British Journal of Psychology Research
Vol.3, No.5, pp.16-27, December 2015

Published by European Centre for Research Training and Development UK (www.eajournals.org)

EFFICACY OF ADVANCE ORGANIZERS STRATEGIES ON CHEMISTRY STUDENT'S COGNITIVE ACHIEVEMENTS IN REDOX REACTION CONCEPT

Theodore Njeribe Ekenobi[1] and Dr. (Mrs) A.A.O Mumuni[2]

[1]Department of Curriculum Studies and Educational Technology,
University of Port Harcourt, Nigeria.
[2]Department of Curriculum Studies and Educational Technology, University of Port Harcourt

ABSTRACT: *This study 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. Gender did not significantly influence the achievement of students in redox reaction concept. It was recommended among others those chemistry teachers and educators 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.*

KEYWORDS: Advance Organizers Strategies, Efficacy, Meaningful Understanding, Cognitive Achievements

INTRODUCTION

Chemistry is the science that underpinned most of the major discoveries of the 20th century and will continue to do so in the 21st century (Webster, 2009). This implies that chemistry is a central science transcending all aspects of human activity. Therefore its knowledge and meaningful understanding are critical for the successfully study of many important professions such as medicine, engineering, technology and agricultural for national socio-economic development and sustainability. However, the dearth in science enrolment in Nigeria whether at secondary or tertiary level of education (Ezeliora, 2004, Nnaka and Aneakwe, 2011) is seriously affecting our developmental growth in science and technology. Despite the low enrolment, efforts of chemistry teachers and educators to improve students learning outcome, do not seem to yield positive results. Students have continued to show weakness in content knowledge and meaningful understanding of chemical concepts, leading to very poor performances in external chemistry examinations as reported in the West African Examination Council WAEC (2000-2010), Chief Examiner's annual reports in chemistry, may/June option.

ISSN 2055-0863(Print), ISSN 2055-0871(Online

Ezeliora (2004), Okoli (2006) and Eya (2011) attributed the consistent poor performances to the poor and inappropriate teaching methods adopted by science teachers during instruction and the absence of efficient and effective strategies and instructional materials in chemistry classrooms. These didactic approaches of imparting chemical knowledge in a practically experimental science like chemistry is so teacher-centered, whole-class, textbook-based methods, that students become passive recipients of knowledge with no ample cognitive involvement in the learning process. Abstract and difficult concepts such as redox reaction are therefore learnt by rote and are not incorporated into the learner's cognitive structure (Mumuni and Mumuni, 2006, Obomanu and Ekenobi, 2011). These authors submitted that Oxidation-reduction or redox reaction is a very important concept in chemical and biochemical systems and in senior secondary school chemistry curriculum. Redox reaction involves two opposing processes which occur simultaneously to complement one another. It is an electron book-keeping process that involves the transfer of electrons from one specie (the reducing agent or reductant) to another (the oxidizing agent or oxidant), leading to changes in electrical charges of the species involved. It provides a framework within which chemical similarities are recognized and chemical properties correlated.

Research reports have indicated that redox reaction possess unique and formidable challenges to students. For instance, the West African Examinations Council, WAEC (2003, 2005, & 2006) chief examiners annual reports in chemistry specifically noted that questions in redox reaction were not of popular choice among chemistry students and those that attempted them performed very poorly. By implication, this may have been contributing significantly to their dismal performances in external chemistry examinations. Mumuni and Mumuni (2006) had also established that chemistry students are deficient intellectually at all cognitive levels due to the lack of cognitive knowledge and structure to cope with the conceptual demands of redox reaction which is perceived as abstract and difficult by both students and teachers. According to Decanato, Remirez, Aspee and Irma (2006), the abstract nature and the difficulties in learning some concepts are so stable and coherent internally that conventional instruction has little effect on them. That could be why Dass and Yager (2009) emphasized a pedagogical necessity to scaffold instruction, building from the students' existing or prior knowledge toward deep level meaningful understanding. This therefore implicates the need for more student-centered and innovative approaches such as advance organizers strategies which could scaffold instruction and ensure that specific aspects of concepts are meaningfully learnt and internalized.

