

Effects of an Advance Organizer on Secondary School Students' Learning Outcomes in Chemistry in Ekiti State

Rufus Oluwafemi JEGEDE

Department of Science Education, Bamidele Olumilua University of Education, Science and Technology, Ikere-Ekiti (BOUESTI), Ekiti State, Nigeria.

Received: March 26, 2021

Accepted: May 01, 2021

ABSTRACT: *The study examined the effects of an Advance Organizer on secondary school students' learning outcomes in Chemistry in Ekiti State. The pretest, posttest control group quasi-experimental design was adopted for this study. The treatment applied to the experimental group was Advance Organizer while the control group was exposed to the conventional method. The population for the study comprised of 19,603 Senior Secondary Schools Two (SSSII) students in 189 public Secondary Schools in the three senatorial districts across the sixteen (16) Local Governments Areas (LGAs) of Ekiti State. The sample for this study consisted of 144 SSS II Chemistry students found in intact classes of the schools selected for the study. The two instruments used for study were Chemistry Performance Test (CPT) and Chemistry Attitudinal Scale (CAS). The instruments were subjected to content and face validity. The reliability of the instruments was determined through the test re-test method and reliability coefficients of 0.87 and 0.85 were obtained for CPT and CAS respectively which were believed to be high enough to adjudge the instruments as internally consistent, stable and reliable enough for use. The results of the data collected from both pre-test and post-test were collated and analysed inferential statistics. Hypothesis 1 was tested using t-test, hypotheses 2 and 3 were analysed using Analysis of Variance (ANCOVA). Each hypothesis was tested at 0.05 level of significance. The findings revealed that there is considerable improvement in the performance of students taught Chemistry using Advance Organizer compared with those taught using conventional teaching method; there is no significant difference in the performance mean scores of male and female students in Chemistry who are taught using advance organizer and those who are taught using conventional method. It was recommended that Advance Organizers should be employed for the teaching of Chemistry in secondary schools as innovative instructional strategy to bridges what students already know and what they are to learn. This will allow for teaching - learning interaction effectiveness.*

Key Words: *Advance Organizer, learning outcomes, chemistry, secondary schools*

Introduction

Science and Technology have long been recognised as the instruments for nation building and every country today craved for this nation building and national development. Nigeria, like the other nations in the world depends on what Science, Technology, and Mathematics could offer for her development. Imperatively, the relevance of science to the cognitive growth of the individual and the nation cannot be overemphasised. We need science for better food production, protection, welfare, provision and maintenance of sundry social service like water, shelter, transportation and medical services. Thus, (Ibrahim, 2012) the significant roles of science towards national development make it pertinent and practically necessary for science to be taught in an organized and well-structured pattern involving activities for both teachers and students. Science can be classified into different branches, namely; Chemistry, Biology, Physics, mathematics and Integrated Science among others. Out of all these branches, Chemistry plays a vital role as it acts as the link to all other branches.

Chemistry can be defined as one of the branches of Science that deals with the properties of matter and its relationship with energy; and the changes that the matters undergo. Chemistry is one of such subjects or activities whose verifiable evidences are based on scientific proof. Webster (2009) stated that Chemistry is the science that underpins most of the major discoveries of the 20th century and still will continue to do so in the 21st century as emphasis moves towards the understanding of biological approaches and more eco-friendly synthetic systems such as forensic Chemistry, environmental, soil and water Chemistry. Therefore, for a student to be enrolled in these courses, his/her academic performance in and attitude toward Chemistry (learning outcomes) must be encouraging.

Academic performance refers to students' short term success or accomplishment in educational goals through Chemistry. According to Popoola (2010) academic performance is described as an expression used to present students' scholastic standing and which is a function of various factors such as method of

teaching, teachers qualifications, students home background, school environment, attitude, interest, among others. Academic performance is measured by teachers made test and is frequently defined in terms of examination performance. Performance test according to Diver (2012) is the type of test which throws light on the ability to deal with things rather than symbols. In relation to educational research, academic performance of a student can be regarded as the observable and measurable behaviour of a student in a particular situation. In Chemistry, students' academic performance consists of his scores at any particular time obtained from a teacher- made test, first term examination, and mid-semester test among others in Chemistry. A student who earns good grades or awards in science has achieved in the academic field of science. Academic performance could be high/good or low/poor achievement. A student who had achieved well in Chemistry is likely to have shown positive attitude to the study and learning of Chemistry in his or her classroom.

