British Journal of Psychology Research
Vol.4, Issue 4, pp.34-46, November 2016
Published by European Centre for Research Training and Development UK (www.eajournals.org)

ENHANCING CHEMISTRY STUDENTS' RETENTION OF REDOX REACTION CONCEPT THROUGH INTERVENTION WITH ADVANCE ORGANIZERS

Theodore Njeribe Ekenobi
Department of Curriculum Studies and Educational Technology
University of Port Harcourt, Nigeria.

Dr. (Mrs) A.A.O Mumuni
Department of Curriculum Studies and Educational Technology
University of Port Harcourt

Dr. (Mrs) A.U. Nwanekezi
Department of Curriculum Studies and Educational Technology
University of Port Harcourt

ABSTRACT: *This study investigated the potency of advance organizers strategies in enhancing chemistry students' cognitive levels retention of redox reaction concept. A pre-test, post test, control group, quasi-experimental design was adopted. Two hundred and twenty (220) senior secondary two (SS2) chemistry students (118 males and 102 females) purposively sampled from the target population in Obio/Akpor education zone of Rivers State, Nigeria, constituted three non-equivalent intact classes that participated in the study. Data was collected using a Redox Reaction Concept Retention Test (RRCART) instrument with Kuder-Richardson's formula 20 reliability co-efficient of 0.90. Mean, standard deviation and percentages as well as analysis of covariance and Scheffe's post hoc analysis were used for data analysis at 0.05 alpha level. Findings revealed that graphics advance organizers strategy consistently produced the highest retention mean gain and therefore was most effective in enhancing the retention abilities of chemistry students in redox reaction concept at all levels of the cognitive domain. Gender did not significantly influence the retention ability of students in redox reaction concept. It was recommended among others that chemistry teachers and educators should adopt graphics and textual advance organizers strategies and resources to effectively and efficiently teach redox reaction concept so as to promote conceptual learning over rote memorization.*

KEYWORDS: Advance organizers strategy, Potency, In-depth learning, Cognitive levels retention

INTRODUCTION

The uniqueness of chemistry makes it occupy a pride of place in the scientific and technological development of any nation. Unfortunately, chemistry is widely perceived as abstract and difficult by both students' and teachers and as a result majority of the students essentially engage in rote learning (Boujaoude and Barakat, 2000). Besides, the prevailing teaching methods do not actively involve students in the learning process (Francisco, Nicoll & Trautmann, 1998) and that could be the reason for students' difficulty in meaningful learning and internalization of chemical concepts. Despite efforts of chemistry teachers and educators to improve students learning outcome, students

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

have continued to show weakness in meaningful understanding and internalization of chemical concepts, leading to very poor performances in external chemistry examinations (WAEC, 2000-2010).

Poor and inappropriate teaching methods adopted by science teachers during instruction and the absence of instructional materials in science classrooms have been identified as the principal causes of high rates of families in science examinations (Okoli 2006, Eya 2011 & Oloyede 2011). Negrette and Lartigue (2004) observed that teachers still rely heavily on didactic methods and teach science as a body of knowledge needed only to be memorized for success in examinations and which the students often forget shortly afterwards. Moreso, Decanato, Ramire, Aspee and Irma (2006) strongly submitted that the abstract nature and the difficulty in learning some concepts are so stable and coherent internally that conventional instruction has little effect on them. Since the goal of instruction is to develop educational experiences that will facilitate meaningful learning and reduce rote memorization, chemistry instruction should deliberately stress effective knowledge transfer to the learner in the most efficient and purposeful manner. Dass and Yager (2009) submitted that teachers need to create a suitable environment by employing strategies that encourage active student participation in identification of issues, concepts and relationships which will be far more effective than the traditional practices whereby students are passive recipients of knowledge with no cognitive involvement in the learning process. Besides, the most important derivatives of learning are knowledge retention and application to real life situations outside the classroom. Cakir (2008) opined that in order to learn a concept meaningfully, students must carry out cognitive processes that construct relations among the elements of information in the concept to promote conceptual learning over rote memorization. The author noted that these processes take time and require that students interact with materials and resources over time through hands-on and by minds- on with advance organizers. Due to the very dynamic nature of science and in order to catch up with the new world order of scientific and technological innovations, Eya (2011) strongly submitted that there must be a drastic change in the method of presentation and delivery of individual concepts in chemistry classrooms and laboratories. This could be achieved through the use of innovative and student-centred approaches in handling abstract and difficult concepts. It has therefore become a pedagogical necessity to search for innovative, student-centred approaches such as advance organizers strategies which could scaffold instruction and ensure that specific aspects of concepts are meaningful learnt and internalized. This could actively involve the students in the learning process, and perhaps make learning more meaningful and enjoyable.

