of man and the society (Ojokuku, 2010). Chemistry has made tremendous contributions in the world. It has helped man to understand the complexity of his body, the environment, benefit and hazard of this world. It has been increasingly used in providing solutions to problems such as health, agriculture, food, shelter, and manufacturing. There is scarcely a single area of our daily lives that is not affected by chemistry. However, it is disheartening to note that chemistry students' academic achievement in the subject in senior secondary school certificate examination has remained consistently poor. The poor achievement of students in chemistry has been attributed to some students' factor such as; student sex role stereotyping, lack of interest and negative attitude towards chemistry and teacher-related factors such as poor teacher preparedness and application of inefficient teaching methods (Chukwu, 2013). In Nigeria, efforts are being made by researchers, government and non-governmental organizations to diagnose the problems associated with teaching and learning of chemistry in order to proffer solutions that lead to better achievement. However, the WAEC Chief examiner's report (2014) indicated that achievement in chemistry at secondary school remained poor. Could it be that teachers' method of teaching is not effective to improve students' achievement?

Effective teaching involves classroom teaching behavior/interaction between the teacher, the student, the subject matter and combination of these three dimensions (Akuezilo, 2009). To achieve effectiveness in teaching and learning of science in general and chemistry in particular, teachers need to adopt some teaching model in the classroom. One of such models could be Generative Learning Model (GLM) instructional strategy.

Generative Learning Model (GLM) is a cognitive model of human learning with understanding that was developed by Wittrock, in 1974. It is a constructivist teaching strategy and instructional model that focuses on cognitive processes that the students used to comprehend concept. GLM focuses on considering the students previous learning experience and understanding so that the learner can actively generate meaningful relationships between the prior knowledge and new information (Grabowski, 2002). The model provides students' opportunity for active participation in the learning process, allows for group and individualized form of learning and empowers learners with ability to express their personal views through its phases. This is unlike the conventional methods, which have no direction or phases, and the teacher talks, writes, and in fact do everything in the classroom. The GLM phases direct both teacher and students in learning environment. There are several versions of generative learning model as proposed by many researchers such as Baker (2001), and Bybee, Buchwald, Crissman, Heel Kuerbis, Matsumoto and Nerney (1990). This study focuses on Bybee et al model. It is a teaching strategy with five instructional phases namely; engagement, exploration, explanation, elaboration and evaluation.

Teaching strategies are the techniques, methods and styles that a teacher can adopt to meet the various learning objectives. Teaching strategies include manner of presentation, the way of arranging conditions, grouping students, guiding activities and providing information to aid learning. Teaching strategies are central to the teacher's goal and strive to enrich the learning environment in which the learner is engaged. The learning environment is the total physical and mental world to which the students are exposed at a particular time, and the enrichment of the environment implies making the learning experience of the physical and mental world more conducive for the students. In addition, looking at today's age (computer age), students need to be taught with innovative teaching strategies. This is to enable them think critically, explore their environment, acquired the necessary attitude and skill to become future scientists. Therefore teachers of today need innovative teaching strategy in order to improve the academic achievement of secondary school students in chemistry, since it is the starting point of students for future carrier in the field of science.

Achievement in Chemistry can be regarded as a course accomplished with special ability, effort and great courage through chemistry scientific process. Those things

that are accomplished can be in physical learning process or moral learning process but are all learning achievement which must pass through scientific process that will bring about those things that came into being through chemistry and chemistry products for example, clothing materials, building materials (Obikezie, 2017). Chemistry and chemistry products like clothing materials, building materials are of great importance to the society.

Irrespective of the great importance of chemistry to a developing country like Nigeria, it is disheartening to note that the students' achievement in the subject in senior secondary school certificate examination has remained consistently poor. The reported record by West Africa Examination Council (WACE) chief examiner 2014 mentioned earlier, stated that students' weaknesses among others are poor knowledge of the concept of "chemical bonding" (electronic configuration, oxidation state, IUPAC nomenclature). Also, it seems there is disparity in the academic achievement of male and female students in these areas of chemistry. This poor achievement has generated concern for the researchers to carry out this study.

Generative learning theory was developed by Wittrock (1999). It states that as we make connection between our existing schema and new information, our knowledge base changes and new information is formed. The generative theory of learning by Wittrock is based on the idea that learners can actively integrate new ideas into their memory to enhance their educational experience. In essence, it involves linking new with old ideas in order to gain a better understanding of the instructed concepts. The concept behind the generative learning theory lies on 'schemata', that is learning process is based on the memory that is already stored in our brains, According to Wittrock (1999), human brain does not just passively observe its environment or the events it experiences, but that it constructs its own perception about problems, scenarios and experience. Wittrock further stated that the learner must be an active participant in the learning process. Emphasizing on the importance of what the student does in order to learn is of greatest importance. The theory involves four key concepts that instructional designers can involve. To involve all four of them or just one depends on the needs of the learner and the learning materials involved. They are: recall, integration, organizer and elaboration.

Recall occurs when the learner accesses information stored in his long term memory. Integration; involves the learner integrating new information with knowledge already collected and stored. Organization involves learners linking knowledge they have already collected to new concepts in an effective way. Elaboration involves the encouragement of the learners to connect and add new concepts to information that they have already collected by analyzing the ideas. Teacher's role is to know how and when to facilitate the learners' construction of relationship; making the learner and teacher or instructor partners in the learning process their priorities. Teacher has the collaborative task of guiding and facilitating the students' activity. The teacher

identifies the students by gathering the students conceptual preconceptions about their learning a topic, identify preconceptions about their role as learners, prior knowledge relating to the topic and Meta cognitive abilities. The teacher encourages learners to become fully immersed in learning, so that they can develop new strategies on how to solve problems or scenarios. It involves teacher allowing the struggling students to interact with more capable ones who continue to mediate transactions for the benefit of all.

Since GLM of Bybee et al emphasizes on engagement and exploration through which students' identified prior knowledge are linked to concept to be learned, the theory of generative learning has been one of the bases on which GLM is built upon. Therefore it is necessary to investigate the impact of generative learning model of Bybee et al on students' academic achievement in chemistry. One will also want to know if GLM will improve academic achievement of male and female students in chemistry.

**Purpose of the Study**

The purpose of the study was to investigate the effect of Generative Learning Model (GLM) instructional strategy on students' academic achievement in chemistry. Specifically, the study sought to investigate the:

1. Differences that exist between the mean achievement scores of students taught chemistry with GLM instructional strategy and those taught with conventional method.
2. Differences that exist between the mean achievement scores of male and female students taught chemistry with GLM.

**Research Questions**

The study provided answers to the under stated questions

1. What are the differences in the pretest and posttest mean achievement scores of students taught chemistry with GLM and those taught with conventional method?
2. What are the differences in the pretest and posttest mean achievement scores of male and female students taught chemistry with GLM instructional strategy?

**Hypotheses**

The following null hypotheses were tested in the study at 0.05 level of significance:

1. There is no significant difference in the mean achievement scores of students taught chemistry with GLM instructional strategy and those taught with conventional method.
2. There is no significant difference in the mean achievement scores of male and female students taught chemistry with GLM.

**Methodology**

The study adopted a quasi-experimental, design specifically; a non-equivalent control group. It used a quasi-experimental research design because the subjects cannot be randomized (Nworgu, 2008). Two intact classes were randomly assigned to experimental control groups. It is the study of effect of the systematic manipulation of one independent variable (GLM instructional strategy).

The study was carried out in Onitsha Education Zone of Anambra State. The zone has three Local Government Areas (LGAs) which consist of Onitsha North, Onitsha South and Ogbaru. The study was conducted in secondary school at Onitsha North and Onitsha South LGAs which have 16 and 9 schools respectively. The choice of these LGAs is that they have large number of student communities and completely urban. The towns around these LGA are; Inland town, G.R.A., Nkpor, Fegge, and Woliwo.

The population consists of 2,194 chemistry students in Senior Secondary year one (SSI) in Onitsha North and South L.G.As of Anambra State. There are 21 public secondary schools, 16 single sex and 5 co-educational schools located in the area. The students' age range is between 14 and 16 years. SS I students were used because their academic self-concept in chemistry needs to be considered, built and improved in chemistry in the sense that after SS1, students make choice of subjects whether to continue in science or move to arts class. In addition, they are not in external examination class and consequently are more agreeable and free to be involved in the study.

Ninety- eight (98) SS1 students were used for the study. To obtain this sample, purposive sampling technique was employed to pick all the government-owned co-educational secondary schools in the two LGAs used for the study. Then two schools, one from each LGA, were selected through simple random sampling. By tossing of the coin, one school became the experimental school while the other became the control. Using simple random sampling, two intact classes, one each from the two selected schools, were selected. The experimental group had 50 students while the control group had 48 students making a total of 98 students (67 males and 31 females).

The instrument used for data collection was a Chemistry Achievement Test (CAT) which comprised of 25 multiple choice items developed by the researchers based on Chemical combination, electrovalent, covalent, co-ordinate covalent, metallic bond and intermolecular force. The questions were selected from past West African Senior School Certificate Examination (WASSCE) questions between 1990-2013 in line with SS 1 scheme of work. CAT was validated by two experts, one from educational psychology and one from department of Science education, all from Nnamdi Azikiwe University, Awka. To ensure the reliability of the instrument, the

25 objective questions were administered to a trial testing group of 15 students who were not part of the main study. A coefficient of 0.81 was obtained using Cronbach Alpha indicating that the instrument was reliable.

**Experimental Procedure**

The chemistry teachers in the sampled schools who served as research assistants were properly briefed. The one in the experimental group received briefing on how to use GLM and expose the students to its five phases of engagement, exploration, explanation, collaboration and evaluation. The chemistry teacher for the control group was also briefed on how to use the conventional lesson plan prepared by the researchers to teach the concept of chemical bonding.

The experiment lasted for six weeks. The first week was used for pre-test using CAT for both groups. The next four weeks was used for the treatment proper. The lessons were delivered for a period of 80 minutes (double period) in each week. At the end of the teaching period, reshuffled CAT was given to the students as Post-test in the $6^{th}$ week.

Scores obtained from pretest and post-test were analyzed and used to answer the research questions and test the hypotheses. Mean and standard deviation were used to answer the research questions while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA).

**Results**

The result and statistical analysis of the data obtained are represented

**Research Question 1:** What are the mean differences in the pretest and posttest mean achievement scores of students exposed to GLM in chemistry and those taught with conventional method?

**Table 1: Difference in Mean and standard Deviations of Pretest and Posttest Achievement Scores of Students in experimental and Control Groups**

| | | Pretest | | Post-test | | |
|---|---|---|---|---|---|---|
| Group | N | Mean | SD | Mean | SD | Mean difference |
| Experimental | 50 | 21.00 | 7.51 | 36.04 | 6.72 | 15.04 |
| Control | 48 | 22.13 | 7.74 | 22.63 | 7.38 | 0.50 |

Table 1 shows that students taught with GLM (experimental group) have a mean posttest achievement score of 36.04 with standard deviation of 6.72 while the control group has a mean posttest achievement score of 22.26 with standard deviation of 7.38. It is observed from the table that difference in mean achievement score of the experimental group (15.04) is higher than the difference in mean achievement score

of the control group (0.50). As such, GLM enhanced achievement in chemistry more than conventional method.