Ausubel (1960), in Daniel (2005) described the advance organizer as a cognitive instructional strategy or mental learning aid to help learners integrate new information with existing knowledge, leading to meaningful learning as opposed to rote memorization. According to Daniel (2005), the advance organizer is usually presented ahead of a learning task at a higher level of abstraction, generality and inclusiveness to act as a conceptual bridge between the old information and the new information. Long-Crowell (2014) noted that the advance organizer provides a structure for students' thinking by activating the learners conceptual pattern so that information can be more readily subsumed into the learner's cognitive structure. Shihasu and Keraro (2009) submitted that advance organizers are frameworks that enable students learn new ideas or information and meaningfully link these ideas to the existing cognitive structure. Ausubel strongly asserted that advance organizers foster meaningful learning by prompting the students regarding pre-existing super-ordinate concepts already in the students' cognitive structures and provides a context of general concepts into which the students can incorporate progressively differented details. That is why advance organizers work best where there is no

ISSN 2055-0863(Print), ISSN 2055-0871(Online

prior knowledge possessed by the learner because the advance organizer becomes the learner's prior knowledge or template on which the new content is anchored.

Earlier research reports have demonstrated the effectiveness of using advance organizers in teaching scientific concepts. For instance Robinson (1998), and Shihasu and Keraro (2009) showed that advance organizers facilitated meaningful learning and enhanced students' performance. Hendron (2014) reported that students who use graphic presentations perform better in tests that require higher cognitive skills, due to the way the organizers provide scaffolding of new ideas with pre-existing schema. Onwioduokit and Akinbobola (2005), and Oloyede (2011) also demonstrated that pictorial organizer was most facilitating, followed by written organizer and non-organizer was least in enhancing student's achievements. Boujaoude and Attieh (2008) showed that students exposed to advance organizers performed better than those that did not use advance organizers at knowledge, comprehension and application levels respectively and that females perform better than males when their total test scores were considered. The consistent poor performance of students in external chemistry examinations and the dearth in science enrolment are indications that many prospective candidates may not meet admission requirements into tertiary institutions and if this ugly trend is not checked will not auger well for the desired application of chemistry for national socio-economic development and sustainability. Teachers' continued reliance on didactic methods does not promote higher cognitive skills in the students and has not yielded expected results especially when abstract and difficult tasks are involved. Therefore in the search for a better conceptual understanding of redox reaction this study investigated the efficacy of graphics and textual advance organizers strategies on chemistry students' cognitive achievements in redox reaction concept.

Specifically the following objectives guided the study:

1. To determine how the efficacies of graphics and textual advance organizers strategies enhance students achievements in redox reaction concept at lower level of the cognitive domain.

2. To ascertain how the efficacies of graphics and textual advance organizers strategies enhance students achievements in redox reaction concept at higher level of the cognitive domain.

3. To find out the extent to which the efficacies of graphics and textual advance organizers strategies enhance gender achievements in redox reaction concept.

To achieve the stated objectives, the following research questions were raised:

1. How do the efficacies of graphics and textual advance organizers strategies enhance students' achievements in redox reaction concept at lower level of the cognitive domain?

2. How efficacious are graphics and textual advance organizers strategies in enhancing student's achievements in redox reaction concept at higher level of the cognitive domain?

3. To what extent do the efficacies of graphics and textual advance organizers strategies enhance gender achievements in redox reaction concept?

ISSN 2055-0863(Print), ISSN 2055-0871(Online

To further guide the achievement of the objectives, the following null hypotheses were formulated and tested at 0.05 level of significance:

Ho_1: No significant difference exists in the achievements of students exposed to graphics and textual advance organizers strategies and those taught with the expository presentation approach in redox reaction concept at lower level of the cognitive domain.

Ho_2: No significant difference exists among the achievements of students exposed to graphics and textual advance organizers strategies and those taught with the expository presentation approach in redox reaction concept at higher level of the cognitive domain.

Ho_3: There is no significant difference in the achievement of male and female students exposed to graphics and textual advance organizers strategies and those taught with the expository presentation approach in redox reaction concept.

RESEARCH METHODOLOGY

The study was conducted in Obio/Akpor education zone of Rivers State, Nigeria and it adopted a pre-test, post-test, control group, quasi-experimental design. Gender was incorporated into the study as a critical variable. A sample of two hundred and twenty (220) senior secondary two (SS2) chemistry students (118 males and 102 females) was purposively selected from three out of the ten public co-educational senior secondary schools in the zone to constitute three (3) non- equivalent, intact classes that participated in the study based on the following criteria:

- Schools that have at least one graduate chemistry teacher with at least three years of teaching experience
- Schools that have functional chemistry laboratories
- Schools where the students have not been taught redox reaction concept.

