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BOOSTING ACHIEVEMENT OF SENIOR SECONDARY TWO STUDENTS IN SELECTED DIFFICULT CHEMISTRY CONCEPTS USING ASSERTIVE QUESTIONING AND PRIOR KNOWLEDGE OF BEHAVIOURAL OBJECTIVES STRATEGIES

[1] Emmanuel E. Achor, [2]Emmanuel E. Otor and [3]Rose U. Kalu
1&2. Department of Science and Mathematics Education, Benue State University, Makurdi-Nigeria; 3. Postgraduate Student, Department of Science and Mathematics Education, Benue State University, Makurdi-Nigeria

ABSTRACT: *This study focused on effects of two teaching methods on achievement of senior secondary two students in difficult chemistry concepts in Benue State, Nigeria. Two difficult concepts investigated were electrolysis and rate of chemical reaction. Two research questions were answered and two null hypotheses were tested. The study was a quasi-experiment, pretest posttest control group design. The target population was all senior secondary two (SS2) students in Benue State of Nigeria. A sample of 122 students was selected from104 accredited governments and government grant - aided schools in Benue State by purposive and random sampling techniques. Three intact classes were used and members constitute the sample. Chemistry Achievement Test (CAT) was used for data collection. The instrument was validated by experts in the course of the study. The reliability estimate of the instrument was established through trial testing. The data obtained using CAT were subjected to analysis using Kuder Richardson (KR-21). The reliability coefficient of CAT was 0.98. Mean and standard deviation were used to answer the research questions and the hypotheses were tested at using 0. 05 level of significance using ANCOVA. The findings of the study revealed that there is significant difference in the mean chemistry achievement scores of students taught electrolysis and rate of chemical reaction using assertive questioning, prior knowledge and those taught using conventional strategies. However, there is no significant difference in the mean chemistry achievement scores of students taught electrolysis and rate of chemical reaction using assertive questioning strategy and prior knowledge teaching strategy but significant difference exist between each experimental strategies(that is, assertive questioning and prior knowledge of behavioural objectives) and conventional strategy. There is no significant difference in the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using assertive questioning teaching strategy as well as in the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using prior knowledge of behavioural objective teaching strategy. There is no significant interaction effect of methods and gender on students' achievement in difficult chemistry concepts (electrolysis and rate of chemical reaction). The study recommended among others, that teachers should be encouraged to use assertive questioning and prior knowledge of behavoural objective as methods of instruction in electrolysis and rate of chemical reaction.*

KEY WORDS: Chemistry achievement; electrolysis and rate of reaction; gender; interactive effect; assertive questioning strategy; knowledge of behavioural objectives strategy.

INTRODUCTION

Science deals with discovery of knowledge through systematic experimentation that is guided by scientific attitude and process skills. Science education has been recognized as a very important factor for sustainable development globally (Gyuse & Adejoh, 2010). Science education has contributed immensely towards improvement of quality of life worldwide. Hardly is there any sphere of life that is not affected by developments in science and technology. Global and natural phenomena are easily predictable through scientific knowledge, application and technological achievements. Man consequently needs to be scientifically literate to exist in order to cope up with his environment.

According to Achor and Kalu (2014), education particularly chemistry is the instrument through which the immense height of technology evident in the developed countries was attained. It is therefore through it that Nigeria as well as other developing countries could come to grips with the needed level of development. Chemistry as one of the science subjects taught at senior secondary school level has attained a unique position in the school curriculum. Of all the sciences, chemistry occupies a central position due to its possible influence on man's survival. Adejoh and Ityokaa (2010) observe that teaching chemistry like any other science subject provides a platform for teaching students the ability to apply learnt science concepts and principles in solving everyday life problems. Similarly, Ezeliora (2009) maintains that the power of chemistry is what creates an enabling infrastructure that delivers food, medicine and materials that are necessity of modern life. Therefore, chemistry is indispensably significant because of its requirement as a pre-requisite for the study of courses like education/chemistry, food science, medicine, pharmacy, biochemistry, Agriculture and engineering (Achor & Kalu, 2014).

Due to the unique importance of chemistry, there is need for a qualitative and functional chemistry education. Chemistry concepts are generally related to or based on structure of matter that is abstract in nature (Coll & Treagust, 2001). These abstract concepts are important because further chemistry concepts or theories cannot be easily understood if the underlining concepts are not grasped early by the students. West African Examination Council (WAEC) and national Examination Council (NECO) Chief Examiners' Reports from 2005 to 2014 have persistently reported students' weaknesses in answering questions in some chemistry concepts among which are electrolysis, radioactivity, chemical equilibrium, hybridization, mixture and separation technique and rate of chemical reaction (NECO Chief examiners' report, 2015; WAEC Chief examiners' report, 2015). Similarly, some studies have reported that some chemistry concepts such as atomic structure, energy level and quanta, periodicity, reaction rate of chemical reaction and chemical equilibrium, electrolysis, hybridization, chemical nomenclature, radioactivity and mixture and separation techniques pose unique and formidable challenges to students (Samba & Eriba, 2012; Otor, 2013; Agbir, 2016). This study will choose only two of these concepts namely electrolysis and rate of chemical reaction for investigation. The reason for selecting these

two concepts is because they are the concepts that West African Examination Council (WAEC) and National Examination Council (NECO) Chief Examiners' Reports (WAEC, 2015 & NECO, 2015) indicated that over the years students avoided, failed or could not tackle adequately.