**Research Question 2:** What are the mean differences in the pretest and posttest mean achievement score of male and female students exposed to GLM instructional strategy?

**Table 2: Difference in Mean and Standard Deviations of Pretest and Posttest Achievement Scores of Male and Female Students in experimental Group**

| | | Pretest | | Post-test | | |
|---|---|---|---|---|---|---|
| Gender | N | Mean | SD | Mean | SD | Mean difference |
| Male | 32 | 22.37 | 8.21 | 35.81 | 7.32 | 13.44 |
| Female | 18 | 18.56 | 5.47 | 36.44 | 5.67 | 17.88 |

In Table 3, the male students have a mean achievement score of 35.81 with standard deviation of 7.32 in their posttest, while the female students have a mean achievement score of 36.04 with SD of 5.67 in their posttest. It was also observed that the mean difference of female students (17.88) is higher than the mean difference of male students (13.44). This implies that GLM improves female students' achievement in chemistry more than in the male.

**Hypothesis 1: T**here is no significant differences in the mean achievement scores of students taught chemistry with GLM instructional strategy and those taught with conventional method.

**Table 3: Analysis of Covariance (ANCOVA) of Chemistry Students' Mean Achievement Scores by Teaching Method and Gender**

| Chemistry achievement posttest | | | | | |
|---|---|---|---|---|---|
| **Source of variation** | **Type III Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
| Corrected model | 7349.396[a] | 4 | 1837.349 | 93.220 | .000 |
| Intercept | 1987.796 | 1 | 1987.796 | 100.853 | .000 |
| Precat | 2792.158 | 1 | 2792.158 | 141.663 | .000 |
| Group | 4566.349 | 1 | 4566.349 | 231.679 | .000 |
| Gender | 42.500 | 1 | 42.500 | 2.156 | .145 |
| Group* gender | 78.946 | 1 | 78.946 | 4.005 | .048 |
| Error | 1833.012 | 93 | 19.710 | | |
| Total | 94290.000 | 98 | | | |
| Corrected Total | 9182.408 | 97 | | | |

a. R Squared =.800 (Adjusted R Squared =.792)

The result in Table 5 indicates a significant mean effect of method with respect to achievement in chemistry, since the probability of obtained F- value (231.679) is 0.00, which is less than the 0.05 level of significance that is P=0.00< 0.05. The null hypothesis therefore is not accepted, which means that there is a significant difference between the scores of students' taught chemistry with GLM instructional strategy and those taught with conventional method in favour of the former.

**Hypothesis 2**
There is no significant difference in the mean achievement scores of male and female students exposed to GLM instructional strategy in chemistry.

Table 3 shows that the probability of obtaining the F- value of 2.156 is 0.145, which is higher than the 0.05 level of significance (P = 0.145 > 0.05). The null hypothesis therefore is accepted, which means there is no significance difference between the mean achievement scores of male and female students taught chemistry using GLM.

**Discussion**
The findings of this study show that students taught chemistry using generative learning model performed better than students taught using conventional method. The result indicates a significant difference between the mean achievement score of experimental group (generative learning model) and control group (conventional method) in favour of the experimental group with high mean score. This appears to be consistent with the findings of Ofiiah and Igboegwu (2010), Chukwu (2013) that students taught conceptual change using GLM performs better than those taught with conventional method.

The possible explanation to the significant difference can be that GLM phases serve as a guard which the teacher follows to direct instruction to the students. The experimental group is able to undergo learning following the five phases of GLM which allow the students to make connection between their previous knowledge and the chemistry concept to be learned. Also the phases may have helped them to explore ideas among themselves, ask questions and formulate scientific explanation in chemistry concept that are otherwise difficult for them before.

**Conclusion**
This study has provided empirical data as it concerns the impact of GLM in teaching and learning of chemistry. The generative learning model (GLM) instructional strategy has significant impact on students' academic achievement in chemistry. The experimental group taught chemistry GLM has higher mean achievement score than the control group taught with conventional method.

**Recommendations**
Based on the findings of this study, the following recommendations were made;

1. Educators of pre-service teachers should ensure that in their teacher education programmes more emphases are laid on the usage of constructivist or innovative instructional strategy such as GLM so that student teachers can learn the model and use it in teaching of science.
2. Generative Learning Model instructional strategy should also be used by chemistry teachers to enhance gender equity in academic achievement of all students in science.
3. Government and Professional Bodies like Science Teachers Association of Nigeria (STAN) and Chemical Society of Nigeria (CSN) can organize seminars, workshop and conferences chemistry teachers and other science teachers can be trained on the use of GLM in teaching and learning.
4. Curriculum planners should include GLM as a teaching model in their curriculum for the teachers to adopt in the classroom.

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# COMPARATIVE EFFECTS OF CONCEPT MAPPING AND SIMULATION-GAME TEACHING STRATEGIES ON STUDENTS' INTEREST IN ENVIRONMENTAL CONCEPTS IN CHEMISTRY

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***Abstract***
*The study investigated the comparative effects of concept mapping and simulation-game teaching strategies on students' interest in environmental concepts in chemistry. The quasi-experimental, pre-test, post-test, non-equivalent control group design was adopted. The sample comprised of four hundred and sixty-seven (467) SS2 chemistry students randomly drawn from four (4) single-sex schools. The instrument for data collection was Environmental Concepts Inventory (ECII), while six research questions and six null hypotheses guided the study. Three intact classes were assigned to concept mapping, simulation-game and lecture method groups. Means, standard deviations were used to answer the research questions, while ANCOVA and Multiple Classification Analysis (MCA) using the Scheffe's test were used to test the null hypotheses at 0.05 level of significance. Results revealed that the simulation-game teaching strategy was more efficient in enhancing students' interest than the concept-mapping strategy. Gender was found to be insignificant. Based on the findings, some recommendations were made.*

**Keywords:** Concept mapping, stimulation-game, teaching strategies, environmental concepts, chemistry

## Introduction

The emergence of modern scientific and technological activities, rapid industrialization and population explosion all geared towards economic growth, combating hunger and provision for other basic human needs has led to a drastic transformation of environmental situation. These activities have put so much pressure on the natural environment that the rate at which they are causing environmental degradation is far outrunning the environmental self-capacity to regenerate, and this has resulted in serious environmental problems world over. Asaju&Arome (2015) identified the problem of pollution and solid waste among others as major causes of environmental degradation in Nigeria. Some of these wastes are toxic, flammable, and non-biodegradable while others are more of a nuisance than a danger to man. Solid wastes are common sights in residential zones, schools, market areas, motor parks, along the streets and numerous other locations where wastes are generated. Further compounding the problem is the unavailability

and or poor implementation of regulated or bye laws on population and solid waste management and as a result of this lapse, indiscriminate dumping of waste became the order of the day. Consequently backyards, gutters, roadsides, drainages and in fact any available open space automatically gets converted into unauthorized dumpsite (Osuafor, 2014). This ugly scenario has lots of adverse health and economic implications.

The dumping of toxic waste by unknown persons in Koko, Delta State was the wake-up call on the government on the need for environmental protection and resulted in the 'birth of a child of circumstance'-FEPA-Federal Environmental Protection Agency (now Federal Ministry of Environment) established in 1988 (Eguabor, 2005). Other intervention measures introduced by government towards tackling environmental problems include the infusion of environmental education (EE) topics into primary, secondary and adult education curricular by Nigerian Educational Research and Development Council (NERDC). It has been reported that the teaching of the infused EE topics aimed at addressing the environmental problems has not been vigorously and purposefully implemented. It does appear that the infusion of EE concepts into school curriculum seem not to be achieving the desired objectives (Eguabor, 2005, Osuafor, 2014, Osuafor&Samuel 2015; and Adekola &Fischbacher-Smith, 2017). This is a matter of great concern because the environmental problems continue to increase in complexity. Since Education is an essential tool to effect change in the current destructive relationship between human beings and the environment, the onus lies in the school process to encourage and bring about this change. In the school system, the teacher has a pivotal role to play.
Chemistry as an academic discipline in Nigeria secondary schools is one of the subjects into which environmental concepts have been infused. The EE concepts are examined alongside the core chemistry concepts in the same examination such as West African Examination Council (WAEC) and National Examination Council (NECO). Unfortunately, despite the undisputable relevance of chemistry to vocational and allied disciplines needed for national, scientific, technological and economic development, indices from these examination bodies have shown consistent trend of low enrolment and poor achievement of students in these examinations. On investigating the cause of this ugly trend, researchers (Nja, 2020; Akpu, 2020; Ojukwu, 2016; and Okeke, 2011) reported that lack of qualified teachers, ill-equipped laboratories and inappropriate teaching strategies were some of the factors responsible for the recorded poor achievement and declining interest of students in the subject with inappropriate teaching strategies as the major cause. However, while these studies examined achievement, interest and retention in other core areas of chemistry, the EE aspects of the chemistry syllabus has not been examined for conceptual difficulties and /or poor achievement and interest to students in these examinations.

The environmental problems that necessitated these infusions and teaching of EE concepts in chemistry as well as other subjects has continued to aggravate in alarming and complex proportions and on daily basis. It therefore became necessary to investigate the students' interest in environmental concepts in chemistry. Over ten years after NERDC came up with the infusion for the attainment of the objectives of EE such as (i) awareness (ii) knowledge (iii) attitude (iv) skill (v) evaluation ability and (vi) participation in solving present environmental problems and preventing new ones (UNESCO-UNEP 1986), the objectives according to Adekola et al 2017, Asaju&Arome, 2015 Osuafor & Samuel, 2015 and Osuafor, 2014) are very far from being achieved, judging from the fact that the attitude of the Nigerian citizens in particular towards the environment have not changed one bit. This is not unexpected when it has been reported (Adekola, 2017; Ajai &Arome 2015; Osuafor & Samuel, 2015 and Osuafor, 2011) that the infused EE concepts are not being properly taught in schools with the seriousness they deserve. It can be deduced therefore that one major challenge facing the chemistry teacher is the exploration and adoption of teaching strategies that will be able to reverse this trend of poor achievement in both core and infused EE concepts in chemistry. Nja (2020); Ezike (2018); Ojukwu (2016) and Okeke, (2011) have reported that activity oriented and problem-based teaching strategies which involve the active participation of the students are more efficient in motivating and enhancing students' interest much more than the conventional lecture method currently dominating chemistry classroom instructions. Concept mapping, field trips, simulation-game/ role play are some of the strategies described by UNESCO/UNEP (1998) as being of high potential value to the science teacher and quite essential to the teaching of science for EE.

Concept mapping as defined by Novak (1990) are diagrams indicating inter-relationship among concepts as representation of meanings or ideational framework specific to a domain of knowledge. It is a meta-cognitive tool developed by Novak and a team of researchers from the Cornell University in 1972 (Okonkwo &Nwagbo 2014). Initially, the concept mapping strategy was first developed as a research tool to represent learners' prior, relevant knowledge and later as a tool to enhance meaningful learning. The development of the strategy was based on Ausubel's assimilation theory which is based on the principle that the single most important factor influencing learning is what the learner already knows (prior knowledge). The fundamental idea in Ausubel's cognitive theory is that learning takes place by assimilation of new concepts and prepositions into existing concepts and prepositional structures or framework held by the learner. The knowledge structure already held by the learner according to Caniglia (2019) is also referred to as the individual's cognitive structure. Students while constructing concept maps adopt an active, deep questioning approach to the subject matter and such active, self-engaging transformational interaction with learning material enhances learning in general.