Three of the six schools that met sampling criteria were randomly assigned one each to two experimental groups and one control group. A Redox Reaction Concept Achievement Test (RRCAT) instrument designed by the researchers which consisted of forty (40) multiple choice items in redox reaction was used to obtain data for the study. Blooms taxonomy of educational objectives guided allocation of the items into the different cognitive processes. The items were then condensed into the lower and higher levels of the cognitive domain. Thirty percent (30%) of the test items were at the lower level of the cognitive domain (knowledge and compression processes). While seventy percent (70%) were at higher level of the cognitive domain (Application and higher processes, while the instrument was face and content validated by a panel of subject experts and revised accordingly before use. A pilot study of the instrument on fifty (50) SS2 chemistry students from a non-participating school in the main study yielded a reliability co-efficient of 0.90 using Kuder-Richardson's formula 20. Graphics and textual advance organizers packages which served as subsumes for the learning of various content area of redox reaction concept as well as instructional packages using advance organizers strategies and the expository presentation approach for the treatment of the subjects were also developed by the researchers and presented to the subject experts along with the RRCAT instrument for validation.

ISSN 2055-0863(Print), ISSN 2055-0871(Online

To correct for initial differences in ability and ensure homogeneity in entry behaviour, RRCAT instrument was administered to the three groups as pre-test and their results used as covariate measures. Thereafter the groups were treated by research assistants who are in-service chemistry teachers in the sampled schools specifically trained for this purpose by the researchers. The experimental group1 was exposed to graphics advance organizers strategy (GAOS) while the experimental group 2 was exposed to textual advance organizers strategy (TAOS). The advance organizers were presented to them one day before each lesson. The control group was taught the same content of redox reaction using the expository presentation approach (EPA) without any advance organizers. The treatment took place concurrently in the sampled schools and lasted for four weeks. After treatment, RRCART was re-shuffled and administered to the three groups as post-test to determine the students' gain in achievement.

The data collected were analyzed using mean, standard deviation and percentages and two-way Analysis of Covariance (ANCOVA) using the pre-test scores as covariates and Scheffe's post hoc analysis of means which tested the null hypotheses at 0.05 level of significance.

RESULTS

The results of the analysis are presented in Tables 1-7. Mean, standard deviation and percentages were used to answer research question one, (Table 1).

Table1: Students mean gain achievement in redox reaction concept at lower level of the cognitive domain based on the instructional strategies

Group	Strategy	N	Pre-test		Post test		Mean gain score	
			Mean	SD	Mean	SD	Gain	Gain%
Experimental 1	GAOS	71	6.72	3.11	18.90	3.14	12.18	47.5
Experimental 2	TAOS	75	7.09	3.61	15.55	5.15	8.46	37.4
Control	EPA	74	6.92	3.40	11.69	2.99	4.77	25.6

Results in Table 1 indicated that the mean gain scores of students exposed to GAOS and TAOS were 12.18 or 47.5% and 8.46 or 37.5% respectively while that of the students taught with EPA was 4.77 or 25.6% at lower level of the cognitive domain. It could therefore be deduced that the students exposed to GAOS obtained the highest mean gain achievement followed by those exposed to TAOS while the students taught with EPA had the least mean gain achievement in redox reaction concept at lower level of the cognitive domain. The significance of the observed mean gain differences was determined using the following null hypothesis one.

Hypothesis One (H_O1)

No significant difference exists in the achievements of students exposed to graphics and textual advance organizers strategies and those taught with the expository presentation approach in redox reaction concept at lower level of the cognitive domain.

A two-way analysis of covariance was employed in testing the hypothesis and the results presented in Table 2.

