Journal of CUDIMAC (J-CUDIMAC)
ISSN 0794-4764 (Print) ISSN 2651-6063 (Online)
Vol 6, No.1 2019

https://cudimac.unn.edu.ng/cudimacjournals/

Effect of Prior Conception, Exploration, Discussion, Dissatisfaction and Application (PEDDA) Constructivist Model on Students' Retention in Chemistry

[*1] Okotcha, E.N. PhD; [2] Okorie, E.U. PhD; [3]Obielumani, J.O. PhD and [4]Eze, P.

[1] Department of Integrated Science Education, Federal College of Education (Technical) Asaba, Delta-State

[2] Department of science education, University of Nigeria Nsukka

[3,4] Department of Chemistry Education, Federal College of Education (Technical), Asaba, Delta-State

E-mail: okotchaevangeline@yahoo.com

Abstract

This study set out to empirically examine students' retention in electrochemistry using prior conception, exploration, discussion, dissatisfaction and application (PEDDA) instructional model and conventional method of instruction, which is widely used in our secondary schools. The study was guided by two research questions and three null hypotheses. The study adopted the quasi-experimental design, specifically the non-equivalent control group design. The study was conducted in Delta State, Nigeria. The population of the study comprised 2340 Senior Secondary school two (SS2) chemistry students. The sample of the study consisted of 148 students. Students were assigned to experimental and control groups in their intact classes. The experimental group was taught using PEDDA constructivist model while the control group was taught using the conventional method of instruction. Both groups were given pretest, posttest and delayed posttest. The instrument used in this study was the Electrochemistry Achievement Test (EAT), validated by five experts in the Department of Science Education, University of Nigeria, Nsukka. It has reliability coefficient of 0.84, obtained using Cronbach's Alpha. MEAN scores and standard deviations were used to answer the research questions while Analysis of Covariance (ANCOVA) were used in testing the hypotheses at 0.05 level of significance. The findings of the study showed that PEDDA instructional model enhanced students' retention in electrochemistry compared to the conventional method of instruction. Also, there was no significant influence of gender on students' retention, it was recommended among others that chemistry teachers should be trained and retrained on how to use PEDDA instructional model in teaching chemistry concepts.

Keywords: Constructivism, Chemistry, Electrochemistry, retention, strategy, understanding

Introduction

The level of scientific attainment of any nation is an important index for measuring its level of development. Every nation craves for scientific and technological advancement, which can be achieved through the medium of education. In the light of this, the Nigerian National Policy on Education (2004) emphasized amongst others that the goal of science education shall be to cultivate inquiry and rational mind for the conduct of a good life. This objective is laudable and can only be achieved if learnt science concepts, for example Chemistry concepts are remembered and put into use. Chemistry is one of such science subjects offered at the senior secondary school level in Nigeria.

Credit level pass in Chemistry at the ordinary level certificate examination is a prerequisite for subsequent specialist studies in science-related courses such as medicine, engineering, and nursing. Advancements in the field of chemistry have brought about major improvements in our world.

Chemistry has continued to play an interesting important role in the lives of all mankind. One of such concepts in chemistry is electrochemistry.

Electrochemistry is a concept in chemistry concerned with the relationship between electricity and chemical changes. It deals with chemical reactions that produce electricity and with the application of electricity to produce chemical changes (Brown & Lemary 2009). Electrochemistry therefore studies the relationship between matter and electric current. Electrochemical reactions are very important to man due to its wide applications in the production industries. Chuku as cited in Echekwube (2010) explained that it is applied extensively in welding, steel industry, metal extraction and purification, hospital and ceramics industries. The most important deterioration of iron due to electrochemical process is rusting, this leads to enormous damages to buildings, bridges and cars. The knowledge got by learning electrochemistry can be used in preventing corrosion of metals and improving techniques in refining metals with electrolysis (Echekwube, 2010). In fact, the lace and importance of electrochemistry and chemistry generally cannot be over emphasized as exemplified by its aforementioned application and uses.