A simulation as defined by encyclopedia of Education is an operating model reproduction or imitation of physical or social phenomena consisting of a set of interrelated factors or variables which function in essentially the same manner as the actual or hypothetical system. It is a concentration of imitation learning experience specifically designed to represent real-life activities by providing the learner with the essential elements to model real-life activity. A simulation is a form of experimental learning and may take a number of forms; they may contain elements of game, a role play or activity that acts as a metaphor. The goal of simulations is not to win but to acquire knowledge. Simulation is a role-playing which involve people adopting roles in a mock-up of a situation; there need not to be a winner rather a changed condition or situation to be achieved by participants (Ajai,2013; Akinsola & Animashun 2007). Both game and simulation share some common features such as in the use of tactics and strategies from the participants' initiative, their ability to provide drill and practical applications where students learn in a play-way. The boundary between game and simulation is so superficial that often times the two approaches are used interchangeably; while some writers prefer to combine the two terms 'simulation-game' to represent instructional games generally. This approach was adopted in this study in which simulation-game would be regarded as a structured imitation of reality which makes use of role play and game elements to stimulate real situations for problem solving.

Researchers (Caniglia, 2019; Vlachopoulos&Makri 2017; Obeka, 2007; Akinsola and Animashun, 2007) reported that the simulation-game strategy may be effective for teaching complex and real-world situations which changes as the students are involved in the activity. Similarly, Ajai, (2013) and Cañas (2003) reported that in the course of constructing concept maps, learners adopt an active, deep and questioning approach to the subject matter, and that such active self-engaging transformational interaction with learning material may enhance learning in general. From these reports, it may be that concept mapping and or simulation-game teaching strategy or both will effectively enhance students' interest in environmental concepts in chemistry. Therefore, this study investigated the comparative efficacies of these two activities- oriented teaching strategies in enhancing students' interest. All the studies reviewed compared each of these strategies separately with the conventional lecture method.

Interest of students in chemistry may be influenced by gender. Gender has been reported to be among the factors interacting with interest and achievement of students in Chemistry and other sciences (Ajai &Ogbeba 2017; Anderson 2017, Owojaiye & Zuya 2016). In the meantime, research findings on how gender actually influences achievement and interest remains inconclusive. Anderson (2017), Owojaiye et al (2016); Okonkwo & Nwagbo (2014),and Obeka, (2007) reported that males have higher achievement and interest in Chemistry than females, and this was attributed to sex-role stereotyping, masculine image of science and female

socialization process. On the contrary, Ojukwu (2016) reported influence of gender in favor of females, while Ajai and Ogbeba (2017) and Danmole and Femi-Adeoye, (2004) found no significant influence of gender on achievement and interest of students in Chemistry but opined that the achievement and interest of both male and female can be influenced by teaching and learning styles. On this premise this study contributed to the on-going debate by investigating the influence of gender on the interest of students in environmental concepts in Chemistry.

**Purpose of the study**

The purpose of the study was to determine the comparative effect of concept mapping and simulation-game teaching strategies on the interest of students in environmental concepts in chemistry. Specifically, the study.

1. determined whether there is any significant difference in the interest mean scores of students in Environmental Concepts Interest Inventory (ECII) due to teaching strategy.
2. determined whether there is any significant difference in the interest mean scores of male and female students in ECII after treatment.

**Research Questions**

The study was guided by the following research questions

1. What is the difference in the interest mean scores of students in ECII due to teaching strategy?
2. What is the difference in the interest mean scores of male and female students in ECII due to teaching strategy?

**Hypotheses**

The following null hypotheses were tested at $p<0.05$.

1. There is no significant difference in the interest mean scores of students in ECII due to teaching strategy.
2. There is no significant difference in the interest mean scores of male and female students in ECII due to teaching strategy.

**Research method**

The study employed the quasi-experimental, pre-test, post-test, non-randomized control group design. The population consisted of all senior secondary class two (SS2) students who offered chemistry in all the 50 public secondary schools in Nnewi Education Zone (NEZ) of Anambra state Nigeria. The sample comprised of four hundred and Sixty-seven (467) Senior Secondary Two (SS2) chemistry students drawn through purposive and multi-stage stratified random sampling technique from four (4) single-sex (2 male and 2 female) schools. Single sex schools were used to avoid interferences between boys and girls as gender was a variable in the study.

Environmental Concepts Interest Inventory (ECII) was the instrument used for the study. The ECII is a 28-item, 4-point response options scale developed by the researchers based on the following environmental concepts in chemistry namely: pollution (a) Air pollution, ozone/ozone layer depletion, green-house effect, acid rain (b) water pollution (c) land pollution: solid wastes. The research instrument was face-validated by two experts in the Department of Science Education of Nnamdi Azikiwe University Awka, Nigeria. The construct validity of the ECII was determined using Factor-Analysis. The Factor Analysis which adopted Principal Component Analysis method yielded eight factors. The 28 items of the ECII loaded above .35 in only one factor and were therefore factorially pure. Furthermore, its reliability coefficient was 0.94 obtained using Cronbach-alpha.

Three teaching strategies employed in the study were; concept mapping ($E_1$), simulation-game ($E_2$) as experimental groups and the lecture method (C) as control.

**Experimental Procedure**

The actual teaching was done by the regular chemistry teachers in the selected schools. They were briefed by the researchers for four days during which they were adequately exposed to the concepts and strategies involved in the study. A pre-test was administered to three intact classes after they had been randomly assigned to groups ($E_1E_2$, and C) in each of the sampled schools a day before the commencement of the treatment. In concept mapping-group $E_1$, the teacher began the lesson with a brief explanation of what concept mapping is and how it is constructed using concept maps constructed by the researchers. Thereafter, the students were instructed to construct their own concept maps as the lesson proceeds and also after the lesson under the teacher's supervision.

In group $E_2$-simulation-game, the students were taught conventionally prior to the game exercise. Pre-game hand-outs/role cards were given to the students in advance to get prepared for their roles and procure the necessary materials needed for the game. In the treatment, the students were divided into groups according to their roles and after a brief introductory lesson, the simulation-game exercise took off. There was a debriefing session at the end of the game. It is a general discussion highlighting important points in the exercise. During this time, the experiences of the participants were sought, the views of the teacher were passed on to the participants and effects of co-operation and conflicts resulting from the learning experience were harmonized. In the control group C, the lecture method only was used.

The teaching lasted for five weeks. Post-tests were administered to all the groups in each school a day after the completion of treatment. The pre-test and post-test scores were analyzed using mean and standard deviation scores to answer the research questions while ANCOVA, and Multiple Classification Analysis (MCA) using Scheffe's test were used for testing the hypotheses at 0.05 level of significance.

**Results**

Results are presented according to research questions and the hypotheses.

Research question 1 sought information on the comparative effects of teaching strategies (concept mapping, simulation-game and lecture) on the interest mean scores of students. Data for answering research question 1 is presented in table 1.

**Table 1: Mean Effects of Three Teaching Strategies on Students' Interest in Chemistry**

| Treatment | Pre-test | | | Post-test | | Mean |
|---|---|---|---|---|---|---|
| Group | N | $\bar{X}$ | SD | $\bar{X}$ | SD | gain |
| Concept mapping ($E_1$) | 157 | 1.67 | .72 | 3.19 | .44 | 1.52 |
| Simulation-game ($E_2$) | 154 | 1.71 | .71 | 3.37 | .52 | 1.66 |
| Lecture method (C) | 156 | 1.71 | .72 | 1.90 | .44 | 0.19 |

Data on the table above shows that the Simulation-Game Teaching Strategy (SGTS) had the highest mean gain of 1.66 followed by concept mapping (CMTS) with 1.52 and then control group (CLM) with 0.19. This implies that $E_2$-simulation-game strategy had the greatest influence on students' interest than concept mapping strategy. Both concept mapping and simulation-game recorded higher interest mean gains than the lecture method. In order to make a decision on students' interest based on the different teaching strategies, hypotheses 1 which stated that there is no significant difference in the interest mean scores of students due to teaching strategy was tested at 0.05 level of probability as presented in Table 2

**Table 2: Analysis of Covariance (ANCOVA) of Students' Interest Mean Scores x Teaching Strategies x Gender x School Location**

| **Source** | **Sum of Squares** | **d*f*** | **Mean squares** | **F** | **Sig.** | **Decision** |
|---|---|---|---|---|---|---|
| Corrected model | 209.2269 | 12 | 17.435 | 84.230 | .000 | |
| Intercept | 503.225 | 1 | 503.223 | 2.431E3 | .000 | |
| Pre ECII | .950 | 1 | .950 | 4.588 | .003 | |
| Methods | 201.9422 | 2 | 100.971 | 487.789 | .000 | S |
| Gender | .002 | 1 | .442 | 2.935 | .107 | Ns |
| Method and gender | .328 | 2 | .464 | 2.623 | .104 | Ns |
| Error | 93 .977 | 454 | .207 | | | |
| Total | 4011.110 | 466 | | | | |
| Corrected total | 303.202 | | | | | |

**=Significant at p<0.05**

Data on table 2 shows that teaching strategy as main effect is significant on students' interest. This is shown by the calculated f-value of 487.789 which is significant at .000 level. To determine the direction of the observed significant differences, a multiple comparison analysis was conducted using Scheffe's test and the result is presented in Table 3 below.

**Table 3: Results of Multiple Comparisons Analysis of Students' Interest Scores x Teaching Strategies Using Scheffe's Test**

| (i)Teaching Strategy | (j)Teaching Strategy | Mean Differences (i-j) | Std Error | sig | Decision |
|---|---|---|---|---|---|
| Concept mapping | Simulation-game | -18354* | .05322 | .003 | S |
| | Lecture method | 1.2910 | .05305 | .000 | S |
| Simulation-game | Concept mapping | -18354* | .05322 | .003 | S |
| | Lecture method | 1.47464 | .05330 | .000 | S |
| Lecture method | Concept mapping | -1.29110* | .05305 | .000 | S |
| | Simulation-game | -1.47464* | .05330 | .000 | S |

Results of the Scheffe's post-hoc pair wise MCA show that significant difference existed between concept mapping $E_1$ and simulation-game $E_2$. Significant difference also exists between groups ($E_1$& $E_2$) and the control group C. Therefore the simulation-game strategy is significantly more efficient than the concept mapping in promoting students' interest in chemistry while both strategies are significantly superior to lecture method in enhancing students' interest.

Research question 2 sought information on the influence of gender on students' interest in environmental concepts in chemistry. Data used for answering this question is presented in Table 4.

**Table 4: Mean and Standard Deviation Scores of Students' Interest by Gender**

| | | Pre-test | | Post-test | | Mean |
|---|---|---|---|---|---|---|
| Gender | N | $\bar{X}$ | SD | $\bar{X}$ | SD | Gain |
| Males | 232 | 1.71 | .72 | 2.77 | .73 | 1.06 |
| Females | 235 | 1.67 | .72 | 2.86 | .87 | 1.19 |
| Total | 467 | 1.69 | .72 | 2.82 | .81 | 1.13 |

Table 4 shows that females showed higher interest with interest mean gain of 1.19 than the males with a lower interest mean gain of 1.06. To determine if this observed difference is significant, hypotheses 2 was tested at $p<0.05$. Table 2 reveals that

there is no significant difference in the interest of male and female students. This is shown by the calculated f-value of 2.935 which is not significant at 0.107. To this effect, the researchers failed to reject the null hypotheses and concluded that there was no significant difference in the interest mean scores of male and female students.