ISSN 2055-0863(Print), ISSN 2055-0871(Online

Table 4.2: Summary of 2-way ANCOVA on the difference between students mean gain achievements in redox reaction concept at lower level of the cognitive domain

Source of Variance	Sum of squares	Df	Mean square	F	Sig
Corrected model	1948.948a	6	324.82	21.32	.000
Intercept	9959.61	1	9959.61	653.57	.000
Pre test lower cog	.283	1	.283	.019	.892
Instructional strategy	1889.80	2	944.90	62.01	.000
Gender	.001	1	.001	.000	.993
Error	3245.84	213	15.24		
Total	56909.00	220			
Corrected total	5194.78	219			

a. R squared = .375 (Adjusted R squared = .358)

The results in Table 2 showed that the calculated F- value for the strategies was 62.01 at degrees of freedom 2 and 213, significant at 0.000 probability level (F2, 213= 62.01, p< 0.05). Therefore hypothesis one (Ho1) was rejected, consequent upon a significant difference among the achievements of students exposed to GAOS, TAOS and EPA at lower level of the cognitive domain. A post hoc comparison by least significant difference (LSD) was used to determine the direction of the observed significant difference (Table 3).

Table 3: Post hoc analysis of mean gain differences of students achievements in redox reaction concept at lower level of the cognitive domain based on the three strategies.

Pairwise Comparisons

Dependent Variable:PostLowerCogScore

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
GAOS	TAOS	3.343*	.649	.000	2.064	4.622
	EPA	7.264*	.653	.000	5.976	8.552
TAOS	GAOS	-3.343*	.649	.000	-4.622	-2.064
	EPA	3.921*	.643	.000	2.654	5.188
EPA	GAOS	-7.264*	.653	.000	-8.552	-5.976
	TAOS	-3.921*	.643	.000	-5.188	-2.654

Based on estimated marginal means

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

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Results in Table 3 showed that all the group means compared yielded significant mean differences at 0.000 probability level (P<0.05). The results further indicated that the mean difference between GAOS and TAOS was 3.34, between GAOS and EPA was 7.26 and between TAOS and EPA was 3.92.This implies that graphics advance organizers strategy

ISSN 2055-0863(Print), ISSN 2055-0871(Online

(GAOS) contributed most to the observed significant difference and therefore was most efficacious in enhancing student's achievements in redox reaction concept at lower level of the cognitive domain followed by textual advance organizers strategy (TAOS), while the expository presentation approach (EPA) was least efficacious in enhancing students' achievements at lower level of the cognitive domain.

To answer research question two, mean standard deviation and percentages were also employed and the results presented in Table 4.

Table 4 : Gain scores of students achievements in redox reaction concept at higher level of the cognitive domain based on the groups.

Group	Strategy	N	Pretest		Post test		Mean gain score	
			Mean	SD	Mean	SD	Gain	Gain%
Experimental 1	GAOS	71	12.31	3.26	35.85	6.89	23.54	48.9
Experimental 2	TAOS	75	13.56	3.16	25.39	7.29	11.83	30.4
Control	EPA	74	12.61	3.15	15.84	5.37	3.23	11.4

The results in Table 4 showed that the students exposed to GAOS and TAOS had mean gain scores of 23.54 or 48.9 % and 11.83 or 30. 4% respectively while those taught with EPA obtained a mean gain score of 3.23 or 11.4 %. Therefore, the students exposed to GAOS had the highest mean gain achievement followed by those exposed to TAOS. The students taught with EPA obtained the least mean gain score at higher level of the cognitive domain.

The significance of the observed mean gain difference was also determined using null hypothesis two.

Hypothesis two (Ho_2)

No significant difference exists among the achievements of students exposed to graphics and textual advance organizers strategies and those taught with the expository presentation approach in redox reaction concept at higher level of the cognitive domain.

A two-way analysis of covariance was also used to test the hypothesis at 0.05 level of significance. The results are presented in Table 5.

Table 5: Summary of ANCOVA on the difference between students mean gain achievements in redox reaction concept at higher level of the cognitive domain

Dependent Variable:PostHigherCogScore

Source of Variance	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	15294.281[a]	6	2549.047	63.338	.000
Intercept	6364.543	1	6364.543	158.145	.000
PreHigherCogScore	135.863	1	135.863	3.376	.068
Group	14453.207	2	7226.603	179.566	.000
Gender	40.558	1	40.558	1.008	.317
Group * Gender	612.718	2	306.359	7.612	.001
Error	8572.169	213	40.245		
Total	167483.000	220			
Corrected Total	23866.450	219			

a. R Squared = .641 (Adjusted R Squared = .631)