Ausubel (1960) in Daniel (2005) introduced the advance organizer to foster meaningful learning by prompting the student regarding pre-existing super-ordinate concepts into which the student can incorporate progressively differentiated details. The advance organizer is therefore a cognitive strategy to promote rapid learning and retention of concepts. It is a means of preparing the learners' cognitive structure and provides a structure for students' thinking (Long-Crowell, 2014). 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 strengthen the learners' cognitive structure. Therefore the advance organizer emphasizes the influence of students' prior knowledge on meaningful learning. That is why advance organizers work best when there is no prior knowledge possessed by the learner because the advance organizer becomes the learners' prior knowledge or foci on which the new content is anchored. This facilitates the assimilation of the

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

new information by helping the students' make connections between it and the new material (Daniel, 2005). Studies conducted with advance organizers indicated positive effects on learning and retention. Shihasu and Keraro (2009), Lin and Cheng (2006) had in separate studies shown that the use of advance organizers improved students' understanding and retention of science concepts due to the way the organizers provide retention and scaffolding of new ideas with pre-existing schema. Hendron (2014) submitted that advance organizers improve levels of understanding and recall and that higher level or more abstract organizers produce deeper learning than lower level or more concrete advance organizers. Onwioduokit and Akinbobola (2005), Oloyede (2011) and Atomatofa (2013) demonstrated that pictorial advance organizer was most facilitating followed by written organizer and non organizer was least in enhancing students' retention of learned concepts. Novak and Canas (2008) agreed with Tsien (2007) that approaches that have remarkable capacity for acquiring and retaining visual images such as graphics organizers significantly enhance the learning capability and retention of all learners. Novak (1990) submitted that graphics organizer is a simple tool that facilitates meaningful learning and the creation of powerful knowledge frameworks that not only permit utilization of knowledge in new contexts but also the retention of the new knowledge for long periods of time. According to Tobin (1990) in Hofstein and Lunetta (2003), meaningful learning is possible if students are given opportunities to manipulate equipment and materials n an environment suitable for them to construct their knowledge of phenomena and related scientific concepts. Heron (1994) explained meaningful learning in terms of retention and emphasized that retention is a term used to denote the demonstration that learning has been maintained over time and may be displayed through recognition or recall. Hendron (2014) observed that recall or recognition is enhanced by presenting information in both visual and verbal forms.

Redox reaction as explicated by Mumuni and Mumuni (2006) and Obomanu and Ekenobi (2011) is a very important concept in chemical and biochemical systems and in the senior secondary school chemistry curriculum. It is an electron book keeping process that involves the transfer of electron(s) 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. Studies by Udo (2006) and Mumuni and Mumuni (2006) indicated that redox reaction poses unique and formidable challenges to students. This may have been contributing significantly to their very poor performances in external chemistry examinations. The consistent poor performance of students in external chemistry examinations is an indication of paucity in science enrolment in tertiary institutions. Teachers' continued reliance on traditional methods does not promote higher cognitive functioning in the students and has not yielded expected results especially when abstract and difficult tasks are involved. However, research addressing the use of advance organizers strategies in senior secondary school chemistry teaching and learning in Nigeria is limited. This study is therefore designed to investigate the potency of graphics and textual advance organizers strategies in enhancing senior secondary school chemistry student's retention of redox reaction concept.