**Discussion of Findings**

Result in table 1and 2 show significant main effect of treatment on interest measure. The results indicate that students' interest was greatly improved when they were exposed to the concept mapping and simulation-game teaching strategies when compared with the conventional lecture method. This is consistent with the reports of Nja, (2020); Akpu, 2020; Ojukwu, 2016; Osuafor, 2011 and Longjohn, (2009) that students' interest could be enhanced through activity-oriented instructional strategies. However, results of Scheffe's post-hoc pair wise multiple comparison analysis on the interest mean scores of the three groups as presented in table 3 revealed that comparatively, the simulation-game strategy is significantly more effective than the concept mapping strategy in enhancing students' interest. This could be attributed to the fact that, in simulation-game environment, there seems to be a more engaging interaction by learner, provision of motivating activities which students find enjoyable and consequently learn in a fun-filled play-way which removes aversion, tension and boredom. The superiority of simulation-game in enhancing interest as reported in this study is consistent with Obeka, (2007); Akinsola and Animashun, (2007); Onwukwe,(2010); Ajai, (2013); Vlachopoulos & Makri, (2017) and Caniglia, (2019) who reported that simulation-game teaching strategy motivates students' interest. Both concept mapping and simulation-game create room for tangible thinking because in playing games, and constructing concept maps, thoughts are connected out physically and results are seen. Another possible reason for the superior achievement recorded by the treatment groups in this study is the activity and problem- oriented nature of the two strategies. In both strategies, students' attention was focused on the learning materials as the onus of deciding what to do at each stage of the learning process falls on them.

The results of this study also indicated that gender is not a significant factor in students' interest. This is consistent with the findings of Ajai &Ogbeba, (2017) and Imoko, (2005), who reported that gender has no significant effect on students' interest but at variance with the views of Isa, (2005) and Osuafor (2011) that reported significant influence of gender on students' interest. In this study, the relative effects of concept mapping and simulation games across the students' gender are consistent, implying that they are not sex stereotyped. Therefore, a gender balanced atmosphere accounted for the superiority of the two experimental strategies in enhancing interest over the lecture method.

**Summary of Findings**

1. Students in the simulation-game teaching strategy (SGTS-$E_2$) had a statistically significant higher interest mean scores than those in concept mapping (CMTS-$E_1$) and both treatment strategies were significantly more effective than the lecture method in enhancing interest of students in environmental concepts in chemistry.
2. The difference in the interest mean scores of male and female students was not significant.

**Recommendations**

1. Science teachers should endeavor to introduce fun and interactive activities that are student-centered in their lessons in order to arouse and motivate students to learn meaningfully to enhance and sustain their interest.
2. Ministries of education at both federal and state levels in conjunction with professional associations like Science Teachers Association of Nigeria (STAN) should organize in-service training in the form of seminars and workshops on a regular basis to keep chemistry teachers abreast of the application of innovative, problem-solving and activity-based teaching strategies like concept mapping and simulation.
3. Examination bodies like the West African Examination Council (WAEC), National Examination Council (NECO) should give the environmental concepts infused in all subjects in the school curricula the importance and prominence they deserve by increasing the number of test items on these environmental concepts.

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# PRODUCTION-BASED DEMONSTRATION INSTRUCTIONAL APPROACH ON PRE-SERVICE CHEMISTRY TEACHERS: A PANACEA FOR STEM ACADEMIC ACHIEVEMENT

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## ABSTRACT
*This study investigated the production-based and demonstration instructional approach on pre-service Chemistry teacher's academic achievement. One research question and one hypothesis guided the study. The study adopted a non-equivalent control group quasi experimental design. The study was conducted in four Colleges of Education in the South East Geo-political zone. Out of the four schools, two colleges were exposed to the use of production-based and demonstration instructional approach (experimental group), while the other two were exposed to conventional lecture method (control group). 150 pre-service Chemistry students participated in the study. Production-based chemistry achievement test (PCAT) which was developed by the researchers was used as an instrument for data collection. PCAT was subjected to face and content validation. Its reliability was established at 0.87 using Kuder-Richardson formula 21(K-R-21). Mean and standard deviation as well as analysis of covariance (ANCOVA) were used to answer the research question and test the hypothesis at 0.05 level of significance respectively. The result of the study revealed that the production based and demonstration was significance at 0.05 probability level in enhancing the academic achievement in pre-service Chemistry teachers. It also revealed that gender had no effect on the level of academic achievement of pre-service Chemistry teachers. Based on these findings, recommendations were made which included that Chemistry teachers should adopt demonstration with production-based instructional approach in enhancing academic achievement in pre-service Chemistry teachers.*
**Keyword:** Production-based Demonstration, pre-service teachers, panacea, capacity building.

## INTRODUCTION
Production-based teaching method according to Nnoli (2016) is the process of using materials or reagents to produce useful products. It helps the learner to learn faster and helps to minimize the abstract nature of chemistry. For example, the production of car-wash using the following materials; Antisol, Soda ash, Sulphonic Acid, Formalin, Colorant and Perfume. Nnoli maintained that demonstration method can be used as a technique within a method of teaching and sometimes as a method itself for example, when you do the experiment by yourself so that students will watch and

learn from your action, especially if you emphasize the use of apparatus or reagents. Osisioma (2015) posited that production- based method is a systematic process of applying creativity and innovations, it involves the acquisition of skills, knowledge and competences that enable learners to maximize the use of existing resources for firm career commitments such as setting a business, marketing services or being produce-employee of an organization.

One key way of which one can develop skills for production in individuals is through education. This is because education *provides a lot of opportunities, values and resources that will equip an* individual to contribute to national economic growth (Nnoli, 2016). One of the objectives of National Policy on Education (NPE, 2013) is that education will be used to build among other things, a great and dynamic economy. Science, Technology, Engineering and Mathematics (STEM) Education (Chemistry inclusive) to a larger extent provides a conducive opportunity to achieve the stated national objective. This is because STEM are powerful tools for the development of academic achievement and socio-economic growth of many nations. Many developed countries of the world like China, USA and Japan have continued to invest their resources in STEM education for proper and improved economy and for achieving self-reliance. A self-reliant person can be described to be creative, productive, resourceful and objective. Such an individual can be viewed to be scientifically literate.

Nnoli (2014) stated that a scientifically literate person is critically minded, creative, objective and can apply skill where necessary. These qualities are what productive-based stands for. However, in any developed countries, STEM curricula (Chemistry inclusive), are designed to prepare students towards the acquisition of skills and competences for self- reliance. Unfortunately, the percentage of skill acquisition is noticed to be poor in most developing countries of the world such as Nigeria. Some researchers noted that poor acquisition of skills emanates from poor availability of infrastructure, lack of integration of entrepreneurship education in curriculum and poor utilization of innovative instructional approach in teaching (Nnoli 2015). Furthermore, most secondary schools and tertiary institutions in Nigeria, neglect practical aspect of STEM teaching and adopt only the theoretical aspect leading to poor acquisition of productive and demonstration skills.

Chemistry is a branch of pure science which deals with the properties, compositions and uses of matter. It is taught to students at all levels of education including tertiary education. The knowledge of chemistry is important for professional growth and for personal adaptation to one's environment. Acquisition of chemistry knowledge could expose learners to acquire skills on how to set up and manage small business such as production of wine using grape and pineapple flavor. Chemistry knowledge can also be used in setting up small enterprises such as production of soaps (saponification), car-wash, disinfectants, paints as well as detergents (Nnoli, 2016). In chemistry

classroom teaching, students are expected to be exposed to many innovative teaching approaches that can foster active participation and skill development. It is expected that skill acquisition in STEM (chemistry inclusive) should be through the activity/production-centered instructional approach. Nnoli (2014) posited that activity-centered instructional approach is student centered, uses science process skills and investigative teaching approach. In this approach, the learner is exposed to innovative changes, can recognize new ideas and opportunities in new areas.

At tertiary level of education, chemistry is taught to undergraduates both as a discipline and for professional development. It should be noted that many faculties of education or departments in universities and colleges of education train undergraduates or pre-service teachers to become professionals who specialize in one teaching subject or the other. In their area of specialty,the pre-service teachers are undergraduates who are trained to qualify as teachers but have not taught before. In recent times, many pre-service graduate teachers are unemployed either because they have no place they are employed to teach or they have not acquired appropriate skills needed to build on or become self-reliant or that they do not posses skills needed to establish and manage a small business. Osisioma (2015) noted that the development of skills include; inner discipline, ability to take risks, being innovation, change- oriented persistence and recognition of economic opportunities.

A good utilization of production-based, demonstration centered teaching in STEM education / chemistry in tertiary education will facilitate the development of skills, critical mindedness and creative thinking in pre-service chemistry teachers. According to literature, creative thinking serves as one of the important attributes for skill development. Nnoil (2017) identified creative thinking, problem solving and ability to recognize opportunities as some aspects of skill development. STEM educators suggest that under this period of dwindling economic growth and massive unemployment in Nigerian nation, there is need for proper inculcation and integration of production-based instructions in teacher-development program. Many schools of thought are advocating the integration of skill acquisition in classroom instruction so as to expose the learner to development of new ideas to start new business for self-adaptation and development. With regards to this, some chemistry concepts offer opportunity for productive-based instructions. This can be achieved through innovative teaching approach that is activity- oriented which offers opportunity for hands on, minds on science to motivate critical mindedness, skill acquisition and sense of commitment in students. Some of these innovative teaching approaches that can generate use of skills and deep thinking in learners include; demonstration and project instructional approach.

Demonstration instructional approach involves showing by reason or proof, explaining or making clear by use of examples. Nnoli (2019) stated that demonstration is a process of teaching through examples or experiments which

allows learners to relate theoretical concepts to practice. It is also any learning experience that involves student activities such as observing, measuring, counting, and experimenting among others. The importance of demonstration as a teaching approach includes that it follows systematic procedure; it generates curiosity and keen observation ability among learners. Demonstration can be performed by the teachers alone, the teachers and student groups among others. On the other hand, demonstration can be applied alone in teaching or can be used with other innovative teaching approaches such as project instructional approach or any other good innovative teaching approach to achieve an intended objective (Egbezor&Nnoli, 2015). Researchers also noted that many science educators (chemistry inclusive) fail to inculcate in their students the habit of practical- oriented lessons like demonstration lessons.

Osisioma (2015) noted that science students of all levels show poorly developed skills of problem analysis, planning and carrying out controlled experiments. The implication of this report with regards to teacher education is that such a pre-service teacher cannot be creative and resourceful since no skill is acquired, and may not be well equipped to teach others and consequently will not have anything to add to the national economic growth. This state of affairs calls for serious investigation so as to improve teacher development programme in the country. However a nation without good teacher education is already facing problems and will continue to be in a moribund state economically.

**Purpose of the Study**

The main purpose of the study is to investigate the gender influence on academic achievement of STEM pre-service chemistry teachers exposed to productive-based demonstration instructional approach and those exposed to traditional lecture methods.