In spite the key role of Chemistry as the central science that forms the basic foundation to many disciplines and in improving the quality of life, research revealed that the performance and enrolment of students in the subject in our secondary schools has not reached the level expected making it a matter of serious concern to science educators as this performance serves as a gate-way limiting access to other science fields. This poor performance is a challenge to science educators mostly Chemistry teachers hence finding better ways of enhancing the teaching-learning process is the desire of science educators. The analysis of WAEC results of Chemistry students in Ekiti State from Ekiti State Ministry of Education, Science and Technology, Ado Ekiti also showed that between 2013 and 2018, there was an erratic performance of students in Chemistry as presented in Table 2.

Table 1: Analysis of WAEC Results in Chemistry in Ekiti State from 2013-2018

Years	Candidates Registered	A1-C6	%	D7-F9	%
2013	5043	3817	75.7	1093	21.7
2014	5829	3477	59.7	2352	40.3
2015	6072	4580	75.4	1492	24.6
2016	5258	4471	85.0	787	15.0
2017	5258	4894	93.1	364	6.9
2018	5155	3964	76.9	1191	23.1

Source: Ekiti State Ministry of Education, Science and technology

Table 1 shows the analysis of students' performance in Chemistry at West Africa Certificate Examination (WAEC) in Ekiti State from 2013 – 2018. The table showed the performance of students with grade A1-C6 recorded 75.7% in 2013 and declined by 16% to 59.7% in 2014. In 2015, the performance increased 75.4% by 15.7% which further increase to 85.0% and 93.1% respectively in 2016 and 2017. However, in 2018 there was a noticeable decline in the performance of students by 16.2% to 76.9%. From the above analysis, it shows that, the performance of students in Chemistry had improved but it was erratic performance.

Efforts made through research had been in the areas of discovering the causes of the persistent student erratic performance in Chemistry which include the researchers' observation that many students perceive the learning of Chemistry to be abstract and thus thought that it can only be learnt by memorization to ensure they pass their Chemistry examinations. Others are teaching methods, school environment, quality of Chemistry teachers and teaching aids among others. This observation was supported by Adeyemi, (2010) who posited that students' achievements in Chemistry are influenced by classrooms, libraries, quality and quantity of Chemistry teachers, the availability and non-availability of facilities, teaching aids, school management, teaching method, environment and the location of the School. According to WAEC chief examiners' report (2015) and (2016); students under performance in Chemistry can be attributed to ineffective ways of teaching Chemistry with lack of familiarity with common Chemistry laboratory equipment or apparatus and poor knowledge in the fundamental principles and procedures for practical Chemistry.

The teaching of Chemistry involves the use of various methods and techniques. This includes lecture, discussion, demonstration, experimental, inquiry among others. From the experience of the researcher, the lecture method is the most popular conventional method of teaching Chemistry in our

secondary schools in Ekiti State. This is due to the fact that it allows a lot of topics to be covered in a very short time. Studies done in Nigeria suggested that teachers are in a hurry and tend to rush through the scheme of work to enable them cover the topics in the curriculum within the given period (Oludipe & Awokoya, 2010; Opara & Waswa, 2013 & Muhammad, 2014). Ashaolu (2014) posited that the use of lecture method is attributed to the fact that the school calendar in Nigeria is often interrupted by industrial actions and public holidays, and there is a need for completion and covering of the syllabus to prepare the students for both external and internal examinations, hence the use of lecture method which is less time consuming and it can be used to teach large and small class size. Olatunji (2015). Opined that other factors contributing to the failure may be connected to the way in which the teachers introduce their lesson at the beginning of each topic or unit, hence the need by the teachers to change their pattern of introduction, lack of or insufficient laboratory facilities and equipments, psychological factors such as anxiety, low self-esteem among others. But Adunola (2011) indicated that in order to bring desirable changes in students, teaching methods used by the educators should be best for the subject matter. Therefore; emphasis should be among others on the use of innovative teaching strategies such as the use of Advance Organizer.

Advance organizer is the information that is presented prior to learning which can be used to organize and interpret new incoming information. This study is based on the Ausubellian theory of advance organizers propounded by David Ausubel. The theory of advance organizer focuses on meaningful verbal learning. This theory emphasizes and contributes to the aspects of cognitive learning that encourages rapid learning and retention abilities. Advance organizer as teaching strategy was first used by Ausubel in 1960 and defines it as a cognitive instructional strategy used to promote the learning and retention of new information. In explaining meaningful learning, a primary process in learning emphasis that new material is related to old and relevant ideas in the existing cognitive structures (Ausubel, 1960). Thus, Adebola, (2011) asserted that the organizer is introduced in advance of learning itself, and is also presented at a higher level of abstraction.