Specifically, the study will achieve the following objectives:

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

1. Determine the extent to which graphics and textual advance organizers strategies enhance students' retention mean scores in redox reaction concept at lower level of the cognitive domain.
2. Verify how graphics and textual advance organizers strategies enhance students' retention mean scores in redox reaction concept at higher level of the cognitive domain
3. Determine how graphics and textual advance organizers strategies enhance gender retention mean scores in redox reaction concept.

To achieve the above objectives, the following research questions guided the study:
1. To what extent do graphics and textual advance organizers strategies enhance students' retention mean scores in redox reaction concept at lower level of the cognitive domain?
2. How do graphics and textual advance organizers strategies enhance students' retention mean scores in redox reaction concept at higher level of the cognitive domain?
3. To what extent do graphics and textual advance organizers strategies enhance gender retention mean scores in redox reaction concept?

The following null hypotheses were formulated and tested at 0.05 alpha level:
Ho_1: There is no significant difference in the retention mean scores 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 retention mean scores 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 among the retention mean scores 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 adopted a pre-test, post-test control group, quasi-experimental design in a 3x2 factorial matrix showing three (3) levels of experimental factors and two (2) levels of retention.
The sample consisted of two hundred and twenty (220) senior secondary two (SS2) chemistry students (118 males and 102 females) purposely selected from three out of the ten public co-educational senior secondary schools in Obio/Akpor education zone of Rivers State, Nigeria that participated in the study. The sampling was based on the following criteria:
i. Schools that have at least one graduate chemistry teacher with at least three years of teaching experience.
ii. Schools that have functional chemistry laboratories, and
iii. Schools where students have not been taught redox reaction concept
Three of the six schools that met sampling criteria were constituted into non-equivalent intact classes and randomly assigned one each to the experimental and control groups. a Redox Reaction Concept Retention Test (RRCART) instrument designed by the researchers consisted of four-option, forty multiple choice items in redox reaction concept was used to obtain data for the study. Bloom's taxonomy of educational objectives guided the allocation of the test items into the different cognitive processes. Thereafter, the items were condensed into the lower and higher levels of the cognitive domain. Thirty percent (30%) of the items were at lower level (knowledge

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

and comprehension processes) while seventy percent (70%) were at higher level of the cognitive domain (application and higher processes). The instrument was face and content validated by a team of subject experts from Science Education and Measurement and Evaluation Departments of the University of Port Harcourt and Ignatius Ajuru University of Education, Port Harcourt. A pilot study of RRCRT instrument on fifty (50) senior secondary two (SS2) chemistry students from a non-participating school in the main study yielded a reliability coefficient of 0.90 using Kuder-Richardson's formula 20. Graphics and textual advance organizers packages which served as subsumers for the learning of various content areas of redox reaction as well as instructional packages using graphics and textual advance organizers strategies and the expository presentation approach for the treatment of the subjects were also developed by the researchers and presented to the team of subject experts along with the RRCRT instrument for correction before being used for the intervention.

Experimental Procedure

The RRCRT instrument was administered to the three groups as pre-test to correct for initial differences in ability and ensure homogeneity in entry behavior and their results used as covariate measures. The groups were then taught by research assistants (in-service chemistry graduate teachers in the sampled schools specially trained for this purpose by the researchers) using their respective strategies and lesson packages. The experimental group 1 was exposed to graphics advance organizers strategy (GAOS) while the experimental group 2 received treatment with textual advance organizers strategy (TAOS). The advance organizers were presented to them one day before each lesson. The control group was also taught the same contents of redox reaction using expository presentation approach (EPA), without any advance organizers. The treatment took place concurrently in the sampled schools and lasted for four weeks in eight 80-minute lessons. After treatment, RRCRT was administered to the three groups as post-test. Three weeks after the post-test, RRCRT was reshuffled and administered to the groups to check the students' level of retention of the concept. The data collected were analyzed using descriptive statistics (mean, standard deviation and percentages) which provided answers to the research questions and inferential statistics(Analysis of covariance (ANCOVA) using pre-test scores as covariates and Scheffe's post hoc and analysis) to test the null hypotheses. All hypotheses were tested at 0.05 level of significance.