**Research question**

What is the difference in the mean achievement scores of male and female pre-service chemistry teachers exposed to productive-based demonstration instructional approach and those exposed to traditional lecture method?

**Research Hypothesis**

**$H_{o1}$:** There is no significant difference in the mean achievement scores of male and female chemistry teachers exposed to productive-based demonstration instructional approach and those exposed to traditional lecture methods.

**Design**

The study adopted the non-equivalent control group quasi experimental design. This is because intact or pre-existing groups were used, as the experiment was conducted in institution setting where randomization was not possible.

**Sample**

The sample comprised of 150 (300 level) pre-service students taking courses at National Certificate in Education (NCE) programme in Colleges of Education in the South-East geopolitical zone of Nigeria. The College were purposively selected based on the availability of:

1. Students offering chemistry as one of their combinations of study in their area of specialty.
2. Students who have stayed up to 3 years in their academic pursuit in chemistry option.
3. Availability of a functional chemistry laboratory.

**Instructional procedure**

Two out of the four colleges of education used were randomly assigned for experimental conditions. The chemistry lecturers in the experimental schools were trained for a period of one week. These teachers were provided materials to teach the experimental group with demonstration and productive-based instructional approach, while the control group was taught by conventional method (lecture method) by their regular lecturers. Detailed lesson plans were used to teach both experimental and control groups. The same lesson plans bearing the same instructional objectives, instructional materials, content and method of elevation were provided for both experimental and control groups. Pre-test was administered to both experimental and control groups before commencing the treatment. After the pre-test, the trained staff teaching the students commenced the treatment by teaching the pre- service chemistry teachers using production-based demonstration instructional approach. At the end of the experiment, the post –test was administered on the students in both groups.

**Results**

**Research Question**: What are the mean achievement scores of male and female pre-service chemistry teachers exposed to productive-based demonstration instructional approach and those exposed to traditional lecture methods?

**Table 1:** Mean and standard deviation of pre-test and post scores of pre-service chemistry teachers by method and gender

| | | | **Pre-test** | | **Post-test** | |
|---|---|---|---|---|---|---|
| **Group** | **Sex** | **N** | **Mean** | **SD** | **Mean** | **SD** |
| **Experimental** | Male | 35 | 42.90 | 8.70 | 75.67 | 8.06 |
| | Female | 40 | 40.70 | 8.50 | 73.65 | 9.66 |
| | Total | | 41.80 | 8.60 | 74.66 | 8.86 |
| **Control** | Male | 35 | 46.80 | 7.30 | 56.50 | 5.07 |
| | Female | 40 | 45.81 | 5.37 | 56.70 | 4.66 |
| | **Total** | | 46.31 | 12.69 | 56.64 | 4.87 |

The result presented in the table showed a remarkable difference between the two groups of pre-service teachers. In pre-test, the mean achievement score of pre-service teachers under experimental condition was 41.80 with standard deviation of 8.60 while those students under control condition had a mean score of 46.31 with standard deviation of 12.69. This shows that the groups were almost at the same level before the experimental intervention. After the treatment, the experiential group had a mean score of 74.66 with a standard deviation of 8.86 while those under lecture instructional approach (control group) had a mean achievement of 56.64 with a standard mean deviation of 4.87. This indicates a higher mean gain achievement score by the students exposed to the experimental conditions. The indication is that productive-based demonstration instructional approach (experimental group) performed better than the control group.

The implication is that the use of production-based demonstration instructional approach can enhance the acquisition of entrepreneurial skills if applied in teaching chemistry concepts. In terms of gender, male students under experimental condition had a mean gain score of 32.77 while their female counterparts had a mean score of 32.95. On the other hand, male pre-service chemistry teachers in control group had a mean gain score of 10.03 whereas their female counterpart had 10.89. These figures show that gender gap as measured by the mean gain scores, reduced maximally.

**Table 2:** Analysis of covariance (ANCOVA) on academic achievement of male and female chemistry teachers exposed to productive-based demonstration instructional approach and those exposed to traditional lecture methods.

| **Type III** | **Sum of Squares** | **DF** | **Mean Square** | **F** | **Sig.** |
|---|---|---|---|---|---|
| **Correct model** | 8034.21 | 4 | 2160.815 | 535.673 | 000 |
| **Intercept** | 3365.050 | 1 | 3365.050 | 81.012 | 000 |
| **Pre-test** | 816.110 | 1 | 816.110 | 20.280 | 000 |
| **Teaching Method** | 7857.457 | 1 | 7857.435 | 196.540 | 000 |
| **Gender** | 85.466 | 1 | 65.466 | 1.546 | 202 |
| **Teaching method** | 18.403 | 1 | 18.403 | 434 | 502 |
| **Gender** | | | | | |
| **Error** | 3030.226 | 80 | 39.526 | | |
| **Total** | 337259.000 | 83 | | | |
| **Corrected Model** | 11083.488 | 82 | | | |

Table 2 presents the summary of ANCOVA. This shows that instructional approach which is the treatment was significant at 0.05 level of significance (F= 196.54,

P>0.05). On the other hand, gender (F=1.546, P= 0.202) and teaching method interaction (F= 0.434, P =0.502) were not significant at 0.05 level of significance.

**Discussion**

The result of this study revealed that production-based instructional approach if used with demonstration method had significant effect on pre-service teachers' academic achievement. This outcome corroborates the views of Akinsola (2012) that the basic ingredient necessary for effective teaching is the active participation and involvement of learners in the learning situation and activities. The demonstration with production-based instructional approach directs the teachers to incorporate strategies that care for learners with different characteristics to benefit from the instruction. This is done by exposing learners to different activities that can facilitate the development of skills and creative thinking. The Implication of this is that the production-based demonstration group of students are exposed to various activities and techniques that will enable them to engage in tasks that can lead to use of skills to create or produce new products or opportunities. Demonstration with production-based instructional approach fosters active participation and high retention of information. It provides the gender groups ample opportunity to explore, explain, elaborate their views and have deep understanding of such concepts treated by their teachers. The results also revealed substantial reduction in gender gap in the acquisition of skill. This implies that demonstration production-based approach has no gender bias.

**Recommendation**

Since productive-based Demonstration instructional approach is found to be useful in improving academic achievement in STEM pre-service teachers, it is recommended that STEM educators should apply the use of demonstration with production-based instructional approach in their STEM (Chemistry inclusive) classroom instruction. This will ensure that pre-service teachers are adequately trained and equipped for self-reliance and to incorporate same in classroom instruction to their students upon graduation. On the other hand, Curriculum developers should include this technique in science/chemistry education curriculum of teacher education.

**Conclusion**

In conclusion, the use of production-based demonstration instructional approach in teaching chemistry to pre-service teachers has significantly enhanced the academic achievement of pre-service chemistry teachers when compared with conventional methods. It also led to substantial reduction in gender gaps towards the acquisition of skills between male and female undergraduate chemistry teachers.

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# THE EXTENT OF AVAILABILITY AND UTILIZATION OF BIOLOGY EQUIPMENT/MATERIALS IN SECONDARY SCHOOLS IN ONITSHA EDUCATION ZONE: IMPLICATIONS FOR SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT IN NIGERIA

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**Abstract**
*This study examined the extent of availability and utilization of biology equipment/materials in secondary schools in Onitsha education zone: Implication for economic crisis in Nigeria. Three research questions were formulated and answered. The population of the study consisted of all the 48 biology teachers and 49040 Senior Secondary Two (SS 11) biology students totaling 29088 subjects in the thirty-two (32) secondary schools in Onitsha Education Zone. The sample consisted of 20 biology teachers and 500 SS 11 biology students 520 subjects in 10 randomly selected schools. Data was collected using summated rating scale, and was analyzed using percentages and mean. The result of the study showed that biology equipment/materials were on the average rarely available in the secondary schools and the available ones were not utilized. The implication of rare availability and low utilization of biology equipment/materials were discussed. It was concluded that for Nigeria to overcome the present economic crisis, biology equipment and materials must be made available and also be utilized maximally to make our biologists self-reliant and thereby rise above poverty and backwardness.*
**Keywords:** Availability, utilization, scientific and technological development.

## Introduction

For any science is to be taught well, it should be done practically. Each student should be able to perform necessary experiment, use certain tools, produce some equipment, make and record accurate observations and as the case may be. Science is the key to economic, intellectual, sociological, human resource development and the wellbeing of the society. The growth of any nation is a measure of its advancement in science. As soon as individuals are made to acquire the right attitude and skills in science for self-reliance and national development, then that society becomes developed.

It is unfortunate however that in most secondary schools, the equipment, facilities and materials needed for meaningful work are either grossly inadequate or in bad state of repairs. Teachers also lack the competence, skills and creativity to organize practical classes in biology ( Ofogbu, 2003, Akubuilo, 2004). Ebele in Yahya and Shamsudeen (2017) observed that in most of the schools in Anambra State, there are inadequate equipment for teaching of biology in all the Secondary Schools in Nnewi

Education Zone of Anambra State. Again, Bello (2013) reported that most schools in Sokoto State do not have well equipped biology laboratory. It is essential that students do something more than listening to lectures. They should participate in demonstration and experiment. They must have experience even if it is as simple as swinging a bunch of keys, hanging on a string and timing the pendulum. (Novak in Olajide and James, 2009).

The issue of economic crisis has been ravaging our nation for some time now. What the nation requires is the type of education that can help our students discover their talents at a very early age and also encourage them to develop and utilize their talents well. One way this researcher thinks this can be effectively done is encouraging pupils to find out things for themselves. This cannot be done where there is unavailability of biology equipment. The use of equipment/materials for teaching biology actually motivates and arouses interest in students in a lesson. It focuses students' attention and initiates problem-solving. If materials for teaching biology are made available, our students will be self-reliant after graduation and this will go a long way to alleviate the present economic crisis in Nigeria.

For Nigeria to meet up with other developed countries of the world, greater emphasis should be on the provision of equipment and materials needed for practical work in Science in general and biology in particular. Students should actually be given opportunity to discover, invent and get involved in the rapid expansion in science and technology. This is because, biology has made great impact in the development of this nation and its importance warrants the need to provide biology equipment in our secondary schools. If biology materials are adequately provided in our secondary school laboratories, students will be able to apply knowledge, communicate effectively, be analytical, critical thinkers, inquisitive and imaginative. They need to be self-confident, motivated learners, creative and curious (NBTE, 2006).These attributes have a lot of implications for economic crisis in Nigeria. Once an individual acquires the right skills and attitude through manipulation of science equipment, he can survive easily in the society.

**Statement of the Problem**

Biology is one of the science subjects in Nigerian Secondary Schools. It is important in many ways for both individuals and societal development as seen in biotechnology and genetic engineering. Good knowledge of the subject is required for an individual to rise above poverty and backwardness especially in the light of the present economic crisis. Available statistics from West African Examination Council (WAEC, 2004-2012), Ofoegbu (2003) and Akubuilo, (2004) revealed that although biology has the highest enrolment relative to other science subjects, it records a very poor performance at senior certificate examinations especially in the practical examinations where students exhibit very poor science skill acquisition. The poor science skill acquisition by students is not in keeping with the objectives of

education in Nigeria which states that "education should aim at helping the child acquire appropriate skills, ability and competence both mental and physical as equipment for the individual to live and contribute to the development of his society" (FRN, 2004). It is possible that provision and use of adequate biology equipment and materials in teaching and learning of biology may improve the situation. Consequently, the problem is: To what extent is biology equipment/materials available and used in our secondary schools?