Studies have shown that the use of advance organizer in teaching has been proved to be effective in enhancing students' performance in science subjects and Chemistry in particular. For instance, Hendron (2014) due to the way the organizers provide scaffolding of new ideas with pre-existing schema reported that students who use graphic presentations perform better in tests that require higher cognitive skills. In a study conducted in Anambra State, Enekwechi (2018) examined the effect of advance organizers in the teaching of Chemistry in secondary schools. The study used the pre-test post-test control group quasi-experimental design with eighty-four senior secondary 2 (SS2) Chemistry students as subjects selected from two sampled schools. Chemistry Achievement Test (CAT) and Scientific Attitude Questionnaire (SAQ) were the instruments used for collection of data. Analysis of covariance (ANCOVA) was used as the statistical technique for the data analysis at 0.05 level of significance. The study revealed that students taught Chemistry with advance organizers achieved better and had a higher level of scientific attitude than their counterparts taught with the conventional method. Hence, the study recommended that Chemistry teachers should adopt the use of advance organizers in order to improve students' achievement and scientific attitudes.

In another study, Ekenobi & Mumuni (2015) adopted a re-test, pre-test control group, quasi-experimental design in a 3x2 factorial matrix to investigate the efficacy of advance organizers strategies on Chemistry students' cognitive achievements in redox reaction concept. A total of two hundred and twenty (220) senior secondary two (SS2) Chemistry students (118 males and 102 females) purposively selected from three out of six public co-educational senior secondary schools that met sampling criteria in Obio/Akpor education zone, Rivers State, Nigeria constituted three non-equivalent intact classes that participate in the study. A Redox Reaction Concept Achievement Test (RRCAT) instrument with Kuder-Richardson's reliability co-efficient of 0.90 was used to obtain data. Descriptive statistics (mean, standard deviation and percentages) and inferential statistics (ANCOVA and Scheffe's post hoc analysis) were used for data analysis at 0.05 alpha level. The findings established that graphics advance organizers strategy consistently produced the highest levels of achievement gain and was therefore found to be most efficacious in promoting meaningful understanding and enhancing higher cognitive achievements in redox reaction concept at all levels of the cognitive domain among the three strategies compared. The study concluded that Chemistry teachers should adopt graphics and textual advance organizers strategies as purposeful and efficient instructional strategies and resources in teaching redox reaction so that students could reap the full benefits of active classroom involvement.

In Kenya, Omondi, Keraro & Anditi (2018) examined the effects of using advance organizers on students' achievement in biology in secondary schools in Kilifi County. Solomon Four, Non-Equivalent control group design was used. The study targeted all secondary school students in Kilifi County. Purposive

sampling was used to select four co-educational secondary schools in Kilifi County. The four schools were randomly assigned to experimental groups (E1) and (E2) and control groups C1 and C2. A total of 156 students participated in the study. Data was collected using Biology Achievement Test (BAT). The data collected was analyzed using mean, one-way ANOVA and t-test. The level of significance was 0.05. The findings of the study revealed that there was statistically significant difference in achievement between learners in favour of those taught using advance organizers compared to those taught using conventional teaching methods. From the foregoing empirical findings, it is evidence that the use of advance organizers facilitated learning more than the conventional teaching approach regardless of geographic boundaries. Meanwhile in the contrary, Okey & Avwiri (2014) who found no significant difference in the performance of students taught using advance organizer and those taught using conventional method.

Gender difference in science has received serious attention in Science education research for the last two decades. Boys and girls have been compared on variables such as achievement, attitude, motivation, interest and performance behaviour. According to Ogundola & Fakorede (2009), gender is a sense of awareness of being male or female. According to them, research reports on the influence of gender on students' academic performance have been inconsistent and conflicting. Research shows different opinions on the issue. In Nigeria, studies on the contribution of gender on students' performance are numerous. Omoniyi, (2003), conducted a study on the effects of constructivism on gender related differences in solving student's misconceptions in Chemistry and found out that female students performed significantly better than their male counterparts. The findings further revealed significant in the aspect of gender difference in favour of boys in Physics achievement. In the view of Fatokun & Odagboyi (2010), gender has a significant factor in Students' achievement in Chemistry due to interaction patterns.