It is when concepts are not meaningfully understood by students, they tend to avoid questions set on them during Senior Secondary Certificate Examinations (SSCE) and this could affect their performance. Academic achievement is one measure of qualitative education. Achievement is the act of successful accomplishment of a task as viewed by Okoye, Okongwu and Nweke (2015). Academic achievement can also be referred to as the successful attainment of a study. In this regard it is the measure of what the students have learnt or the skills they have acquired. Students' achievement is reflected in their performance in the area assessed. In this work, it is regarded as the academic Performance of senior secondary two (SS2) students in chemistry. It is usually determined using assessment techniques such as quizzes, tests and examinations and is expressed in terms of scores.

Despite the unique importance of chemistry, students' performance in this subject is worrisome. Some researchers such as Ezeudu and Obi (2013) and Otor (2013) have investigated and reported lack of interest and poor performance of students in chemistry and for fear of failure many students do not enroll into senior secondary to study chemistry. Students' performance in West African Examination Council (WAEC) and National Examination Council (NECO) examinations in chemistry has remained poor over the years. The West African Examination Council (WAEC) and National Examination Council (NECO) Chief Examiners' Reports (WAEC, 2015 & NECO, 2015) showed that 31% of the total students who sat for chemistry passed at credit level and above. Poor achievement and lack of students' interest in the subject have been attributed to a number of factors such as lack of qualified chemistry teachers, inappropriate teaching methods for difficult chemistry concepts (Jack, 2013). Similarly, Shikaan (2012) maintains that one of the most cited problems in implementing science curriculum has been the use of inappropriate approaches for teaching and learning of difficult concepts. Many chemistry teachers use mainly lecture method to teach even when teaching difficult concepts and this has not yielded the desired result because of the recurrent poor performances of students in WAEC and NECO examinations (Anaekwe, 2006).

Some of the innovative teaching strategies that a chemistry teacher could use to teach difficult chemistry concepts include assertive questioning and prior knowledge and concept mapping (Ezekannagha 2007; Petty 2009; Otor, 2013). Invariably, not all the innovative teaching strategies may be very effective for teaching difficult chemistry concepts to students. If students' achievement in difficult chemistry concepts will be high, then teachers have to use the most effective and appropriate teaching methods for different ability groups.

Prior knowledge of behavioural objective is a teaching strategy in which students are exposed to objectives of the lesson which avails them the advantage of having knowledge and understanding of content to be taught before the instruction is given by the teacher to the class. Akinbolola and Edinyang (2008), Anderson (2014) and also Okebukola (2002) discovered that prior knowledge of objectives can help to improve the performance of students in science subjects such as chemistry. Although, this teaching method may have been in use by chemistry teachers to teach difficult topics but its effectiveness in improving different ability students' achievement and interest is may not have been determined.

According to Petty (2009), assertive questioning is a teaching strategy that makes use of questioning technique. The teacher comes up with thought- provoking questions in advance that he or she will use in a lesson. The teacher also decides whether the students will work in groups or individually on the thought -provoking question. The teacher asks individuals learner to give his/ her or their group's answer, as the case may be and then asks individual class members to criticize the answer by agreeing or disagreeing with a group's or an individual's answer. Only after then that the teacher provides or summarizes the right answer. This teaching strategy also has defined procedures that should be followed by the teacher. It is a student- centred strategy although the teacher is in control but full participation of the students is ensured. Petty (2009) maintained that the use of assertive questioning to teach students improves their achievement and interest. This is so because assertive questioning is one of the teaching strategies that is creative, challenging and greatly enjoyed by students. It requires the learner to do more in class and the teacher less and equips the students for progression by 'teaching intelligence'.

Based on the likelihood that assertive questioning and prior knowledge of behavioural objective might help the students to have better understanding of the concept of electrolysis and rate of chemical reaction, it is hoped that these teaching strategies could improve the students approach to tackling problems in these two concepts. Apart from teaching approach, there are other factors that may affect learners' achievement and interest in a subject.

Gender could be a factor that has effect on students' achievement and interest in electrolysis and rate of chemical reaction. On the gender difference in achievement, there is still some controversy on the influence of gender on students' achievement in chemistry and other sciences generally. Some studies have indicated no significant difference in the academic achievement of boys and girls in difficult chemistry concepts (Otor 2013; Jack 2013; Duguryil, 2004). These studies found that the poor achievement of students in science is common to both sexes. Akpoghol, Ezendu, Adxape and Otor (2016) and Shikaan, (2012) tend to favour the girls on the other hand.