**Research Questions**

The following research questions were answered:

1. To what extent is biology equipment/materials available in schools?
2. To what extent do biology teachers make use of equipment/materials in teaching?
3. What are the implications of non-availability and non-utilization of biology equipment/materials on global economic crisis in Nigeria?

**Methodology**

The study employed a survey research design. The population of the study comprised of all SS 11 Secondary School biology students in Onitsha Education zone. The Zone has a total of 32 schools in which there are 48 biology teachers and 29040 students. A total of 29088 persons therefore constitute the population.

The sample for the study consisted of all SS 11 biology students and biology teachers in ten (10) randomly selected secondary schools in Onitsha Education zone. The biology students in these 10 schools were 500 in number and teachers were 20. A total of 520 subjects therefore constituted the sample for the study.The instrument used in this study for data collection was a questionnaire of 5-point Likert-type scale. The questionnaire was divided into two parts; Part 1 for biology teachers and Part 11 for biology teachers and SS 11 students.

Copies of the questionnaire were administered to the respondents by the researcher with the help of four research assistants. The biology teachers and students gave maximums cooperation in filling the questionnaires on the spot, resulting in 100% return of the questionnaires.

The statistical tools used in this study for data analysis were mean and percentage. Mean values of less than 1.50 was taken as never/very strongly disagree. Mean values of 1.50-2.54 was taken as rarely/strongly disagree. Mean values of more than 2.54 but less than 3.50 but less than 4.50 was taken as often/strongly agree. Mean value of 4.50 and above was taken as always/very strongly.

**Results**

**Research Question 1: To what extent are equipment/materials available in secondary schools?**

**Table 1: Extent of availability of biology equipment/materials**

| Equipment/ materials | AA | OA | CA | RA | NA | TR Total | AM (X) | Remark |
|---|---|---|---|---|---|---|---|---|
| Quadrate | 5 | 4 | 6 | 22 | 5 | 42 | 2.10 | Rarely available |
| Measuring cylinder | 5 | 4 | 6 | 32 | 0 | 47 | 2.35 | Rarely available |
| Skeleton | 10 | 8 | 12 | 22 | 0 | 52 | 2.60 | Occasionally available |
| Overflow can | 0 | 0 | 6 | 28 | 4 | 38 | 1.90 | Rarely available |
| Dissecting equipment | 0 | 4 | 3 | 20 | 8 | 35 | 1.75 | Rarely available |
| Spring balance | 0 | 8 | 6 | 20 | 6 | 44 | 2.20 | Rarely available |
| Mounted pictures | 20 | 16 | 24 | 8 | 0 | 68 | 3.40 | Occasionally available |
| Handles | 5 | 4 | 6 | 28 | 2 | 45 | 2.25 | Rarely available |
| Flash card | 0 | 0 | 6 | 28 | 4 | 38 | 1.90 | Rarely available |
| Mosquito net | 0 | 4 | 9 | 30 | 1 | 44 | 2.20 | Rarely available |
| Rain guage | 0 | 0 | 6 | 32 | 2 | 40 | 2.00 | Rarely available |
| Laboratory funnel | 50 | 12 | 9 | 8 | 0 | 79 | 3.95 | Often available |
| Biological kits | 0 | 0 | 6 | 32 | 2 | 38 | 1.90 | Rarely available |
| Test tubes and rats | 55 | 4 | 6 | 12 | 0 | 78 | 3.90 | Occasionally available |
| Beaker | 25 | 12 | 24 | 4 | 2 | 62 | 3.10 | Occasionally available |
| Aquarium | 0 | 0 | 0 | 36 | 2 | 38 | 1.90 | Rarely available |
| Thermometer | 10 | 4 | 6 | 30 | 1 | 51 | 2.55 | Occasionally available |
| Microscope | 0 | 8 | 12 | 28 | 0 | 48 | 2.40 | Rarely available |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Anemometer | 0 | 4 | 0 | 24 | 6 | 32 | 1.60 | Rarely available |
| Wind vane | 0 | 4 | 3 | 32 | 2 | 41 | 2.05 | Rarely available |
| Pooter | 0 | 0 | 3 | 30 | 4 | 37 | 1.85 | Rarely available |
| Sachi disc | 0 | 0 | 0 | 20 | 10 | 30 | 1.50 | Rarely available |
| Punnet square | 0 | 0 | 9 | 30 | 2 | 41 | 2.05 | Rarely available |
| Tape recorder | 0 | 8 | 6 | 30 | 1 | 45 | 2.25 | Rarely available |
| Fish trap | 0 | 0 | 6 | 32 | 2 | 40 | 2.00 | Rarely available |
| Sweet net | 0 | 0 | 6 | 32 | 2 | 40 | 2.00 | Rarely available |
| Transect | 0 | 0 | 0 | 30 | 5 | 35 | 1.75 | Rarely available |
| Incubator | 0 | 0 | 6 | 30 | 5 | 35 | 1.75 | Rarely available |
| Water filter | 5 | 8 | 9 | 30 | 0 | 52 | 2.58 | Occasionally available |
| Drying oven | 0 | 0 | 6 | 34 | 1 | 41 | 2.05 | Rarely available |
| Vacuum flask | 0 | 12 | 9 | 32 | 0 | 53 | 2.60 | Occasionally available |
| Herbarium cabinet | 0 | 0 | 0 | 30 | 5 | 35 | 1.75 | Rarely available |
| Charts | 25 | 20 | 15 | 0 | 0 | 70 | 3.50 | Occasionally available |
| Magnifying glasses | 5 | 8 | 3 | 24 | 4 | 44 | 2.20 | Rarely available |
| Dropping pipette | 0 | 8 | 6 | 32 | 0 | 46 | 2.30 | Rarely available |
| Bunsen Burner | 10 | 4 | 6 | 30 | 0 | 50 | 2.50 | Occasionally available |
| Model for eye | 5 | 0 | 4 | 16 | 10 | 35 | 1.75 | Rarely available |
| Model for ear | 5 | 4 | 2 | 14 | 10 | 35 | 1.75 | Rarely available |
| Model for heart | 0 | 0 | 0 | 20 | 10 | 30 | 1.50 | Rarely available |
| Regent for | 0 | 0 | 6 | 16 | 9 | 31 | 1.55 | Rarely |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| food test | | | | | | | | available |
| Biological garden | 0 | 0 | 0 | 0 | 20 | 20 | 1.00 | Never available |
| Computer facilities | 0 | 8 | 6 | 4 | 14 | 32 | 1.60 | Rarely available |
| Bult, cells, battery | 0 | 8 | 3 | 24 | 5 | 40 | 2.00 | Rarely available |
| Preserved specimen | 10 | 4 | 9 | 24 | 2 | 49 | 2.45 | Rarely available |
| Secaleum | 0 | 0 | 9 | 8 | 13 | 30 | 1.50 | Rarely available |
| Vasculum | 0 | 0 | 2 | 6 | 16 | 24 | 1.20 | Never available |
| Plant press | 0 | 0 | 6 | 2 | 16 | 24 | 1.20 | Never available |
| Camera | 0 | 0 | 0 | 0 | 20 | 20 | 1.00 | Never available |
| Binoculars | 0 | 8 | 0 | 8 | 14 | 30 | 1.50 | Rarely available |
| Tripod stand | 10 | 12 | 6 | 12 | 6 | 46 | 2.30 | Rarely available |
| Fire extinguisher | 0 | 0 | 9 | 10 | 12 | 31 | 1.55 | Rarely available |
| Water bath | 0 | 0 | 0 | 2 | 19 | 21 | 1.05 | Never available |
| Round and fat bottom flask | 0 | 8 | 9 | 6 | 12 | 35 | 1.75 | Rarely available |
| Demonstration table | 50 | 16 | 18 | 0 | 0 | 84 | 4.20 | Often available |
| Petridish | 20 | 12 | 6 | 16 | 3 | 57 | 2.85 | Occasionally available |
| Prepared slides | 10 | 4 | 6 | 8 | 10 | 38 | 1.90 | Rarely available |

| | | |
|---|---|---|
| | 2.11 | Rarely available |

AA-Always available, OA-often Available, OA-occasionally available, RA-rarely available, NA-Never available, TR-total rating, AM- Arithmetic mean.

From table 1, it was observed that out of fifty-six (56) equipment/materials listed for effective teaching and learning of biology, five (5) (8.9%) were found to be never available; 40, (71%) were found to be rarely available; Nine (9) (16.07%) were found to be occasionally available. Finally two (2) (3.6%) items were found to be often available in schools. Accordingly, biology equipment/materials were on the average rarely available in secondary schools.