Using advance organizer, Ekenobi & Mumuni (2015) in their study examined the efficacy of advance organizers strategies on Chemistry students' cognitive achievements in redox reaction concept found that gender did not significantly influence the achievement of students in redox reaction concept. Also, in the study of Omondi, Keraro & Anditi (2018) to examine the effects of using advance organizers on students' achievement in biology in secondary schools in Kilifi County in Kenya, it was indicate that there was no statistically significant gender difference in achievement. This implies that the use of advance organizer in teaching Biology does not discriminate gender. However, Onah & Ugwu (2010) who posited that gender is a determinant of performance in chemistry when advance organizer is used. Thus, the focus of this study was to investigate the effect of Advance Organizer on Secondary School Students' Academic Performance in Chemistry in Ekiti State. Specifically, the study intends to examine the performance of students who are taught using Advance Organizer (AO) and those students taught using Conventional Teaching Method (CTM) as well as examine the effects of gender on students' performance in Chemistry when they are taught using Advance Organizer.

Research Hypotheses

The following hypotheses were formulated to guide the study and were tested at 0.05 level of significance.

1. There is no significant difference in the pre-test mean scores of students in the experimental and conventional groups
2. There is no significant difference in the performance mean scores of students who are taught using Advance Organizer and those who are taught using Conventional Teaching Method
3. There is no significant difference in the performance mean scores of male and female students in Chemistry who are taught using advance organizer and those who are taught using conventional method.

Methodology

The pre-test, post-test control group quasi-experimental design was adopted for this study. In this study, there are two instructional groups (i.e. one experimental and one control). The population for the study comprised of 19,603 Senior Secondary Schools Two (SSSII) students in 189 public Secondary Schools in the three senatorial districts across the sixteen (16) Local Governments Areas (LGAs) of Ekiti State, Nigeria as at the time of this study (Ekiti State Ministry of Education, 2018). The sample for this study consisted of 144 SSSII Chemistry students found in intact classes of the schools selected for the study. Chemistry Performance Test (CPT) was the main instrument used for this study. Chemistry Performance Test was used to measure students' performance in Electrolysis. The items test knowledge, comprehension, application and analysis of chemical information. The instrument consisted of 20 items of multiple choice objectives with four options from the past Senior Secondary School Two (SSS II) unified examinations of the

State. The researcher ensured that the questions are constructed based on the topics taught. The CPT used served as both pre-test and post-test. Each item was scored one mark, thus the total obtainable was 20 marks. The instrument was subjected to content and face validity. The reliability of the instrument was determined by test re-test method and the reliability coefficients of 0.8 was obtained which was believed to be high enough to adjudge the instrument as internally consistent, stable and reliable enough for use. The research procedure was in three stages. These are: the pre-treatment stage (one week), the treatment stage (four weeks) and post treatment stage (three weeks), making a total of eight weeks for the study. The data collected was analysed using inferential statistics. The research hypothesis 1 was tested using t-test while hypotheses 2, and 3 were analysed using Analysis of Variance (ANCOVA). Each hypothesis was tested at 0.05 level of significance.

Results

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

Table 2: t-test Analysis of difference in the pre-test mean scores of students in the experimental and conventional groups

Group	N	Mean	S.D	t	df	Sig.
Conventional	73	21.77	17.39	1.159	142	.248
Advance Organizer	71	18.70	14.09			

Table 6 shows that t-calculated was 1.159 while the corresponding p-value was 0.248 (t=1.159, p=.248). The pre-test mean scores and standard deviation for conventional and advance organizer group were 21.77(17.39) and 18.70(14.09) respectively. Since the p-value of 0.248 was greater than 0.05 level of significance. This implies that, there was no significant difference in the pre-test mean scores of students in the experimental and conventional groups. The null hypothesis is not rejected.