ISSN 2055-0863(Print), ISSN 2055-0871(Online

The results in Table 5 showed that the calculated F- value for the strategies was 179.57 at degrees of freedom 2 and 213, significant at 0.000 probability level, which is less than 0.05 the chosen level of probability ($F2, 213 = 179.57, p< 0.05$). Hypothesis two (Ho2) was also rejected showing that a significant difference exists in the achievements of students exposed to GAOS, TAOS and EPA in redox reaction concept at higher level of the cognitive domain. A Scheffe's post hoc comparisons by least significant difference (LSD) in Table 6 showed that all the group means compared yielded significant mean differences at 0.000 probability level ($p<0.05$).

Table 6: Post hoc test on the difference between students mean gain achievements in redox reaction concept at higher level of the cognitive domain based on the groups.

Pairwise Comparisons

Dependent Variable:PostHigherCogScore

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
GAOS	TAOS	10.737*	1.066	.000	8.635	12.839
	EPA	20.119*	1.062	.000	18.026	22.212
TAOS	GAOS	-10.737*	1.066	.000	-12.839	-8.635
	EPA	9.382*	1.053	.000	7.308	11.457
EPA	GAOS	-20.119*	1.062	.000	-22.212	-18.026
	TAOS	-9.382*	1.053	.000	-11.457	-7.308

Based on estimated marginal means

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

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Furthermore, the results in Table 6 indicated that the mean difference between GAOS and TAOS was 10.74, between GAOS and EPA was 20.12 and between TAOS and EPA was 9.38. This also implies that graphics advance organizers strategy (GAOS) contributed most to the observed significant difference and was therefore most efficacious in enhancing student's achievements in redox reaction concept at higher level of the cognitive domain. This was followed by textual advance organizers strategy (TAOS) and the expository presentation approach (EPA) was least efficacious in enhancing students achievements in redox reaction concept at higher level of the cognitive domain.

Research Question three was answered using mean, standard deviation and percentages as shown in table 7.

ISSN 2055-0863(Print), ISSN 2055-0871(Online

Table 7: Gain scores of male and female students achievements in redox reaction concept at higher level of the cognitive domain based on the strategies.

Group	Strategy	Gender	N	Pre test		Post test		Mean Gain	
				Mean	SD	Mean	SD	Score Gain	Gain%
Experimental 1	GAOS	Male	39	12.26	3.57	36.46	6.00	24.20	49.7
		Female	32	12.38	2.88	35.09	7.87	22.71	47.8
Experimental 2	TAOS	Male	37	13.68	3.41	22.59	8.62	8.91	24.6
		Female	38	13.45	2.95	28.11	6.95	14.66	35.3
Control	EPA	Male	42	12.71	3.29	16.55	5.14	3.84	13.1
		Female	32	12.47	3.02	14.91	5.60	2.44	8.91

The results in Table 7 showed that the male students exposed to GAOS obtained a mean gain score of 24.20 or 49.7 % while their female counterparts had a mean gain score of 22.71 or 47.8% . It is deduced that the male students exposed to GAOS had a higher mean gain of 1.49 or 6.16 % over their female counterparts. The mean gain score of the male students exposed to TAOS was 8.91 or 24. 6 % while that of their female counterparts was 14.66 or 35.3%. It is therefore deduced that the female students exposed to TAOS had a higher mean gain score of 5.75 or 10.71% more than their male counterparts. The male students taught with EPA obtained a mean gain score of 3.84 or 13 .1% while their female counterparts had a mean gain score of 2.44 or 8.9% showing that the male students taught with EPA had a higher mean gain of 1.40 or 4.2% over their female counterparts. The significance of the observed mean gain differences was established using null hypothesis three.

Hypothesis Three (H_{o3})

There is no significant difference in the achievements of male and female students exposed to graphics and textual advance organizers strategies and those taught with the expository presentation approach in redox reaction concept.

A two-way analysis of covariance was again used to test the hypothesis at 0.05 significant level (Table 5). A second look at Table 5 showed that the calculated F- value for gender is 1.01 at degrees of freedom 1 and 213, significant at 0.317 probability level which is greater than 0.0.05 the chosen level of probability ($F1, 213 = 1.01, p>0.05$). Hypothesis three (Ho3) was therefore retained. This revealed that gender did not significantly influence the achievements of the students across the groups contrary to expectations.