Statement of the Problem

Teaching and learning of chemistry in secondary schools in Nigeria is unsatisfactory. This may be as a result of poor performances and lack of interest in learning the subject. One of

the root causes of this is because many chemistry teachers are using inappropriate teaching methods to impart skills and knowledge of the contents of some difficult chemistry concepts especially electrolysis and radioactivity without considering the effect such methods will have on achievement students in the subject. As a result students' performance has remained poor over the years and many students do not enjoy studying the subject thus making enrolment into science classes to decline yearly. Students' poor performances in chemistry especially in difficult topics is now a great concern to Science Teachers Association of Nigeria (STAN), government, Ministry of Education and other stakeholders of education. It has been observed that low performance of students is more pronounced in difficult concepts such as electrolysis, atomic structure, radioactivity, chemical equilibrium, hybridization and mixture and separation techniques (Agbir, 2016.) The WAEC and NECO Chief Examiners' report (WAEC,015 & NECO, 2015) showed that more than sixty percent (60%) of all the candidates that sat for science examination especially chemistry performed poorly because their inability tackle some questions especially in electrolysis and rate of chemical reaction. The chief examiners therefore, emphasized the need for schools to help students to understand the rudiments of electrolysis and rate of chemical reaction in order to forestall difficulty in tacking electrolysis and rate of chemical reaction tacking problems that account for students' poor performance in examinations.

In spite of efforts made by the STAN and individual members of the association to tackle this problem through organization of workshops and seminars, these efforts seem not to have yielded the desired results judging from the persistence of under achievement in science especially chemistry in WEAC and NECO examinations (Jack, 2013). The fact that students persistently perceive some concepts of chemistry curriculum as difficult indicates the need for improvement in the teachers' approach to teaching of the subject. Although many teaching strategies including innovative ones have been discovered, their effects and on achievement of students in chemistry when used to teach electrolysis and rate of chemical reaction are yet to be determined. Also little or no specific attempt has been made to discover which of these teaching strategies is more gender-friendly. .

In recent times, some studies have been carried out in Benue State to determine the effects of some innovative teaching strategies but none has compared assertive questioning and prior knowledge innovative methods with lecture method. This study therefore determined effects of assertive questioning and prior knowledge in improving achievement of students in two difficult chemistry concepts (electrolysis and rate of chemical reactions).

Research Questions and Hypotheses

Four research questions were answered and four hypotheses tested at 0.05 level in this study. Details are presented under results.

RESEARCH METHOD

The design used in the study is a quasi-experimental. It is of pretest, posttest, non randomized and control group quasi experimental design. The reason for adopting this design is because the nature of the problem of this research is to establish cause-effect result. Also this design is plausible because subjects were assigned to classes on the basis of their school subject offerings and so intact class was used.The target population of this study is 8,050 senior secondary two chemistry students (SS2) in Benue State. Population is a description of all the respondents or events within the research location (Achor & Ejigbo, 2006). The choice of SS2 chemistry students is because the students are assumed to have acquired knowledge in chemistry. The population of SS2 chemistry students was drawn from the 104 accredited public and government grant - aided secondary schools in Benue State.

The sample for the study is 122 SS2 students offering chemistry which are members of three intact classes of SS2 from the three schools selected using multi stage sampling technique involving simple random and purposive random sampling techniques. Purposive random sampling technique was used for selecting 20 schools from the 104 public and government grant-aided approved schools. The criteria for the purposive selection was based on co-education, five years presentation of candidates for West African Examination Senior School Certificate (WASSCE) and National Examination Council for Senior School Certificate Examination (NECO, SSCE) and having well equipped laboratories. This excluded single-sex schools, schools that do not have well equipped laboratories as well as those that have not presented candidates in chemistry up to five years. Hat and draw approach was then employed in the simple random technique selection of three schools with three intact classes. One was selected as experimental group one, another one as experimental group two and the third one as the control group from the 20 schools selected. These techniques were used for easy constitution of experimental group and control groups. The members of the three intact classes constituted the sample which represents the entire SS2 chemistry students in Benue State. Experimental group 1 are made up of 22 boys and 13 girls, experimental group 11 are made up of 24 boys and 18 girls while control group is made up 29 boys and 16 girls.

The Chemistry Achievement Test (CAT) contains 50 objective questions in line with WAEC and NECO standard of setting chemistry objective questions drawn from topics taught under electrolysis and rate of chemical reaction.

The Mental Ability Test (MAT) is divided into two sections. Section A deals with the biographic data of the students: school, sex and age. Section B, consists of 10 logical test questions adapted from Federal Government Civil Service Aptitude Test 2011 and 2013. The teacher read the questions and the students wrote the answers within 30 second in answer scripts which was marked. The grading was as follows: score range of 10-8 was

considered as high mental ability, score range of 7-5 as middle mental ability while score range of 4-0 is low mental ability. These scores are adopted from the study of Yenilmez, Sungur and Tekkaya (2006). Then based on score each student got from mental ability test, ability group card were issued to students. All the students that scored 8 or 9 or 10 were issued a card number A which stands for high mental ability group. All the students that scored 5 or 6 or 7 were issued a card number B which stands for middle mental ability group. Also, all the students that scored 0 or 1 or 2 or 3 or 4 were issued card number C which stands for low mental ability group.