Considering the indispensability of chemistry in technological development, one would expect a better performance of students in the subject. Surprisingly the performance of students in chemistry is dwindling (Eze, 2015; Umudi, 2011; Udo, 2008). Could it be that the teachers are not using the right teaching method that will arouse inquiry, curiosity and hence, retention of what was learnt by students? According to Ausubel (1968), retention is the process of maintaining the availability of a replica of the acquired new meaning. The author further suggested that the amount of the original meaning that will be retained at any point in time is a variable of the quantity or quality at hand and that retention may be difficult if the material presented cannot be related to the existing cognitive structure. The author defined cognitive structure of the individual as all the information that the individual has about any particular area of experience. The author further opined that when students study new materials presented, relate the new information to what they already know and organize it into more complete cognitive structure, they are engaged in meaningful learning that enhances retention. Gagne as cited in Madu (2004) noted that the type of material included in the learning programme, structured in a carefully formed sequence and presented to the learners using good instructional strategy is quite resistant to forgetting. Hence, retention is a crucial construct worth exploring.

The teacher's method of instruction in the teaching/learning process affects the retention of the learnt concept. Several research reports (Ogbonna¸ 2013; Olodu, 2012; Obiekwe, 2008) indicate that many chemistry teachers prefer the conventional method of teaching which is teacher oriented and shy away from innovative activity-oriented teaching methods, which are constructivist in nature. A constructivist approach suggests that learners construct knowledge through real life experiences as a cognitive activity rather than simply learning from abstract concepts. Nwosu (2010) asserted that constructivist approach to learning is inclusive, interactive and expresses the dynamic conception of human learning. The piece of knowledge constructed by the learner can be said to be retained in the memory. One of such constructivist approaches to learning is the determination of Prior knowledge, Exploration of the phenomenon, Discussion of the experiment, Development of dissatisfaction with prior conception and Application (PEDDA) model developed by Nworgu (1996) based on adaptations from Stofflet and Stoddarts (1994). The acronym PEDDA was derived from

the initial letters of the processes involved. PEDDA emphasizes dissatisfaction with prior knowledge which allows the learner to go back to the exploration stage until learning becomes plausible and fruitful, hence the use of PEDDA in this study.

The ability to remember learnt concepts by male and female gender differs and it is a factor of the instructional technique used (Iwuozor, 2013). It is evident that another variable that can affect retention of a concept is gender. There is need therefore to investigate the effectiveness of PEDDA instructional model in bringing about retention in electrochemistry as well as the influence of gender on students' retention.

Statement of the Problem

Retention of learned concepts is strongly tied to instructional method. Effective teaching helps the learners to learn effectively and retain what was learnt, while poor teaching will lead to poor learning, poor understanding of concepts and hence poor achievement. This leads to hindrance in the realization of the national goals of science education that demands male and female students' to acquire practical knowledge and skills for societal development, thereby living a good and fulfilled life. Studies indicate that students have difficulties in understanding electrochemistry which can be attributed to the teacher's method of teaching. The retention of the knowledge got by understanding this concept can be used in tackling societal problem of rusting, metal extraction and purification amongst others. Hence, there is need to investigate the effect of PEDDA instructional model on students' retention in electrochemistry as well as the influence of gender on students' retention.

Research Questions: The following research questions guided the study.

1. What are the effects of PEDDA instructional model and conventional method of instruction on students' retention in electrochemistry?
2. What is the influence of gender on students' retention in electrochemistry?

Hypotheses

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

Ho_1: There is no significant difference in the mean retention scores of students taught electrochemistry with PEDDA instructional model and those taught with conventional method of instruction.

Ho_2: There is no significant difference in the mean retention scores of male and female students.

$H0_3$: There is no significant interaction effect of strategy and gender on the mean retention scores of students in electrochemistry.