Hypothesis 2: There is no significant difference in the performance mean scores of students who are taught using Advance Organizer and those who are taught using Conventional Teaching Method

Table 3: Analysis of Covariance (ANCOVA) of Difference in the performance Mean Scores of Students who are Taught Using Advance Organizer and those who are Taught Using Conventional Teaching Method

Source	SS	df	MS	F	Sig.
Corrected Model	37946.404	2	18973.202	327.872	.000
Covariates (Pre-test)	24305.101	1	24305.101	420.011	.000
Treatment	17251.193	1	17251.193	298.114	.000
Error	8159.346	141	57.868		
Total	333938.000	144			

Table 7 shows that F-calculated for the treatment was 298.114 and the corresponding p-value was 0.000. Because the p-value of 0.000 was less than 0.05 level of significance, there was significant difference in the performance mean scores of students who are taught using Advance Organizer and those who are taught using Conventional Teaching Method (F=298.114, p<0.05). The null hypothesis was rejected. In order to locate the point of the differences, Scheffe pairwise comparisons was carried out as presented in table 4.

Table 4: Pairwise Comparisons showing effectiveness of the treatment on students performance in Chemistry

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.
Control	Advance Organizer	-21.996*	1.274	.000
Advance Organizer	Control	21.996*	1.274	.000

*The mean difference is significant at the .05 level.

Table 8 indicates that the mean difference of 21.99 for experimental group and control group was significant at 0.05 level of significance. This implies that advance organizer instructional strategy was more effective at improving students' performance in Chemistry than conventional method of teaching.

Hypothesis 3: There is no significant difference in the performance mean scores of male and female students in Chemistry who are taught using advance organizer and those who are taught using conventional method.

Table 5: Analysis of Covariance (ANCOVA) of Difference in the performance Mean Scores of Students who are Taught Using Advance Organizer and those who are Taught Using Conventional Teaching Method by Gender

Source	SS	df	MS	F	Sig.
Corrected Model	38177.102	4	9544.275	167.324	.000
Covariates (Pre-test)	23766.842	1	23766.842	416.665	.000
Treatment	15702.822	1	15702.822	275.292	.000
Gender	106.615	1	106.615	1.869	.174
Treatment * Gender	116.017	1	116.017	2.034	.156
Error	7928.648	139	57.041		
Total	333938.000	144			

Table 9 shows that ($F=2.034$, $p=0.156$) at 0.05 level) of significance. The null hypothesis was not rejected. This implies that interaction effect of treatment and gender was not statistically significant. Similarly, the main effect of gender was not statistically significant ($F=1.869$, $p=.174$). However, the main effect of treatment was statistically significant ($F=275.292$, $p<0.05$). Therefore, there was no significant difference in the performance mean scores of male and female students in Chemistry who are taught using advance organizer and those who are taught using conventional method.

Discussion

The findings from the study discovered that there was significant improvement in the performance students taught Chemistry using advance organizer compared with those taught using conventional teaching method. This implies that the use of advance organizer instructional strategy would be more effective at improving students' performance in Chemistry than conventional method of teaching. This finding align with Enekwechi (2018), Ekenobi & Mumuni (2015); Omondi, Keraro & Anditi (2018) who found out that students taught using advance organizers had significantly higher scores in achievement test than those taught in the conventional way. This is contrary to the findings of Okey & Avwiri (2014) who found no significant difference in the performance of students taught using advance organizer and those taught using conventional method.

There is no significant difference in the performance mean scores of male and female students in Chemistry who are taught using advance organizer and those who are taught using conventional method. This implies that the performance of students in Chemistry was gender justified irrespective of the method used. This finding is in consonance with Ekenobi and Mumuni (2015), Omondi, Keraro & Anditi (2018) no significant difference between male and female student in overall science achievement and contrary to Onah & Ugwu (2010) who posited that gender is a determinant of performance in Chemistry when advance organizer is used.

Conclusion and Recommendations

Based on the findings from this study, it could be concluded that the two groups (advance organizers and conventional group) have uniform knowledge of Chemistry before their exposure to treatment. The use of advance organizers however, yields considerable improvement on students' performance in Chemistry. Meanwhile, gender was no factor to determine students' performance and retention in and attitude towards Chemistry. Therefore, it was recommended that

1. Advance Organizers should be employed for the reaching of Chemistry in secondary school as innovative instructional strategy to bridges what students already know and what they are to learn. This will allow for teaching - learning interaction effectiveness.
2. Chemistry teachers should be encouraged to use Advance Organizers instructional strategy in the classroom regularly to aid knowledge transfer and cross fertilization of ideas among Chemistry students.

References

1. Adebola, S.F. (2011). The Effects of Behavioural Objectives on Students' Achievement in Senior Secondary Mathematics Instruction when used as Advance Organizers. American Journal of Scientific and Industrial Research. Accessed on: <http://www.scihub.org/AJR on 6/7/2011>.
2. Adeyemi, B. (2010). Teacher Related Factors as Correlates of Pupils Achievement in Social Studies in South West Nigeria. Electronic Journal of Research in Educational Psychology, 8(1), 313-332.