**Research question 2: To what extent do biology teachers make use of available biology equipment?**

**Table 2: Extent of use of biology equipment by biology teachers.**

| **Item** | **AU** | **OU** | **CU** | **RU** | **NU** | **TR Total** | **AM** | **Remark** |
|---|---|---|---|---|---|---|---|---|
| Quadrate | 0 | 0 | 0 | 4 | 18 | 22 | 1.10 | Never utilized |
| Measuring cylinder | 5 | 4 | 6 | 4 | 11 | 32 | 1.60 | Rarely utilized |
| Skeleton | 0 | 0 | 6 | 4 | 16 | 26 | 1.30 | Never utilized |
| Overflow can | 0 | 0 | 3 | 2 | 18 | 23 | 1.15 | Never utilized |
| Dissecting equipment | 0 | 0 | 3 | 2 | 18 | 23 | 1.15 | Never utilized |
| Spring balance | 0 | 4 | 3 | 4 | 16 | 27 | 1.35 | Never utilized |
| Mounted pictures | 20 | 12 | 15 | 20 | 3 | 70 | 3.50 | Often utilized |
| Handles | 0 | 0 | 9 | 6 | 14 | 29 | 1.45 | Never utilized |
| Flash card | 0 | 0 | 0 | 0 | 20 | 20 | 1.00 | Never utilized |
| Mosquito net | 0 | 0 | 3 | 4 | 17 | 24 | 1.20 | Never utilized |
| Rain guage | 0 | 0 | 0 | 0 | 20 | 20 | 1.00 | Never utilized |
| Laboratory funnel | 0 | 0 | 9 | 6 | 14 | 29 | 1.45 | Never utilized |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Biological kits | 0 | 0 | 0 | 4 | 18 | 22 | 1.10 | Never utilized |
| Test tubes and rats | 0 | 0 | 9 | 6 | 14 | 29 | 1.45 | Never utilized |
| Beaker | 0 | 0 | 12 | 10 | 11 | 33 | 1.65 | Rarely utilized |
| Aquarium | 0 | 0 | 0 | 0 | 20 | 20 | 1.00 | Never utilized |
| Thermometer | 0 | 0 | 3 | 4 | 17 | 24 | 1.20 | Never utilized |
| Microscope | 0 | 0 | 0 | 6 | 14 | 29 | 1.45 | Never utilized |
| Anemometer | 0 | 0 | 3 | 4 | 17 | 24 | 1.20 | Never utilized |
| Wind vane | 0 | 0 | 0 | 6 | 17 | 23 | 1.15 | Never utilized |
| Pooter | 0 | 0 | 0 | 0 | 20 | 20 | 1.00 | Never utilized |
| Sachi disc | 0 | 0 | 0 | 2 | 18 | 20 | 1.00 | Never utilized |
| Punnet square | 0 | 0 | 9 | 4 | 15 | 28 | 1.40 | Never utilized |
| Tape recorder | 0 | 0 | 0 | 6 | 17 | 23 | 1.15 | Never utilized |
| Fish trap | 0 | 0 | 3 | 2 | 18 | 23 | 1.15 | Never utilized |
| Sweet net | 0 | 0 | 0 | 0 | 20 | 20 | 1.00 | Never utilized |
| Transect | 0 | 0 | 0 | 0 | 20 | 20 | 1.00 | Never utilized |
| Incubator | 0 | 8 | 6 | 6 | 15 | 35 | 1.75 | Rarely utilized |
| Water filter | 5 | 4 | 9 | 8 | 11 | 37 | 1.85 | Rarely utilized |
| Drying oven | 0 | 0 | 0 | 0 | 20 | 20 | 1.00 | Never utilized |
| Vaccum flask | 0 | 0 | 9 | 12 | 11 | 32 | 1.60 | Rarely utilized |
| Herbarium cabinet | 0 | 0 | 0 | 0 | 20 | 20 | 1.00 | Never utilized |
| Charts | 15 | 12 | 12 | 8 | 5 | 55 | 2.75 | Rarely utilized |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Magnifying glasses | 0 | 0 | 9 | 6 | 14 | 29 | 1.45 | Never utilized |
| Dropping pipette | 0 | 4 | 3 | 6 | 16 | 29 | 1.45 | Never utilized |
| Burnsen Burner | 0 | 4 | 3 | 9 | 15 | 31 | 1.55 | Rarely utilized |
| Model for eye | 5 | 0 | 4 | 16 | 10 | 35 | 1.75 | Rarely utilized |
| Model for ear | 5 | 4 | 2 | 14 | 10 | 35 | 1.75 | Rarely utilized |
| Model for heart | 0 | 0 | 0 | 20 | 10 | 30 | 1.50 | Rarely utilized |
| Regent for food test | 0 | 0 | 0 | 20 | 10 | 30 | 1.50 | Rarely utilized |
| Biological garden | 0 | 0 | 0 | 0 | 20 | 20 | 1.00 | Never utilized |
| Computer facilities | 0 | 0 | 0 | 10 | 15 | 25 | 1.25 | Never utilized |

TR-total rating, AM- Arithmetic mean.

From table 2, it was observed that out of 56 equipment/materials in the list, 39 (69.6%) were never utilized; 15 (26.8%) were rarely utilized; one (1) (1.8%) was occasionally utilized, and finally one (1) (1.8%) was often utilized. Accordingly biology equipment/materials in secondary schools were on the average never utilized.

**Research question 3: What are the implications of availability and utilization of biology equipment/materials?**

**Table 3: The implications of availability and utilization of biology equipment/materials.**

| **Item statement** | **VSA** | **SA** | **D** | **SD** | **VSD** | **TR** | **AM** | **Remark** |
|---|---|---|---|---|---|---|---|---|
| Student react positively when they use equipment / materials in teaching and learning | 1300 | 640 | 90 | 60 | 40 | 2130 | 4.09 | Strongly Agree |
| Teachers use of science equipment / materials motivate students' interest in | 1300 | 560 | 66 | 92 | 52 | 2070 | 3.98 | Strongly Agree |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| biology | | | | | | | | |
| Students perform well in topics taught with equipment/materials | 950 | 960 | 60 | 76 | 32 | 278 | 3.99 | Strongly Agree |
| Students taught without equipment/materials learn by rote leading to poor understanding of biological concepts | 975 | 796 | 90 | 96 | 48 | 2005 | 3.86 | Strongly Agree |
| Many biology teachers do not know how to use the available equipment | 925 | 836 | 153 | 76 | 37 | 2027 | 3.89 | Strongly Agree |
| Students cannot apply knowledge to real life situation when taught without equipment/materials | 880 | 780 | 153 | 130 | 33 | 1976 | 3.80 | Strongly Agree |
| Poor understanding of biological concepts may lead to production of biologists who cannot be self-reliant | 840 | 792 | 201 | 124 | 25 | 1982 | 3.81 | Strongly Agree |
| This poor understanding of biological concepts may be one of the causes of low rate of development in Nigeria | 990 | 768 | 147 | 152 | 05 | 2062 | 3.97 | Strongly Agree |

VSA- very strongly agree, SA-strongly agree, D-disagree, SD- strongly disagree, VSD-very strongly disagree, TR-total rating, AM- Arithmetic mean.

From table 3, both biology teachers and students strongly agreed on the following points:

- Students react positively when they use equipment/materials in teaching and learning;
- Teachers' use of science equipment/materials motivate students interest in biology;
- Students perform well in topics taught with equipment/materials;

- Students taught without equipment/materials learn by rote leading to poor understanding of biological concepts;
- Many biology teachers do not know how to use most biology equipment/materials;
- Poor understanding of biological concepts may lead to production of biologists who cannot be self-reliant;
- Poor understanding of biological concepts may be one of the causes of economic crisis in Nigeria.

**Discussion**

The information in table 1 revealed that biology equipment/materials were on the average rarely available in secondary schools. Accordingly, 8.9 of the materials were never available in schools, 71 percent of materials were found to be rarely available, 16.01 percent of materials were found to be occasionally available in schools while 3.6 percent of materials were found to be often available. This result was supported by observations of earlier researchers. For instance, Achufusi, Umeh & Okoye (2009), Olangunji (2003) Ibukun (1992) reported serious lack of equipment/materials in the teaching and learning of biology. This may be why teachers most times avoid conducting practical work which in itself has implication for the academic performance of students. Laboratory equipment availability plays a vital role in determining the extent of acquisition of science process skills and competence in science concepts by the learner (Yahya and Shamsudeen 2017). Abuja, Katcha and Wushishi (2015) in Yahya and Shamsudeen (2017) reported that there is a significant difference between the performance of biology students exposed to well-equipped laboratory and those exposed to ill-equipped laboratory.

On a similar note, Table 2 revealed that biology equipment/materials were on the average never utilized by biology teachers. Accordingly, 69.6 percent of materials were never utilized, 26.8 percent were rarely utilized, 1.8% of materials were occasionally utilized and finally 1.8 percent were often utilized. This was supported by the findings of Olangunji (2003), Abudrauf, Alhassan and Jubril (2019) who reported low utilization of ICT facilities in Nigeria secondary schools of which biology equipment is part.

Again the information in table 3 revealed many implication of non-availability and low-utilization of biology equipment/materials which includes, poor understanding of biology concepts leading to rote learning, inability to apply knowledge to real life situation leading to lack of self-reliance. Some of these points were also highlighted by NBTE (2006). It also reveals teachers inability to use the available science equipment/materials. This was supported by the observations of Ofoegbu (2003) and Akubuilo (2004) who reported that teachers lack the competence, skills and creativity to organize practical classes in biology. This may be one of the reasons biology equipment and materials are never utilized in schools.

**Summary and conclusion**

Biology equipment/materials were on the average rarely available in secondary schools and the available ones were never utilized by biology teachers. This has a lot of implications which includes: poor understanding of biology concepts leading to rote learning, resulting in inability to apply knowledge of biology to real life situation.

Science Education of which biology is one, is the bed rocks of technological breakthrough. Technologically advanced countries of the world attain their status partly through their knowledge of Science Education. Technological advancement is a must for any nation to rise above poverty and backwardness. It is a well-known fact that no technologically advanced country is poor. This buttresses the importance of availability and utilization of biology equipment/materials in secondary schools by biology teachers in the light of the present developing status of Nigeria.

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# ENHANCING THE TEACHING OF SCIENCE THROUGH THE USE OF ICT IN SENIOR SECONDARY SCHOOLS

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**Abstract**

*Information and Communication Technology (ICT) is an important area that cannot be ignored in education because of the demand due to technological growth in both the private and public sectors of the country's economy. Science teachers need to bring their ICT knowledge up to date since ICT tools are considered to be an efficient way to extend the horizons of traditional science teaching. ICT tools can also support learning strategies where students' projects are involved thereby improving and enhancing students' interest. This paper examined the concept of ICT; application of ICT in science education; the benefit of ICT in science teaching and learning; challenges to the use ICT in teaching and learning of science. Some solutions to these problems were also suggested.*

**Keywords:** Information and communication technology, teaching, science education

## Introduction

The importance of ICT cannot be over emphasized as it forms the basis for technological advancement of any nation. The knowledge of ICT plays a very significant role in the economic development of any nation hence the need for the subject to be taught very well to enable students to develop interest and improve their achievement in technology. Effective teaching according to Ogu and Ononugbo (2006) is measured by the expected outcome that follows instruction. For effective learning to take place in teaching, two things are imperative; teachers' knowledge and the learner's interaction (Kola, 2013). Explaining further Kola (2013) stated that both the teacher's knowledge and the learner's interaction are each categorized into three. The teacher's knowledge includes the content knowledge, pedagogical knowledge and technological knowledge while the learner's interactions include learner-teacher interactions, learner-learner interaction and learner-environment interaction (KoIa, 2013).

- **Content knowledge:** This involves the science teacher being knowledgeable about science. The science teacher must know about science theories, concepts, principles and laws.
- **Pedagogical knowledge:** This involves the science teacher knowing about the nature of learning, methods of teaching, how to assess students and how to manage the classrooms.
- **Technological knowledge**: This involves the teacher having skills to operate and apply technologies in the science class.

- **Learner-teacher interactions**: This involves the interaction between students and teachers in the teaching /learning process which includes interaction during lessons and outside classroom interactions.
- **Learner-Learner interaction**: This is the interaction in various group studies either in the classroom or outside the classroom. The implication is that there should be group studies which are very important to students' learning in science.
- **Learner-environment interaction**: This involves various activities carried out by students using community as learning resources. Using learners' community as resources is very important to science learning in general.

  Teachers can effectively deliver their science lessons by using active learning strategies such as ICT tools in the teaching and learning of science. Such teaching strategies will get the students- involved in learning activities. According to Shedd (2004), science teachers must incorporate technology into their science classes since teaching has gone beyond traditional method of talk and chalk. This implies that the integration of Information and Communication Technology (ICT) in science classes is very imperative (Aina, 2012). Such methods will create excitement in students and thus induce their critical thinking and conceptual understanding of the subject.

**The concept of ICT**

Information and Communications Technology (ICT) according to Kola (2013) is an umbrella term that includes any communication device or application. It comprises of radio, television, cellular phones, computers, and network hardware and software and satellite systems. Information and Communication Technology also consist of the various services and applications associated with them. These services and applications includes video conferencing and distance learning. ICTs are defined as basically information — handling tools — a varied set of goal, applications and services that are used to produce, store, process, distributed and exchange information (United Nations Development Programme (UNDP), 2004). The different ICT tools are able to work together and combine to form 'networked world' — a massive infrastructure of interconnected telephone services, standardized computing handling the internet, radio and telephone which now reaches into every corner of the globe. ICT also refers to audio visual aids such as the transparency and slides, tape and cassettes records and radio; video cassette and television, and film.