Methodology

The study adopted the quasi-experimental design. Specifically, the pre-test post-test non-equivalent control group design. The population of this study comprised of all the senior secondary school year two (SS2) chemistry students in all the co-educational secondary schools located in three Senatorial Districts of Delta State. The sample of the study consists of 148 students (93 males and 55 females). The instrument used for data collection was the electrochemistry achievement test (EAT) developed

by the researcher. Table of specification was used in preparing the test. The electrochemistry achievement test (EAT) consisted of thirty (30) test items. The EAT was face-validated by five experts in the Department of Science Education, University of Nigeria, Nsukka. The reliability of the instrument was determined by administering the instrument to 40 SS2 chemistry students in a school outside the study area but shares the same characteristics with the students used for the study. The data obtained from the student's scores were used to measure the co-efficient of stability of the EAT using test-retest reliability method. The scores awarded were correlated using Pearson co-efficient of correlation (r, 0.84). The subjects were randomly assigned to two groups, the experimental group that was taught using PEDDA instructional model and control group that was taught using the conventional method of instruction. The EAT was administered to the subjects prior to the commencement of the experiment. After the treatment, the posttest was administered followed by the delayed posttest after an interval of two weeks. Mean and standard deviation were used in answering the research questions while analysis of covariance (ANCOVA) was used in testing the hypotheses at 0.05 level of significance.

Research Question 1:

What is the effect of PEDDA instructional model and conventional method of instruction on the mean retention score of students' in electrochemistry?

Table 1

Mean and Standard Deviation of pretest, posttest and retention scores after exposure to PEDDA instructional model and conventional method of instruction

		Pretest		Posttest			Retention		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mea Gain**	$\bar{x}$	**SD**	**Mean Gain**
PEDDA	81	18.01	9.50	40.35	13.99	22.34	47.27	12.43	6.92
Conventional	67	13.63	12.63	32.18	12.23	18.55	34.87	15.81	2.69

Results on Table 1 show that for each of the groups, the retention mean scores were greater than the posttest means scores with the group taught electrochemistry using PEDDA instructional model having a higher mean gain (6.92 > 2.69) This is an indication that PEDDA instructional approach improved students' retention in electrochemistry than the conventional method.

Hypothesis 1

Ho_1: There is no significant difference in the mean retention score of students taught electrochemistry using PEDDA and conventional method of instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies, gender and their interactions on students' retention

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	11189.340[a]	4	2797.335	17.142	.000	
Intercept	10433.280	1	10433.280	63.934	.000	
Posttest	5306.872	1	5306.872	32.520	.000	
Strategies	2020.001	1	2020.001	12.378	.001	S
Gender	115.778	1	115.778	.709	.401	NS
Strategies * Gender	220.647	1	220.647	1.352	.247	NS
Error	23336.085	143	163.189			
Total	291331.000	148				
Corrected Total	34525.426	147				

The result on Table 2 shows that with respect to mean retention score of students taught electrochemistry using PEDDA and conventional method of instruction, an F-ratio of 12.378 was obtained with associated probability value of 0.00. Since the associated probability value of 0.00 is less than 0.05 set as bench mark, the null hypothesis (H_{01}) which stated that there is no significant difference in the mean retention score of students taught electrochemistry using PEDDA and conventional method of instruction was rejected. Inference drawn therefore is that, there is a significant difference in the mean retention score of students taught electrochemistry using PEDDA and conventional method of instruction.

Research Question 2: What is the influence of gender on students' retention in electrochemistry?

Results on Table 3 show the influence of gender on mean retention score of students' in electrochemistry using PEDDA instructional model and conventional method. In all cases, the retention mean scores are greater than the posttest means scores with the female students having the highest mean gain in all the two instructional methods.

Table 3: **Mean and Standard Deviation of male and female students' posttest and retention scores of PEDDA instructional model and Conventional method of instruction**

			Posttest		**Retention**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
PEDDA	Male	51	41.55	15.59	48.08	14.08	6.53
	Female	30	38.30	10.69	45.90	9.02	7.60
Conventional	Male	42	33.24	13.23	33.71	16.33	0.47
	Female	25	30.40	10.34	36.80	15.12	6.40

Hypothesis 2

Ho_2: There is no significant difference in the mean retention scores of male and female students.