DISCUSSION OF THE RESULTS

The results of this study revealed significant differences among the achievements of chemistry students exposed to graphics and textual advance organizers strategies (GAOS and TAOS) and those taught with the expository presentation approach (EPA) in redox reaction concept at all level of the cognitive domain. Graphics advance organizers strategy consistently produced the highest achievement gains at both lower and higher levels of the cognitive domain. The post hoc multiple comparisons also established that graphics advance organizers strategy (GAOS) contributed most to the observed significant differences and therefore was most efficacious in

ISSN 2055-0863(Print), ISSN 2055-0871(Online

enhancing students achievements in redox reaction concept at both lower and higher levels of the cognitive domain. This was followed by textual advance organizers strategy (TAOS) while the expository presentation approach (EPA) was least efficacious in enhancing student's achievements at both lower and higher level of the cognitive domain. This trend was due to the fact that advance organizers enabled the students in the experimental groups to develop higher cognitive abilities and knowledge structures to cope with the conceptual demands of redox reaction. Graphics advance organizers strategy enabled the students to be meta-cognitively active, bringing abstract and difficult concepts into a visual format that encouraged deep learning and meaningful understanding of redox reaction concept and hence remarkable cognitive achievements. When concepts are learnt meaningfully and not by rote, students exhibit mastery and control over the subject matter, leading to remarkable learning outcome. The low achievements of the control group students could be blamed on the defectiveness of the expository presentation approach in which students were only passive recipients of knowledge with no ample cognitive involvement in the learning process. The students therefore learnt by rote and could not develop any cognitive abilities, neither demonstrated any meaningful understanding nor obtained higher achievements at all levels of the cognitive domain. These findings are consistent with the findings of Robinson (1998), Shihasu and Keraro (2009) and Hendron (2014) that advance organizers strategies facilitated meaningful learning and enhanced student's achievements.

Onwioduokit and Akinbobola (2005) and Oloyede (2011) demonstrated that pictorial organizer was most facilitating, followed by written organizer and non- organizer was least in facilitating student's achievements. Bouyaoude and Attieh (2008) also showed that students who used advance organizers performed better than those that did not use advance organizers at knowledge, comprehension and application levels respectively.

The findings also revealed that irrespective of the strategy adopted, gender did not significantly influence the achievements of students across the groups. This is due to the fact that both males and females benefitted equally from the exposures and could do equally well in science when exposed to similar learning conditions.

This result is in consonant with previous studies by Onwioduokit and Akinbobola (2005), and Oloyede (2011) which found that gender has no significant effect on the achievement of students taught with pictorial and written organizers because both male and female could do equally well in science if exposed to similar learning conditions. The result however disagrees with that of Boujauode and Attieh (2008) which found that advance organizers favored girls over boys when their total test scores were considered.

CONCLUSION

The result of this study highlighted the efficacies of graphics and textual advance organizers strategies in fostering meaningful understanding and enhancing chemistry student's cognitive achievements. The advance organizers helped the students to overcome the difficulties inherent in learning redox reaction concept which is perceived as abstract and difficult by both students and teachers. Based on the findings of this study, it was concluded that graphics advance organizers strategy (GAOS) was most efficacious in enhancing students' achievement in redox reaction concept at both lower and higher levels of the cognitive domain followed by textual advance organizer strategy (TAOS) while the expository presentation approach (EPA)

ISSN 2055-0863(Print), ISSN 2055-0871(Online

was least efficacious in enhancing chemistry students achievements in redox reaction concept at all levels of the cognitive domain.

Gender did not significantly influence the achievements of chemistry students in redox reaction concept across the groups.

RECOMMENDATIONS

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

1. Chemistry teachers and educators 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.

2. Education stakeholders should organize conferences, seminars and workshops for chemistry teachers to acquaint them with the use of graphics and textual advance organizers to improve the process and product of learning.

3. Textbook authors should adopt graphics and textual organizers in their books to support student's organizational process.

REFERENCES

Asiyai, R.I .(2005). Enhancing chemistry in secondary schools through concept mapping instructional strategy. 46th Annual Conference Proceedings of the science teachers Association of Nigeria, 2005, 205-209.