Validation of instrument and Reliability

The CAT was given to lecturers from the Science and Mathematics Education of Benue State University for face and content validation. They were asked to rate the instruments as valid or not. They were also requested to make their recommendations as to whether they are suitable for SS2 students to appropriately interpret and respond to. They made some grammatical corrects. For the CAT, questions set on electrolysis were considered too many because out of the 50 questions set 43 were on electrolysis while only 7 questions were set on rate of chemical reaction. Consequently, the 43 questions were reduced to 35 while the 7 questions on rate of chemical reaction were increased to 15. The lesson notes and the marking scheme were validated also.

The instrument was trial tested on a sample similar to the one under study but not included in the study. Data collected with CAT were used for analysis using Kuder Richardson (KR-21) and it yielded reliability coefficient of 0.98. MAT was subjected to analysis using Cronbach Alpha. The reliability coefficients of MAT was 0.98.

Method of Data Collection and Analysis

The authorities of each of the three schools were contacted to allow the research to be carried out in their schools with their SS11 chemistry students. Three chemistry teachers who are holders of B.Sc. (Ed) were used as research assistants. Two of them were trained by the researcher for one week to assist in teaching the experimental groups. They were trained on how to teach electrolysis and rate of chemical reaction using the teaching strategies applicable to the two experimental groups.
. The instrument was administered as follows:

Week 1 Training of teachers of experimental groups
Week 2 Administering of pre- test CAT and MAT
Week 2-7 Teaching on rate of chemical reaction and electrolysis
Week 8 Administering of post –test CAT

The statistical tools used in answering research questions were means and standard deviations. Analysis of Covariance (ANCOVA) was used to test all the hypotheses at 0.05 level of significance. The choice of ANCOVA as a statistical tool is because it is useful in

comparing experiential groups and remove biasness that may result from using intact groups where equivalence is not determined (Emaikwu, 2008).

RESULTS

Research Question One

What are the mean chemistry achievement scores of students taught concepts of electrolysis and rate of chemical reaction using assertive questioning, prior knowledge and those taught using conventional strategies?

Table 1: Mean Chemistry Achievement Scores of Students Taught Electrolysis and Rate of Chemical Reaction Using Assertive Questioning, Prior Knowledge and Conventional Strategies

Method		PreCAT	PostCAT	Mean Gain
Conventional Strategy	Mean	19.9556	23.9556	4.00
	N	45	45	
	Std. Deviation	9.28576	8.03672	
Assertive questioning Strategy	Mean	19.6857	70.8857	51.20
	N	35	35	
	Std. Deviation	8.95995	9.97872	
Prior Knowledge Strategy	Mean	19.1190	70.7857	51.67
	N	42	42	
	Std. Deviation	7.26905	8.81942	

The analysis of data on Table 1 shows the mean chemistry achievement scores of students taught concepts of electrolysis and rate of chemical reaction using assertive questioning; prior knowledge and those taught using conventional strategies. The table shows that 45 students were taught electrolysis and rate of chemical reaction using assertive questioning instructional strategy, 35 students were taught same topics using prior knowledge of behavioural objectives while 42 students were taught same topics using conventional strategy. The table reveals that the mean achievement scores of students taught using conventional strategy is 19.96 with a standard deviation of 9.29 during pre-test and 23.96 with a standard deviation of 8.04 in post test. The mean achievement scores of students taught using assertive questioning instructional strategy is 19.69 with a standard deviation of 8.96 during pre-test and 70.89 with a standard deviation of 9.99 in post test. While the mean achievement scores of students taught using prior knowledge of behavioural objectives is 19.12 with a standard deviation of 7.27 during pre-test and 70.79 with a standard deviation of 8.82 in post test. The mean gain in chemistry achievement scores of students taught concepts of electrolysis and rate of chemical reaction using assertive questioning is 51.20; prior knowledge teaching strategies is 51.67 and 4.00 for those taught using conventional strategy.

Research Question Two
What is the difference in the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using assertive questioning teaching strategy?

Table 2: Mean Chemistry Achievement Scores of Male and Female Students Taught Electrolysis and Rate of Chemical Reaction Using Assertive Questioning Teaching Strategy

Gender		PreCAT	PostCAT	Mean Gain
	Mean	19.4091	69.6364	50.23
Male	N	22	22	
	Std. Deviation	8.31327	10.85202	
	Mean	20.1538	73.0000	52.85
Female	N	13	13	
	Std. Deviation	10.30248	8.26640	
Mean difference				2.62

Table 2 shows the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using assertive questioning teaching strategy. The table shows that 22 male students and 13 female students were taught electrolysis and rate of chemical reaction using assertive questioning teaching strategy. The table reveals that the mean chemistry achievement scores of male students taught electrolysis and rate of chemical reaction using assertive questioning teaching strategy is 19.41 with a standard deviation of 8.31 during pre-test and 69.64 with a standard deviation of 10.85 in post test. The mean chemistry achievement scores of female students taught electrolysis and rate of chemical reaction using assertive questioning teaching strategy is 20.15 with a standard deviation of 10.30 during pre-test and 73.00 with a standard deviation of 8.27 in post test. Table 1 further shows that the mean gain of male students is 50.23 and that of female students 52.85 when exposed to assertive questioning teaching strategy. The difference in the mean gain in chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using assertive questioning teaching strategy is 2.62 in favour of female students.