3. Adunola, O. (2011). The Impact of Teachers' Teaching Methods on the Academic Performance of Primary School Pupils in Ijebu-Ode Local cut Area of Ogun State", Ego Booster Books, Ogun State, Nigeria.
4. Ashaolu, E. (2014). Readability of two Textbook of Basic Science and its Effects on Performance among Students in Schools. Kaduna, an Unpublished M.Ed Thesis Submitted to the Department Of Science Education A.B.U Zaria
5. Ausubel.D.P. (1960).The use of Advance Organizers in the Learning and Retention of meaningful Verbal Materials. *Journal of Educational Psychology*, 51, 2672
6. Diver, E (2012). Differently Structured Advanced Organizers Lead to Different Initial Schemata and Learning Outcomes. *Journal of research in education*, 2 (2) 24-27.
7. Ekenobi, T. N. & Mumuni, O. A. A (2015). Efficacy of Advance Organizers Strategies on Chemistry Students' Cognitive Achievements in Redox Reaction Concept. *British Journal of Psychology Research*, 3(5), 16-27.
8. Enekeuchi, E. E. (2018). Effect of advance organizers in the teaching of Chemistry in secondary schools: A case study of Anambra State. A Paper presented at the 39th CSN Annual International Conference, Workshop and Exhibition, Rivers State University of Science and Technology, Port Harcourt, Nigeria. Retrieved on the 10/4/2019 from <http://www.proceedings.academicjournals.org/>.
9. Fatokun, K.V.F, & Odagboyi, I. A. (2010). Gender disparity and parental on secondary school students' achievement in Nasarawa State. *Journal of Research in National Development*.
10. Hendron, J. (2014). Advance and graphical organizers: Proven strategies enhanced through technology. Retrieved July 25, 2014 from http://www.glud.k12.VA.US/resources/graphical_organizers
11. Ibrahim H. O. (2012). Curriculum Reform and Teacher Autonomy in Turkey: The Case of the History Teaching. *International Journal of Instruction* 4, (2) 13-25
12. Muhammed, (2014). The Challenges of Problem-Based Learning. (2nd Ed.), London, Kogan page.
13. Ogunbola, P.I. & Fakorede, S.O. (2009).Effect of Scaffolding Instructional Techniques on the Achievements of Auto mechanics Students in SS Schools in Ekiti State. *Educational Focus* 2(1)
14. Okey, I. F. & Awiri, E. (2014). Effects of Use of Advance Organizers on Students' Performance and Retention of the Concepts of Electromagnetism. *Journal of Medical and Applied Biosciences* 6(2) 60-75.
15. Olatunji, F.(2015). Readability of Basic Science and Technology for Primary school. *Research Journal in Organizational Psychology and Educational Studies* 1, (1)23-36
16. Oludipe, D. &Awokoya,J.O. (2010)' Effects of Cooperative Learning Teaching Strategy on the Reduction of Students' Anxiety for Learning Chemistry. *Journal of Turkish Science Education*,(1),30-37.
17. Omondi, K. O. K., Keraro, F.N. Anditi, Z.O. (2018). Effects of Advance Organizers on Students' Achievement in Biology in Secondary Schools in Kilifi County, Kenya. *Frontiers in Education Technology*, 1(2), 191 -205
18. Omoniyi, A.O. (2003). The Effects of Constructivism based Teaching Strategy on Gender-Related Differences in Solving Students' Misconceptions in Chemistry. *Proceedings of GASAT Conferences*. Mauritius.
19. Opara, F. &Waswa, P. (2013).Enhancing Students' Achievement in Chemistry through Piagetian Model: The Learning Cycle. *International Journal for Cross-Disciplinary subjects in Education. (IJCDSE)*, 4(4), 1270-1278.
20. Poopola, A. (2010). Teacher's mathematics anxiety as a correlate of pupil's attitude to mathematics. *Research in Curriculum Studies (RICS)*, 3(2).
21. WAEC (2015). Chief examiner's report. Lagos: WAEC Press Ltd
22. WAEC (2016). Chief examiner's report. Lagos: WAEC Press Ltd
23. Webster, G.H. (2009). Attitude Counts. Self-Concept and Success in General Chemistry. *Journal of Chemical Education*. 86, 6, p.744