RESULTS

The results of the analyses are presented in Tables 1to7. Research question one was answered using mean, standard deviation and percentages. The results are presented in Table 1.

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

Table 1: Gain scores of students' retention of redox reaction concept at lower level of the cognitive domain based on the instructional strategies

Group	Strategy	N	Pre test		Retention		Mean gain score	
			Mean	SD	Mean	SD	Gain	Gain%
Experimental 1	GAOS	71	6.72	3.11	16.27	3.11	9.55	41.50
Experimental 2	TAOS	75	7.09	3.61	13.52	4.01	6.43	31.20
Control	EPA	74	6.92	3.40	9.12	2.74	2.20	13.72

The results in Table 1 indicated that the retention mean gain score of students exposed to graphics advance organizers strategy (GAOS) and textual advance organizers strategy (TAOS) were 9.55 or 41.50% and 6.43 or 31.20% respectively while the students taught with the expository presentation approach obtained a retention mean gain score of 2.20 or 13.72% at lower level of the cognitive domain. This clearly shows that the students exposed to GAOS had the highest level of retention followed by the students exposed to TAOS while the students taught with EPA had the least retention mean gain in redox reaction concept at lower level of the cognitive domain. The significance of the observed retention mean gain differences was determined using hypothesis one.

Hypothesis One (Ho_1)

There is no significant difference in the retention mean scores 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 used to test the hypothesis and the results presented in Table 2.

Table 2: Summary of ANCOVA data on the difference between students retention mean gain in redox reaction concept at lower level of the cognitive domain based on the strategies.

Dependent Variable: Lower Cog Retention

Source of variance	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1978.627[a]	6	329.771	30.170	.000
Intercept	7001.708	1	7001.708	640.563	.000
PreLowerCogScore	.001	1	.001	.000	.992
Group	1896.910	2	948.455	86.771	.000
Error	2328.209	213	10.931		
Total	41072.000	220			
Corrected Total	4306.836	219			

a. R Squared = .459 (Adjusted R Squared = .444)

The results in Table 2 showed that the calculated F-value for group is 86.77 at degrees of freedom 2 and 213, significant at 0.000 probability level which is less than 0.05 chosen level of probability ($F_{2, 213}=86.77$, $P<0.05$). Hypothesis one was rejected, showing a significant difference in the retention mean scores of students exposed to GAOS and TAOS and those taught with EPA in redox reaction concept at lower level of the cognitive domain. A post hoc multiple comparisons

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

by Least Significant Difference (LSD) was used to determine the direction of the observed significant difference (Table3).

Table 3: Post hoc analysis of the difference between the retention mean gain of students at lower level of the cognitive domain based on the strategies.

Pairwise Comparisons

Dependent Variable:LowerCogRetention

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
GAOS	TAOS	2.744*	.550	.000	1.661	3.828
	EPA	7.208*	.553	.000	6.118	8.299
TAOS	GAOS	-2.744*	.550	.000	-3.828	-1.661
	EPA	4.464*	.544	.000	3.391	5.537
EPA	GAOS	-7.208*	.553	.000	-8.299	-6.118
	TAOS	-4.464*	.544	.000	-5.537	-3.391

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).

Table 3 indicated that all the group means compared yielded significant retention mean differences ($P<0.05$). The results further indicated that the mean difference between GAOS and TAOS was 2.74, between GAOS and EPA was 7.21 and between TAOS and EPA was 4.46. This implies that graphics advance organizers strategy (GAOS) contributed most to the observed significant difference and therefore was most effective in enhancing students' retention mean scores followed by textual advance organizers strategy (TAOS) while the expository presentation approach (EPA) was least effective in enhancing students' retention mean scores in redox reaction concept at lower level of the cognitive domain.