Research Question Three
What is the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using prior knowledge of behavioural objective teaching strategy?

Table 3: Mean Chemistry Achievement Scores of Male and Female Students Taught Electrolysis and Rate of Chemical Reaction Using Prior Knowledge of Behavioural Objective Teaching Strategy

Gender		PreCAT	PostCAT	Mean Gain
	Mean	17.7407	69.1852	51.44
Male	N	27	27	
	Std. Deviation	7.34634	9.16531	
	Mean	21.6000	73.6667	52.07
Female	N	15	15	
	Std. Deviation	6.65260	7.61265	
Mean difference				0.63

Table 3 shows the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using prior knowledge of behavioural objective teaching strategy. The table shows that 27 male students and 15 female students were taught electrolysis and rate of chemical reaction using prior knowledge of behavioural objective teaching strategy. The table reveals that the mean chemistry achievement scores of male students taught electrolysis and rate of chemical reaction using prior knowledge of behavioural objective teaching strategy is 17.74 with a standard deviation of 7.35 during pre-test and 69.19 with a standard deviation of 9.17 in post test, while the mean chemistry achievement scores of female students taught electrolysis and rate of chemical reaction using prior knowledge of behavioural objective teaching strategy is 21.60 with a standard deviation of 6.65 during pre-test and 73.67 with a standard deviation of 7.61 in post test. Table 3 further shows that the mean gain of male students is 51.44 and that of female students 52.07 when exposed to prior knowledge of behavioural objective teaching strategy. The difference in the mean gain in chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using prior knowledge of behavioural objective teaching strategy is 0.63 in favour of female students.

Research Question Four

What are the interaction effects of methods and gender on achievement of students in difficult chemistry concepts (electrolysis and rate of chemical reaction)?

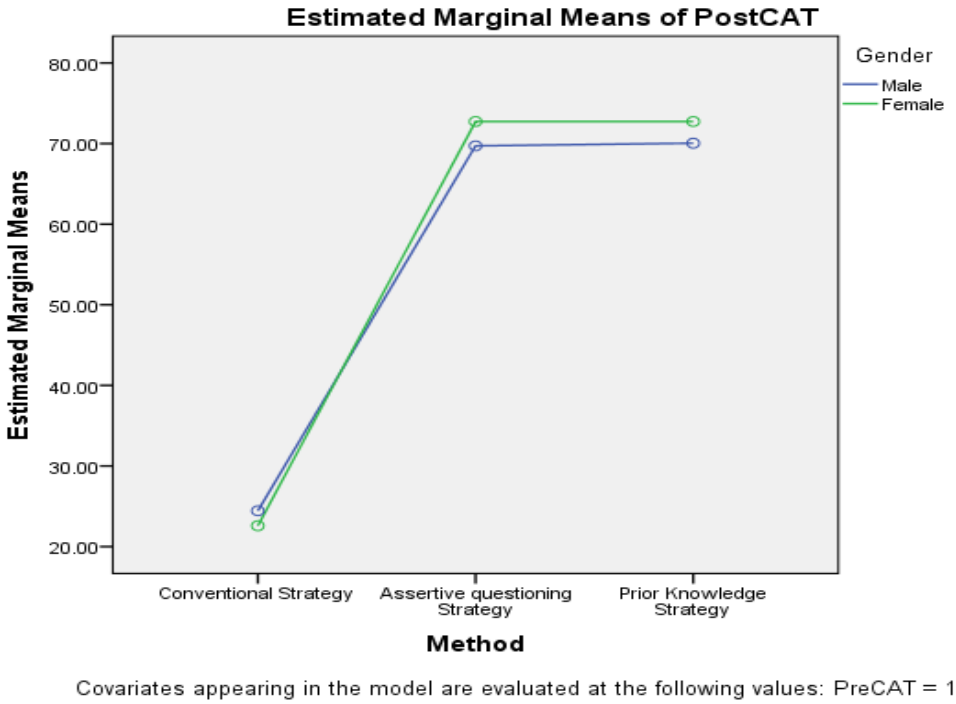

Figure 1: Interaction Effects of Methods and Gender on Achievement of Students in Difficult Chemistry Concepts

In Figure 1, the profile plot/graph shows the interaction effect of methods and gender on achievement of students in difficult chemistry concepts. The interaction pattern shows that the plots for males and females intersect at between conventional strategy and assertive questioning strategy. This indicates that assertive questioning strategy when used in conjunction with conventional strategy has an interaction effect on achievement of male and female students in difficult chemistry concepts (electrolysis and rate of chemical reaction) but there is no intersection at assertive questioning strategy and prior knowledge strategies.

Hypothesis One

There is no significant difference in the mean chemistry achievement scores of students taught electrolysis and rate of chemical reaction using assertive questioning, prior knowledge and those taught using conventional strategies.