Boujaoude, S. & Attieh, M. (2008). The effect of using concept maps as study tools on achievement in chemistry. *Eurasia Journal of Mathematics, Science and Technology Education*, 2008. 4 (3),233-246

Daniel, K.J. (2005). Advance organizers: Activating and building schema for more successful learning in students with disabilities. *Journal of Special Education*. Retrieved July 30, 2014 from http://www.lynchburg.edu/documents/graduate studies/Lynchburg college. Journal of special education/volume/4 PDF Art.

Dass, P.M. & Yager, R.E. (2009). *Professional development of teachers:* History of reforms and contributions of the STS-based 10WA Chautauqua program. Science Education Review, 2009, 8(3), 99-111

Decanato, De 1, Ramirez, de M.M.S, Aspee, M.& Irma, S. (2006). *Concept maps: An essential tool for teaching and learning to learn science*: Focus on learning problems in mathematics. June 22, 2006. Retrieved April 21 2013, from http://www. Encyclopedia.com/doc/161-160922508html

Eya, M.N. (2011). Chemistry curriculum reforms in the 21st century: The need for human resources development. In Abonyi, O.S. (Ed). Reforms in STEM education. 52nd Annual Conference Proceedings of the Science Teachers Association of Nigeria, 2011, 255-260.

Ezeliora, B. (2004). Motivating secondary school science teachers to face the challenges of the third millennium. *Journal of the Science Teachers Association of Nigeria, 39 (1∝2),83-88.*

ISSN 2055-0863(Print), ISSN 2055-0871(Online

Hendron, J. (2014). Advance and graphical organizers: Proven strategies enhanced through technology. Retrieved July 25, 2014 from http://www.glud.k12.VA.US/resources/graphicalorganizers.

Long-Crowell, E. (2014). Advance organizers in the classroom teaching: Strategies and advantages. Retrieved July 24, 2014 from http://www.education-portal.com/academy/lesson/advanced-organizers-in the-classroom-teaching-strategies-advantages.html# lesson

Mumum; A.A.O & Mumum; A.R. (2006). Secondary school students academic achievement in cognitive levels of the concept of redox reaction. *Journal of Education in Developing Areas. (JEDA).* Faculty of Education, University of Port Harcourt. 15, 116-127

Nnaka, C.V. & Anaekwe, M.C. (2011*). Admission policy in science at tertiary education level:* Extent of goal attainment and imperatives for reform in STEM education. In Abonyi, O.S. (Ed).Reforms in STEM education. 52nd Annual conference Proceedings of the Science Teachers Association of Nigeria, 2011, 86-91.

Obomanu, B.J. & Ekenobi, T.N. (2011). Analysis of learning outcome in chemistry among SSIII students in urban and rural settings: Using concept map technique. *Journal of Education and Practice, vol 2, no 4, 2011. 148-154.*

Okoli, J.N. (2006). Effects of investigative laboratory approach and expository methods on acquisition of science process skills by biology students of different levels of scientific literacy. *Journal of the Science Teachers Association of Nigeria 41 (1□2), 79-88.*

Oloyede, O.I. (2011). A meta-analysis of effects of the advance organizers on acknowledgement and retention of senior secondary school (SSS) chemistry. *International Journal of Education Science, 3(2), 129-145.*

Onwioduokit, F.A. & Akinbobola, A.O. (2005).Effects of pictorial and written advance organizers on students achievement in senior secondary school physics. *Journal of the Science Teachers Association of Nigeria,* 40(102), 109-116.

Robinson, D.H (1998). Graphics organizers as aid to text learning. Reading, Research and Instruction, 37, 85-105. Retrieved July 30, 2013 from expanded Academic ASA data base.

Shiuhasu, H. & Keraro, F.N (2009). Using advance organizers to enhance students motivation in learning biology. Eurasia *Journal of Mathematics, Science and Technology Education. 5(4), 413 -420.* Retrieved June 30, 2014 from http://ejmste.com/v5n4/EURASIA-v5n4-shihesu-keraro.pdf

Webster, G.H. (2009). Attitude counts, self-concept and success in general chemistry. *Journal of Chemical Education.* 86(6), 731-744.

West African Examinations council (2000-2010). *Chief examiners annual reports:* Senior secondary school certificate examinations results in chemistry, May /June option,2000-2010. (Nigeria). Lagos

ISSN 2055-0863(Print), ISSN 2055-0871(Online