Research question two was also answered using mean, standard deviation and percentages as presented in Table 4.

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

Group	Strategy	N	Pre test		Retention		Mean gain score	
			Mean	SD	Mean	SD	Gain	Gain%
Experimental 1	GAOS	71	12.31	3.26	33.97	7.09	21.66	46.8
Experimental 2	TAOS	75	13.56	3.16	23.00	6.18	9.44	25.8
Control	EPA	74	12.61	3.15	13.57	3.41	0.95	0.37

Table 4 showed that the retention mean gain scores of students exposed to GAOS and TAOS were 21.66 or 48.8% and 9.44 or 25.80% respectively, while that for the students' taught with EPA was 0.95 or 0.37%. The results clearly indicated that the students exposed to GAOS had the highest level of retention followed by those exposed to TAOS while the students taught with EPA has the least retention mean scores in redox reaction concept at higher level of the cognitive domain. The

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

significance of the observed retention mean differences was determined using the following null hypothesis

Hypothesis two (Ho_2)

No significant difference exists among the retention mean scores 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 alpha level (Table5).

Table 5: Summary of ANCOVA on the difference between male and female students' retention mean gain in redox reaction concept at higher level of the cognitive domain based on the groups

Dependent variable: Higher cognitive retention

Source of variance	Sum of squares	Df	Mean square	F	Sig
Corrected model	15904.847a	6	2650.808	88.328	.000
Intercept	5553.964	1	5553.964	185.065	.000
Pre higher cog score	82.208	1	82.208	2.739	.099
Group	15122.997	2	7561.499	251.958	.000
Gender	40.752	1	40.752	1.358	.245
Error	6392.331	213	30.011		
Total	142433.000	220			

a. R Squared = .713 (Adjusted R Squared = .705)

Results in Table 5 indicated that the calculated F-value for the group is 251.96 at degrees of freedom 2 and 213, significant at 0.000 probability level which is less than the chosen 0.05 level of probability ($F_{-2, 213}=251.96$, $P<0.05$). Hypothesis two was also rejected. This means that a significant difference exists among the retention mean scores of students exposed to GAOS, TAOS and EPA in redox reaction concept at higher level of the cognitive domain. Scheffe's post hoc multiple comparisons by Least Significant Difference (LSD) displayed in Table 6 indicated that all the group means compared yielded significant mean differences at 0.000 probability level ($P<0.05$).

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

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

Pairwise Comparisons

Dependent Variable: Higher Cog Retention

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
GAOS	TAOS	11.208*	.921	.000	9.393	13.023
	EPA	20.572*	.917	.000	18.764	22.380
TAOS	GAOS	-11.208*	.921	.000	-13.023	-9.393
	EPA	9.364*	.909	.000	7.572	11.156
EPA	GAOS	-20.572*	.917	.000	-22.380	-18.764
	TAOS	-9.364*	.909	.000	-11.156	-7.572

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).

The results in Table 6 further indicated that the mean difference between GAOS and TAOS was 11.21, between GAOS and EPA was 20.57 and between TAOS and EPA was 9.36. This implies that graphics advance organizers strategy (GAOS) contributed most to the observed significant retention mean differences and therefore was most effective in enhancing students' retention mean scores. This was followed by textual advance organizers strategy (TAOS) while the expository presentation approach (EPA) was least effective in enhancing students' retention mean scores in redox reaction concept at higher level of the cognitive domain.

To answer research question three, mean, standard deviation and percentages were used and the results are presented in Table 7

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

Group	Strategy	Gender	N	Pre test		Retention		Mean Gain	Score
				Mean	SD	Mean	SD	Gain	Gain%
Experimental 1	GAOS	Male	39	12.26	3.57	34.36	6.43	22.10	47.4
		Female	32	12.38	2.88	33.50	7.90	21.12	46.0
Experimental 2	TAOS	Male	37	13.68	3.44	20.11	5.43	6.43	19.0
		Female	38	13.45	2.95	25.82	5.59	12.37	31.5
Control	EPA	Male	42	12.71	3.29	14.57	2.74	1.86	6.82
		Female	32	12.47	3.02	13.27	3.78	1.10	4.22