Table 4: ANCOVA of Mean Chemistry Achievement Scores of Students Taught Electrolysis and Rate of Chemical Reaction Using Assertive Questioning, Prior Knowledge Conventional Strategies

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	64370.360[a]	3	21456.787	339.673	.000	.896
Intercept	40178.766	1	40178.766	636.053	.000	.844
PreCAT	1962.590	1	1962.590	31.069	.000	.208
Method	63073.488	2	31536.744	499.244	.000	.894
Error	7453.935	118	63.169			
Total	421554.000	122				
Corrected Total	71824.295	121				

a. R Squared = .896 (Adjusted R Squared = .894)

Table 4 reveals that $F(2,118) = 499.244$; $p = 0.000 < 0.05$. Since p is less than 0.05, the null hypothesis is therefore rejected. This implies that there is significant difference in the mean chemistry achievement scores of students taught electrolysis and rate of chemical reaction using assertive questioning, prior knowledge and those taught using conventional strategies. Thus, it can be concluded that based on evidence from data analysis there is significant difference in the mean chemistry achievement scores of students taught electrolysis and rate of chemical reaction using assertive questioning, prior knowledge teaching strategies and those taught using conventional strategy. The partial Eta square of 0.894 was obtained for the strategies meaning that 89.4% of the chemistry achievement scores of students can be attributed to the strategies employed in the teaching of electrolysis and rate of chemical reaction.

Table 5: Pairwise Comparisons of Mean Chemistry Achievement Scores of Students Taught Electrolysis and Rate of Chemical Reaction Using Assertive Questioning, Prior Knowledge and Conventional Strategies

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.
Conventional Strategy	Assertive questioning Strategy	-47.058*	1.791	.000
	Prior Knowledge Strategy	-47.228*	1.707	.000
Assertive questioning Strategy	Prior Knowledge Strategy	-.169	1.820	.926

Based on estimated marginal means. *. The mean difference is significant at the .05 level.

Table 5 shows the bivariate comparisons of the methods of teaching electrolysis and rate of chemical reaction and its effect on the mean chemistry achievement scores of students at $P = 0.000 < 0.05$ for conventional strategy and assertive questioning strategy. Similarly, comparisons of the methods of teaching electrolysis and rate of chemical reaction and its effect on the mean chemistry achievement scores of students at $P = 0.000 < 0.05$ for

conventional strategy and prior knowledge teaching strategy. The null hypothesis is therefore rejected. Therefore, the rejected null hypothesis is confirmed and upheld. This implies that there is significant difference in the mean chemistry achievement scores of students taught electrolysis and rate of chemical reaction using conventional strategy and assertive questioning strategy as well as conventional strategy and prior knowledge teaching strategy. However, comparisons of the methods of teaching electrolysis and rate of chemical reaction and its effect on the mean chemistry achievement scores of students shows that $P = 0.926 > 0.05$ for assertive questioning strategy and prior knowledge teaching strategy. Thus, the rejected null hypothesis is not confirmed and not upheld. This implies that there is no significant difference in the mean chemistry achievement scores of students taught electrolysis and rate of chemical reaction using assertive questioning strategy and prior knowledge teaching strategy.

Hypothesis Two

There is no significant difference in the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using assertive questioning teaching strategy.

Table 6: ANCOVA of Mean Chemistry Achievement Scores of Male and Female Students Taught Electrolysis and Rate of Chemical Reaction Using Assertive Questioning Strategy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	278.628[a]	2	139.314	1.435	.253	.082
Intercept	25118.806	1	25118.806	258.714	.000	.890
PreCAT	186.176	1	186.176	1.918	.176	.057
Gender	81.924	1	81.924	.844	.365	.026
Error	3106.915	32	97.091			
Total	179253.000	35				
Corrected Total	3385.543	34				

a. R Squared = .082 (Adjusted R Squared = .025)

Table 6 reveals that $F(1, 32) = 0.844$; $p = 0.365 > 0.05$. Since p is greater than 0.05, the null hypothesis is therefore not rejected. This implies that there is no significant difference in the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using assertive questioning teaching strategy. Thus, it can be concluded that based on evidence from data analysis no significant difference exist in the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using assertive questioning teaching strategy. The partial Eta square of 0.026 was obtained for the strategies meaning that only 2.6% of the chemistry achievement scores of students can be attributed to gender when assertive questioning teaching strategy is employed in the teaching of electrolysis and rate of chemical reaction.

Hypothesis Three
There is no significant difference in the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using prior knowledge of behavioural objective teaching strategy.