The result on Table 2 shows that with respect to mean retention scores of male and female students taught electrochemistry using PEDDA model and conventional method, an F-ratio of 0.709 was obtained with associated probability value of 0.401. Since the associated probability value of

0.401 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) which stated that there is no significant difference in the mean retention scores of male and female students taught electrochemistry using PEDDA instructional model and conventional method was upheld.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on the mean retention scores of students taught electrochemistry.

The result on Table 2 shows that with respect to the interaction effect of the instructional strategies and gender on the mean retention scores of students taught electrochemistry, an F-ratio of 1.352 was obtained with associated probability value of 0.247. Since the associated probability value of 0.247 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) which stated that there is no significant interaction effect of the instructional strategies and gender on the mean retention scores of students taught electrochemistry was upheld.

Discussions of Findings

The result of the study as presented on Table 1 shows the retention mean scores and standard deviation of students taught electrochemistry using PEDDA Instructional model and the group taught electrochemistry using conventional approach. The findings of the study shows that for each of the groups, the retention mean scores were greater than the posttest mean scores with the group taught electrochemistry using PEDDA instructional approach having a higher mean gain (6.92>2.69). A smaller standard deviation of (12.43) shown by the PEDDA group after the retention test compared to the conventional group (15.81) shows that the students in the PEDDA group retained the concept more. The result from the test of hypothesis one also shows that there was a significant difference in the mean retention score of students taught electrochemistry using PEDDA and conventional method of instruction. This is an indication that PEDDA instructional model improved students' retention in electrochemistry than the conventional method. In other words, PEDDA instructional approach proved to be more effective. The findings of the study is in agreement with Madu (2004) who investigated the effects of constructivist based instructional model, PEDDA, on students' conceptual change and retention in physics and found that PEDDA instructional model enhanced retention of physics concepts than the conventional method. The findings of the study is also consistent with the study carried out by Agomuoh (2010) on the effect of PEDDA and the learning cycle (TLC) constructivist instructional models on students' conceptual change and retention in another concept in physics and found that PEDDA facilitated retention in physics than the learning cycle. In the same vein, Ukwueze (2012) investigated the effect of PEDDA constructivist instructional model on secondary school students' achievement in biology and found among other things that the experimental group that was taught with PEDDA performed better than the control group that was taught using the traditional method. The result of the study therefore shows that PEDDA enhanced students' retention in electrochemistry than the conventional method.

This implies that the constructivist instructional approach used in teaching students electrochemistry led to significant increase in the retention of knowledge. In PEDDA group, students were actively involved in hands-on activities. Students active participation against what was

obtained in the conventional method accounted for the tested significance. This agrees with Piaget, Brunner Dewey and Ausubel's view of learning who maintained that for meaningful learning to take place, students must relate new knowledge to what they already know, constructing knowledge in their own mind and this gave them the opportunity to investigate ideas themselves. The PEDDA instructional approach being activity- oriented enabled students to retain what they have learnt. Hence, the retentive effect of PEDDA instructional approach was because students carried out the activities by themselves at the exploration stage. This led to meaningful learning as against rote learning.

The result of the study as presented in Table 3 shows that in all cases, the retention mean scores were greater than the posttest means scores with the female students having a higher mean gain when taught using PEDDA instructional model. The result from the test of hypothesis 2 however shows that there was no significant difference ($p>0.05$) in the mean retention scores of male and female students. This means gender is not a significant factor in determining students' retention in electrochemistry. This result agrees with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement and retention of male and female students. The insignificant difference in the mean retention scores of male and female students taught electrochemistry using PEDDA instructional model may be due to the fact that the treatments male and female students received gave them equal opportunities. Hence, the strategy is gender friendly.

PEDDA model ultimately helped male and female students to have sound theoretical and practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems. The result in table 2 also revealed that there was no significant interaction effect of strategies and gender on students' mean retention scores in electrochemistry. This means that the PEDDA instructional model did not combine with gender to affect students' retention.