The results in Table 7 indicated that the male students exposed to GAOS obtained a retention mean gain of 22.1 (47.4%) while their female counterparts had a retention mean gain of 21.12 (46.0%). The male students' exposed to TAOS had a retention mean gain of 6.43 (19.0%) while their female counterparts obtained a retention mean gain of 12.37(31.5%). The retention mean gain score of students taught with EPA was 1.86 (6.82%) while that of their female counterparts was 1.10

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

(4.22%). The significance of the observed retention mean gain differences was determined using the following null hypothesis:

Hypothesis three (H_{o3})
There is no significant difference among the retention mean scores 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 used to test the hypothesis at 0.05 alpha level. The results are also as presented in Table 5. Another look at Table 5 shows that the calculated F-value for gender is 1.36 at degrees of freedom of 1 and 213, significant at 0.245 probability level which is greater than 0.05 chosen level of probability ($F_{1,213}=1.36$, $P>0.05$). Hypothesis three (Ho3) was therefore retained, indicating that no significant difference exists among the retention mean scores of male and female students across the groups. This was however contrary to expectations.

DISCUSSION OF RESULTS

The findings of this study revealed a significant difference among the retention mean scores 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 lower level of the cognitive domain. The post hoc analysis of the students retention mean gain scores showed that graphics advance organizers strategy (GAOS) was most potent in enhancing students retention abilities followed by textual advance organizers strategy (TAOS) while the expository presentation approach (EPA) was least effective in enhancing students' retention abilities in redox reaction concept at lower level of the cognitive domain. This might have been due to the scaffolding and stability provided in the cognitive structures of the experimental groups of chemistry students by the advance organizers at the lower level of the cognitive domain. This result corroborates the findings of Lin and Cheng (2006). Atomatofa (2013) and Hendron (2014) which demonstrated that advance organizers increased students understanding and retention abilities and that higher level or more abstract organizers produce deeper learning and retention abilities than lower level or more concrete organizers.

The findings of this study also indicated that there was a significant difference in the retention mean scores of 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 higher level of the cognitive domain. Scheffe's post hoc analysis further indicated that graphics advance organizers strategy (GAOS) was most effective followed by textual advance organizers strategy (TAOS) while the expository presentation approach (EFA) was least effective in enhancing student's retention of redox reaction concept at higher level of the cognitive domain. This might have been due to the fact that the advance organizers enhanced in-depth learning and higher ability to internalize, retain and apply knowledge. Graphics advance organizers helped the experimental group1 students to combine the verbal and non-verbal modes of information processing and storage to visualize the material presented and therefore retained it more than the students in the other two groups. This finding is consistent with the findings of Novak (1990), Onwioduokit and Akinbobola (2005), Oloyede (2011), Hendron (2014) which provided evidence that pictorial advance organizer was most facilitating, followed by written organizer and no-

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

organizer was least effective in facilitating student's retention abilities. The findings also revealed that gender did not significantly influence the retention abilities of chemistry students in redox reaction concept across the groups. This could be due to the fact that both males and females benefited equally well from the exposures. The result agrees with the findings of Onwioduokit and Akinbobola (2005), which reported that gender, had no significant effect on the retention ability of students.

CONCLUSION

Based on the findings of this study, it is concluded that the use of graphics and textual advance organizers was highly potent in promoting in-depth learning of redox reaction and enhancing higher retention abilities in chemistry students. The active participation of the students in the learning process enabled them to overcome the difficulties inherent in learning and retention of rodex reaction concept which is perceived as abstract, difficult and "volatile" by both students and teachers. Graphics advance organizers strategy (GAOS) was most effective in enhancing chemistry students' retention of redox reaction concept, followed by textual advance organizers strategy (TAOS) while the expository presentation approach (EPA) was least effective in enhancing students' retention of redox reaction concept at all levels of the cognitive domain. Gender did not significantly influence the retention ability of structures in redox reaction concept.