ICTS are crucially important to sustainable development in developing countries. Thioune (2003) opines that for the past two decades most developing countries have unstressed significant changes that can be traced to ICTs. ICTs are credited with the ability to transform, and deep and significant changes are expected from their use. Stressing on the importance of ICT, the Federal Republic of Nigeria (FRN) (2001), explained that surviving in the information age depends on access to development of any nation in a rapidly changing global environment, and it challenges us to devise

initiative to address a host of issues such as reliable infrastructure, stalled human resources, open government and other essential issues of capacity building. Information and Communication Technology (ICT) can contribute to universal access to education, equity in education, the delivery of quality learning and teaching, teachers' professional development and more efficient education management, governance and administration. The implication is that there is a need for 1CT in education.

ICT in education is the teaching and learning with ICT. ICT in education has a multiplier effect throughout the education system by:

1. Enhancing learning and providing students with new sets of skills
2. Reaching students with poor or no access
3. Facilitating and improving the training of teachers
4. Minimizing costs associated with the delivery of traditional instruction and
5. Improving the administration of schools in order to enhance the quality and efficiency of service delivery.

The implication of the above is that ICT has the potential to make learning more experimental. The large amount of data and visual availability on any topic can be brought to the classroom from all over the world thereby making educational process more meaningful. Educationists have seen the use of computers and the internet as ideal for enhancing the quality of education by making learning more relevant to life. ICT in Education can be seen from two angles

1. The use of ICT for enhancing learning
2. Exposure to the use of ICT in general which will basically include the use of computers.

Considering ICT in Education from both angles will greatly facilitate the acquisition and absorption of knowledge and offering students unprecedented opportunities to enhance their learning. Mikre (2011) explained that ICT in Education have revolutionized the way students learn today and are now transforming education systems. According to Bransford, Brown and Cocking as cited in Volman (2005), there is a common belief that the use of ICT in education contributes to a more constructivist learning and an increase in activity and greater responsibility of students. In addition, Volman opines that the gradual progress in using computers changes from learning about computers to learning computers and finally to learning with computers. This according to Mikre (2011) limits the role of the teacher to supporting, advising and coaching students rather than merely transmitting knowledge.

ICT in education is a great help in the constructivist approach of learning-an approach that considers learning as authentic and learner-centered where one can design simulated individualized learning environments to students. To achieve the

millennium Development Goals (MDGs), ICT education must be embraced through our academic learning and specifically through science learning. There are many teaching resources that can be used to teach science effectively. The philosophy of the Nigerian Certificate in Education (NCE) of science education is inspired by the desire to help students become intellectually informed in science and the need to produce competent and effective teachers with good mastery of content, method and knowledge of the development of the learners (Kola, 2013).

ICT integration into science learning can be seen as the best solution for improving students' academic performance since ICT attracts students and makes them lively in class, promotes students interaction in the course of learning thereby increasing, the effectiveness of teaching and improving students' learning. It is therefore desirable that science teachers are trained to make use of ICTs in their teaching.

**Application of ICT in Science Class**

ICT can be applied in the science class under four main categories;

1. Finding more about science and current discoveries through the use of internet, email CD-Rom, Database, and video coverage.
2. Collecting, handling and interpreting/analyzing data involved in science through data logging using software such as Excel for spreadsheets and graphs
3. Aiding understanding/explanation of science concepts, especially visualizing abstract concepts and processing by using models, simulation games, digital video and multimedia adventures and,
4. Communicating ideas through the use of presentation software such as PowerPoint digital Video, desktop publishing, web based publishing (Oldham, 2003).

Applying ICT in science concept refers to the set of activities which involves planning, organizing, control, staffing, directing and coordinating ICT towards the goal of developing people as a resource material. Ebong (2004) opined that the science teacher should be involved in the curriculum reformation since planning the curriculum courses should aim at optimizing the contribution of individuals and groups, integrating related information and communication component and coordinating delegated tasks in the management process.

ICT materials can be applied in the teaching of science in the following ways.

1. Instrumentation-Appropriate software can be used to describe working principles of sophisticated instruments. For instance the teaching of electric motor in science can be done with the aid of Encarta educational software.
2. Analysis of Data- Data generated from experiment can be analyzed using appropriate software.
3. Computer can be used to stimulate various phenomena in science to give a better representation of the real life occurrence:

4. Laboratories experiments can also be simulated and put into memory devices for students to learn at their own pace.
5. Lecture and process of learning instruction can be presented with the use of PowerPoint.

Apart from educational software, video and community resource can be used for learning in science. According to Kola (2013), soldering of resistors, transistors and other active electronics components can be done showing videos of electronic technicians at work already to surmount the problem of not carrying out electronic experiments in science due to the problem of electric power supply in the country. In this way, students will be able to learn how to perform such activity even though they were not directly taught in the class by their science teacher. Wilson and Redish (1989) also opined that microcomputer can be used to acquire data from thermistor, photodiodes and pressure transistors and be used to teach topic like chain reaction and retroactive decay in nuclear physics which cannot be easily carried out in classroom situation. Computer simulation and video can also be used to teach concepts like optical phenomena, magnetic and mechanic phenomena, movement of air, its interactions and collision which seemed to be abstract to students who find them very difficult to comprehend. According to Kola (2013) Computer Assisted Instruction (CAI) tools like spreadsheet and word processor are used to collect and analyze data.

Aina &Adedo (2013) argued that feedback is very important in teaching and learning process because it improves students' learning. Supporting this, Kola (2013) stated that such feedback could be gotten through computer. Explaining further Kola said that students can learn how to spell words correctly in a word processor when text is being underlined by the computer. According to Nguyen & Nguyen (2012), learning activities could be communicated through e-mail system. Students could be in contact with their teacher who is away from school by sending learning activities to their teacher through e-mail. Many teachers supervise their students' project through this method.

Students can also learn a lot through internet, social network and online chat. Physical articles in journals are uploaded into website or blog to be accessed for learning (Kola, 2013). Osunade (2003) explained that internet is a valuable source of information for students looking-for ideas for writing their projects and assignments.

**Benefits of ICT to Science Education**

Application of ICT to science education has numerous benefits. According to Kola (2013), such benefits include: -

- Helping science students to learn science concepts, laws and theories with ease and also retaining what they have learnt in their memory for a very long period.
- Promoting hard work for both science teachers and students.

- Improving science students' participation in classroom activities.
  >Helping both science student and teachers to exchange ideas, learning materials and teaching strategies quickly.
- Affording both science teachers and students the opportunity of organizing seminars, workshops and conferences on uses relating to science education across the globe without boundary restriction.
- Helping both science teachers and students sustain and update their knowledge in science.
- Helping science students to understand abstract and very difficult concepts in science.

  Yusuf and Yusuf (2009) explained that the application of ICT in science education has the potential for enhancing the tools and environment for science learning since it allows materials to be presented in multiple media, motivate and engage science students in learning process, foster enquiry and exploration and provide access to world made information resources. Explaining the importance of ICT in science education, Okpurukhre, William, Esikpe and Ezewi (2013) opined that through the internet, science students and teachers can gain access to a rich source of information to keep abreast of new sources of knowledge. They went further to explain that through the internet, digital libraries science teachers can easily get access to relevant and current resources in science. This will therefore enhance the quality of science-students' learning through ICT; science teachers, students, Librarians and schools can communicate with one another and share information that will enhance understanding of science concepts. Stressing on the benefits of ICT in science education, Wiki Education (2009) asserted that ICT is beneficial to science education in the following ways: Giving science students
- Access to a vanity of learning resources ICT provides a lot of learning resources that will enhance learning in all aspects of science
- Immediacy of information - ICT has a fast pace of imparting knowledge to students thereby enabling science students to be educated anywhere and at anytime because of the already available information on the internet.
- Anytime anywhere learning - ICT make it possible for science students to study at will. According to Yung (2002), such flexibility in learning has heightened the availability of first — in — time learning and has also provided opportunity for more learners who perilously were constrained by other commitment.
- Authentic and up to date information.
- Access to online Libraries — through internet service where a lot of date are available.
- Individualization of Instruction — ICT encourage students to learn at their own pace.
- The teaching science is made interesting though ICT tools like video thereby ensuing high reiterations of learning experiences.

**Challenges to the Use of ICTs in Secondary Schools.**

Many problems have been militating against the application of ICT in Nigerian secondary schools. Some of these factors impeding the use of ICT in education have been identified by STAN (2011) and Nzewi (2009) to include:

- Lacks of training among teachers — many teachers in the secondary schools are computer illiterates and according to Nzewi (2009) in some states where attempt were made to train them, adequate time and resources were not devoted to the exercise.
- Inadequate funding to support the purchase of ICT tools like computer.
- High enrolment in school — According to Fafunwa as cited in Okeke and Nzewi (2009), the universal primary education led to remarkable increase in school enrolment from 6 million in 1976 to 15 million in 1982. There is therefore an increase in school population without a corresponding increase in the supply of ICT facilities and this has posed a serious problem on the educational system.
- Lack of motivation and need among teachers to adopt ICT as teaching tools some teachers are not aware of the innovations ICT has brought to teaching and learning. Processes and have refused to adopt it as a teaching tool.
- Lack of skills — Nzewi (2009) observed acute shortage of trained personnel in application software, operating system etc which has resulted in the lack of human skills and knowledge needed to integrate ICT into the education sector.
- Conservation attitude of teachers — Teachers have found it difficult to embrace the innovations offered by ICT facilities due to the fact that, according to Schein(1988), individuals and organization possess natural tendency to maintain a steady state and any change that disrupts this status quo are viewed with caution.
- Irregular and inadequate power supply — there is lack of uninterrupted power supply in Nigeria and this imposes threat to the education system since these ICT facilities require electric power supply for effective functioning.
- High cost of technology — computer equipment and others like software, printers, scanners etc are very expensive and not easily affordable by schools or individuals.

**Solutions**

In order to solve some of these problems, the following action should be taken.

1. Government should supply sufficient ICT teaching equipment like computers, projectors and educational software in schools and ensure that all schools are internet compliance. Such equipment should be supervised regularly to make sure that they are there and are used for the purpose for which they were supplied.
2. Government should also organize computer conferences, seminars and workshop for science teachers and make sure that all science teachers in both private and public secondary schools are mandated to attend these trainings that will improve their competencies in the use of ICTs.

3. Government should fund the schools very well for them to be able to purchase ICT tools and other technologies to be used in the schools.
4: Power generation must be given adequate attention by the government in order to maintain a country with uninterrupted power supply which is the heart of every technology.
5. Science teachers should be encouraged to have laptops and modems which will enable them have access to internet anywhere and at anytime.
6. Science students and teachers should be encouraged to have e-mail addresses. Science teachers should also give their student assignments on internet for them to be able to tap the rich resources from the internet.

**Conclusion and Recommendation**

The application of ICT in science education can improve students' academic performance in science. There is a great need for all the science teachers to be computer literate so that they can deliver properly to the students. However there are a lot of problems militating against the use of ICTs in the science classroom. These problems include among others, high enrolment in schools, lack of motivation among teachers and irregular and inadequate supply of electricity. To surmount these problems, the government, individuals, teachers and students have to make necessary sacrifices.

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