Table 7: ANCOVA of Mean Chemistry Achievement Scores of Male and Female Students Taught Electrolysis and Rate of Chemical Reaction Using Prior Knowledge of Behavioural Objective Strategy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	434.037[a]	2	217.018	3.072	.058	.136
Intercept	19239.554	1	19239.554	272.353	.000	.875
PreCAT	240.373	1	240.373	3.403	.073	.080
Gender	89.401	1	89.401	1.266	.267	.031
Error	2755.035	39	70.642			
Total	213635.000	42				
Corrected Total	3189.071	41				

a. R Squared = .136 (Adjusted R Squared = .092)

Table 7 reveals that $F(1, 39) = 1.266$; $p = 0.267 > 0.05$. Since p is greater than 0.05, the null hypothesis is therefore not rejected. This implies that there is no significant difference in the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using prior knowledge of behavioural objective teaching strategy. Thus, it can be concluded that based on evidence from data analysis no significant difference exist in the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using prior knowledge of behavioural objective teaching strategy. The partial Eta square of 0.031 was obtained for the strategies meaning that only 3.1% of the chemistry achievement scores of students can be attributed to gender when prior knowledge of behavioural objective teaching strategy is employed in the teaching of electrolysis and rate of chemical reaction.

Hypothesis Four
There is no significant interaction effect of methods and gender on students' achievement in difficult chemistry concepts (electrolysis and rate of chemical reaction).

Table 8: ANCOVA of Interaction Effect of Methods and Gender on Students' Achievement in Difficult Chemistry Concepts

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	64549.216[a]	6	10758.203	170.059	.000	.899
Intercept	38774.744	1	38774.744	612.927	.000	.842
PreCAT	1838.203	1	1838.203	29.057	.000	.202
Method	59654.253	2	29827.127	471.489	.000	.891
Gender	45.230	1	45.230	.715	.400	.006
Method * Gender	144.704	2	72.352	1.144	.322	.020
Error	7275.080	115	63.262			
Total	421554.000	122				
Corrected Total	71824.295	121				

a. R Squared = .899 (Adjusted R Squared = .893)

Table 8 reveals that $F(2,115) = 1.144$; $p = 0.322 > 0.05$. Since p is greater than 0.05, the null hypothesis is not rejected. This implies that there is no significant interaction effect of methods and gender on students' achievement in difficult chemistry concepts (electrolysis and rate of chemical reaction). Thus, it can be concluded that based on evidence from data analysis no significant interaction effect of methods and gender on students' achievement in difficult chemistry concepts. The partial Eta square of 0.020 was obtained for the strategies meaning that only 2.0% of the chemistry students' achievement can be attributed to interaction effect of methods and gender.

DISCUSSION OF FINDINGS

One of the findings revealed that there is significant difference in the mean chemistry achievement scores of students taught electrolysis and rate of chemical reaction using assertive questioning, prior knowledge and conventional strategies. The bivariate comparisons of the methods of teaching electrolysis and rate of chemical reaction and its effect on the mean chemistry achievement scores of students confirmed and upheld significant difference between conventional strategy and assertive questioning strategy as well as between conventional strategy and prior knowledge teaching strategy. However, comparisons of the methods of teaching electrolysis and rate of chemical reaction and its effect on the mean chemistry achievement scores of students was not confirmed and not upheld for assertive questioning strategy and prior knowledge teaching strategy. This means that chemistry could be better taught using either assertive questioning strategy or prior knowledge of behavioural objectives strategy or that both strategies are equally good for use in teaching difficult chemistry concepts such as electrolysis and rate of chemical reaction. This finding agrees with that of Udo and Ubana (2016) and Chinweoke (2016) that there was significant difference in academic achievement between the experimental and control groups. Specifically, Chinweoke found that students taught with prior knowledge of behavioural objectives and study questions achieved significantly higher

than those taught with conventional lecture method. The students exposed to study questions only also achieved significantly better than those exposed to prior knowledge of behavioural objectives. Ausubel (1960) and Kujawa and Huske (1995) posited that prior knowledge influences how the teacher and students interact with the learning materials both as individuals and as a group. They maintained that the proper entry point for instruction is that which builds on what is already known. This demands that the material to be learnt must be conceptually clear and presented in language and with examples that are related to the learner's prior knowledge. According to Khader (2015) and Ogbeba (2009), providing students with prior knowledge of content / objective motivates them to learn and that motivation enhances meaningful learning. Assertive questioning involves the teacher asking a thought- provoking questions in advance that he or she will use in a lesson; Students either work in groups of two or work individually on the thought - provoking questions. According to Samba (2018), Assertive Questioning helps the students to develop subject specific thinking and ensures motivation. These developments are possible because throughout the teaching and learning period of the class, there is an active scrutiny of the knowledge and skills being learned. In this teaching strategy, the class is encouraged to take collective responsibility for working out new learning while the teacher confirms, summarizes and emphasizes the new learning making links and comparisons with prior learning. These attributes of prior knowledge of behavioural objectives and assertive questioning strategies must have placed the students at a vantage position to achieve better than the control class.

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Findings revealed that there is no significant difference in the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using assertive questioning teaching strategy. This implies that the use of assertive questioning strategy is not gender sensitive based on the mean achievement scores of students. The finding agrees with that of Okorie and Ezeh (2016) that gender as a main effect on students' achievement in chemical bonding is not significant. However, the finding disagrees with that of Ibe (2013) that female students out-performed the males in the RMBT. The finding also disagrees with that of Udo and Ubana (2016) that there was significant difference in achievement between male and female students with the females taking the lead when of prior knowledge of behavioural objectives is used for instruction.