RECOMMENDATIONS

From the conclusion, the following recommendations are made:

1. Chemistry teachers and educators should adopt graphics and textual advance organizers strategies and resources in teaching redox reaction and other abstract and difficult concepts in chemistry so as to promote conceptual learning over rote memorization
2. Seminars, conferences and workshops should be organized by education stakeholders to acquaint chemistry teachers with the use of advance organizers strategies to improve the process and product of learning
3. Textbook authors should adopt graphics and textual organizers in presenting materials in their books to support students' organizational process essential for building conceptual networks.

REFERENCES

Atomatofa, R. (2013). Effect of advance organizers on attainment and retention of student's concept of gravity in Nigeria. *International Journal of Research Studies in Educational Technology*. Vol2 no.1, 81-90.

Boujaoude, S. & Barakat, H. (2000). Secondary school students' difficulties with stoichiometry. School Science Review. 81, 91-98.

Cakir, M. (2008). Constructivist approaches to learning in science and their implications for science pedagogy: A literature review. *International Journal of Environmental and Science Education.* Vol.3, No. 4. October 2008. 193-206.

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

Daniel, J.K. (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.lynchbury.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 chantauqua program. Science Education Review. 8(3), 2009, 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/161-160922508.hfml

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.

Francisco, J., Nicoll, G.& Trautmann, M. (1998). Intergrating multiple teaching methods into general chemistry classroom. *Journal of Chemistry Education* 75, 201-213

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

Heron, C.A. (1994). An investigation of the effectiveness of using an advance organizer to introduce video in a foriegh language classroom. *The Modern Language Journal*. 78(2), 12-17.

Hofstein, A.& Lunetta, V.N. (2003). The laboratory in cience education: Foundations for the twenty-first century. *Journal of Science Education*. 88(1). 28-54. 2003. Wiley periodicals

Lin, H.& Cheng, T. (2006). Decreasing cognitive load for novice EFL learners: Effects of question and descriptive advance organizers in facilitating EFL learners' comprehension of animation-based content lesson. *Intentional Journal of Education Technology and Applied Linguistics* 34(3). 416-431.

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.

Mumuni; A.A.O.& Mumuni; 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.

Negrete, A.& Lartigue, C. (2004). Learning from education to communicate science as a good story: A review. Endeavour. Vol. 28. No.3. September 2004, 120-124. Retrieved July 30, 2013 from http://www.sciencedirect.com0160-9327/&doi:10.1061;-endeavour 2004. 07.003.

Novak, J.D. (1990). Concept maps and vee diagrams: Two meta-cognitive tools for science and mathematics education. Institutional Science. 19, 20-52.

Novak, J.D.& Canas, A.J. (2008). The theory underlying concept maps and how to construct and use them. Technical report, Institute for Human And Machine Cognitive. CMap tools, 2006. Retrieved April 21, 2013 from http://cmaps.ihmc.us/publications/researchpapers/theory(map/th.....

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

Obomanu, B.J. & Ekenobi, T.N. (2011). Analysis of learning outcome in chemistry among SSIII students in urban and rural setting: Using concept map techniques. *Journal of Education and Practice,* vol 2, no. 4, 2011 148-154. Retrieved February 15, 2012 from http://www.ijste.org.

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 (102), 79-88.

Oloyede, O.I. (2011). A meta-analysis of effects of the advance organizers on acknowledgment and retention of senior secondary school (SSS) chemistry. *International Journal of Education Science*, 3(2), 129-135.

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

Shihasu, 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/EURASIAV5n4-shihasu-keraro.pdf.

Tsien, Z. (2007). The memory. Scientific American. July, 2007, 52-59.

Udon, M.E. (2006). The chemistry of corrosion of metals: A resource for effective teaching of redox reaction and electrochemistry. *Journal of the Science Teachers Association of Nigeria*. 41(1□2), 44-50

West African Examination Council. (2000-2010). Chief examiner's 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)