Conclusion

On the basis of the findings of this study, the following conclusions were made:

1. PEDDA instructional model improved students' retention in electrochemistry.
2. There was no significant difference in the retention of male and female students taught electrochemistry with PEDDA instructional model
3. The interaction effect of strategies and gender on retention of students taught electrochemistry was not statistically significant.

Recommendations

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

1. Chemistry teachers should be trained and retrained on how to use PEDDA instructional model in teaching chemistry concepts.
2. PEDDA instructional approach should be used in teaching.
3. Curriculum planners should include PEDDA instructional approach as one of the strategies for teaching chemistry in secondary schools in Nigeria.

References

Agomuoh, P. C. (2010). Effects of prior knowledge, exploration, discussion, Dissatisfaction with prior knowledge and Application (PEDDA) and the Learning cycle (TLC) constructivist instructional models on students' conceptual change and retention in physics. *Unpublished Ph.D thesis*, University of Nigeria Nsukka.

Ausubel, D. P. (1968). *Educational psychology*. A cognitive view. New York: Holt Rinehman & Winston.

Brown, P. L & Lemary, S. K (2009). Examining the learning cycle: *Science and children 44*(5) 58-59.

Echekwube, H. O. (2009). Diagnosis of senior secondary school students learning difficulties in electrochemistry. *Unpublished M.Sc (ed) Thesis*, University of Nigeria, Nsukka.

Eze, S. N (2015). Education of Science and mathematics textbooks: The rating scale approach. *Unpublished M.ed Thesis*, Nnamdi Azikiwe University of Science and Technology, Awka.

Iwuozor, E. (2013). Revisiting the difficult concepts in chemistry. *A paper presented at the chemical society of Nigeria (CSN)*, Asaba chapter on the 4th of June, 2013.

Madu, B. C. (2004). Effects of constructivist based instructional model on students' conceptual change and retention in physics. *Unpublished doctorate degree thesis*, university of Nigeria Nsukka.

Miriogu, C. A. (2012). Effect of framing instructional strategy on students' achievement and retention in mole concept. *Unpublished doctorate degree thesis*. University of Nigeria, Nsukka.

Nworgu, B. G. (1996). *Teaching for conceptual understanding in physics: A conceptual change instructional model*. A lead paper presented at the 37th Annual Conference of *Science Teachers Association of Nigeria (*STAN) held at Uyo.

Nworgu, B. G. (2006). *Educational research: Basic Issues and methodology*. Enugu: University trust Publishers.

Nwosu, A. A. (2010). Breaking gender barriers in STME-The role of the science teacher. *Journal of Science Teachers Association Nigeria. 45* (1) 46-58.

Obiekwe, C. L. (2008). Effects of constructivist instructional approach on students' achievement and interest in basic ecological concepts in biology. *Unpublished M.Sc. Thesis*, University of Nigeria, Nsukka.

Ogbonna, C. C. (2013). Effect of constructivist instructional approach of senior secondary school achievement and interest in mathematics. *Unpublished Ph.D. Thesis*, University of Nigeria, Nsukka.

Olodu, G. (2012). Effects of computer assisted instruction package on interest and achievement of senior secondary school biology students. *Unpublished M.Sc(Ed) Thesis.* Nnamdi Azikiwe University, Awka.

Robert, E. S. (2009). *Educational psychology: Theory and practice*. New Jersey: Pearson Education, Inc.

Stofflett, R. T. & Stoddart, T. (1994). The ability to understand and use conceptual change pedagogy as a function of prior content learning experience. *Journal of Research in Science Teaching*, *31*(1) 31-51.

Udo, N. (2008). Effect of advanced organization on students achievement and relation in senior secondary school physics. *Unpublished M.Sc (Ed) Thesis*, University of Nigeria, Nsukka.

Ukwueze, N. T. (2012). Effect of PEDDA constructivist instructional model on secondary school students' achievement and retention in biology in Enugu State. *Unpublished M.Ed Thesis*, University of Nigeria, Nsukka.

Umudi, E. D. (2011). *Chemistry education for entrepreneurship and sustainable development in Nigeria.* Abraka: University Printing Press.