In assertive questioning, the teacher does not ask only volunteers to answer but nominates those to answer. This makes male and female student to construct and avoid being caught out. In assertive questioning teaching strategy, the answer does not come from the teacher verbally, facial or other body expressions, it makes or fosters curiosity in male and female students. The use of assertive questioning teaching strategy enables the teacher to bestow on male and female students curiosity which is a good attribute of a scientist. This method ensures that errors, misconceptions are discovered and corrected by the teacher and gender difference is eliminated. The teachers' skill in questioning, help students to find answering question an active and enjoyable activity especially as answering correctly gives them confidence and a feeling of success irrespective of their gender.

Findings revealed that there is no significant difference in the mean chemistry achievement scores of male and female students taught electrolysis and rate of chemical reaction using prior knowledge of behavioural objective teaching strategy. This implies that the use of prior knowledge of behavioural objective teaching strategy is gender friendly based on the mean achievement scores of students. This finding disagrees with that of Teo and George (2007) that boys provided with instructional objectives achieved significantly higher scores than girls. The finding also disagrees with that of Nkwo, Akinbobola and Ikitde (2008) that male students achieved higher than female students given the same condition of exposure to prior knowledge of instructional objectives of physics difficult concepts.

Meaningful learning occurs when new knowledge is related to relevant existing concepts in the learners' cognitive structure. The most important single factor influencing learning is what the learner already knows, that is, relevant prior knowledge. The use of prior knowledge of behavioural objective teaching strategy influences how teacher and students interact with the learning materials both as individuals and group irrespective of their gender. Finding of the present study maintained that the use prior knowledge of behavioural objective teaching strategy builds on what male and female students already know because it is gender friendly. The prior knowledge of behavioural objective teaching strategy provides that material to be learnt are conceptually clear and presented with examples in language that are related to the learner's prior knowledge irrespective of their gender.

Findings revealed that there is no significant interaction effect of methods and gender on students' achievement in difficult chemistry concepts (electrolysis and rate of chemical reaction). This means that male and female students' achievement in chemistry is not influenced differently by the strategies employed in chemistry class as evident in the findings in the study. When two or more independent variables are involved in a research design there is more to consider than simply the main effect of each of the independent variables (also termed factors). That is, the effect of one independent variable on the dependent variable of interest may not be the same at all levels of the other independent variable. This means that the effect of one independent variable (method) may depend on the level of the other independent variable (gender). A factorial design was involved, in which the two independent variables (method and gender were "crossed" with one another so that there are observations at every combination of levels of the two independent variables. In this study they are close in one instance and crossed once only towards the conventional strategy and this was indicated by the fact that there was no significant interaction effect of methods and gender on students' performance and interest in difficult chemistry concepts such as electrolysis and rate of chemical reaction. Thus any main effect on performance and interest in chemistry, that is, treatment on the two dependent variables could be said to be as a result of treatment, which is the teaching strategy (assertive questioning and prior knowledge of objective teaching strategies and not another factor). This contradicts the findings of Kurumeh and Achor (2008) as well as Achor, Imoko and Ajayi (2010) who found that there were no significant interaction effects of methods and

gender on achievement. However, the studies in reference were in mathematics and not chemistry and that could have accounted for the differences though this could be subjected to further studies.

CONCLUSION

Teaching methods, assertive questioning teaching strategy and prior knowledge of behavioural objective teaching are important factors in chemistry achievement of learners thus both knowledge, skills and affective acquisition depended on the method of teaching. The study revealed no gender disparity in achievement and interest with the use of assertive questioning and prior knowledge of behavioural objective teaching strategies at the secondary school level. If the right method is employed for teaching, it is hoped that both boys and girls will continue to perform equally well in their chemistry career. This will improve enrolment for all sexes in professional courses like medicine, engineering, pharmacy and others. Assertive questioning and prior knowledge of behavioural objective teaching strategies had been proven to enhance interest and achievement in senior secondary school chemistry among boys and girls.

Recommendations

The following recommendations are made based on the findings of this work.

1. Assertive questioning and prior knowledge of behavioural objective teaching strategies are suitable for senior secondary school students. Curriculum planners and implementers should therefore recommend it as a teaching method. Consequently the current senior secondary chemistry curriculum should be reviewed with view to in-cooperating these teaching methods in curriculum guideline for achievement of intended learning outcomes.
2. Government through the Federal Ministry of Education and that of the State should organize and sponsor participant (teachers) a workshop and seminars for training teachers on the use of Assertive questioning and prior knowledge of behavioural objective teaching strategies.
3. Teacher training institutions like Colleges of Education, Faculties of Education of Universities should incorporate Assertive Questioning and Prior Knowledge of Behavioural Objective teaching methods in their curricula to train pre-service and in-service chemistry teachers regarding theoretical and effective practical usage of these methods. This necessary so that these methods can be used by these teachers effectively to teach electrolysis rate of chemical reaction when necessary.
4. The result shows Assertive Questioning and Prior Knowledge of Behavioural Objective teaching methods are gender friendly as they do not discriminate in their effect on student's achievement and interest. Both male and female learner should be given equal opportunities both in enrolment and study of science subjects and carriers.

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