Review of Education – [Special Edition] Volume 37, Issue 4 [2025}: 249-255
https://reviewofeducation.unn.edu.ng/ | ISSN: 978-2585-10-6 [PRINT]

TEACHING ELECTROCHEMISTRY USING PROBLEM-BASED LEARNING METHOD FOR BETTER RETENTION: A PANACEA FOR NATIONAL TRANSFORMATION

Ifeoma Onyi, Anthonia Ebere Onah & Eunice Chukwunworgo
Department of Science Education, University of Nigeria Nsukka

Abstract
Electrochemistry is a great enterprise which is indispensable for national transformation. This paper examined the teaching of electrochemistry in Enugu Education Zone of Enugu state using Problem based learning (PBL) method: A panacea for national transformation. One research question and one hypothesis guided the study. Quasi-experimental research design was used for the study. The population of the study was 2042 SSII science students in 32 government-owned secondary schools in the zone. The sample size was 215 SSII science students from four co-educational schools using purposive sampling technique. Data were collected with Electrochemistry Achievement Test (EAT). The instruments were face and content validated by three experts in Science Education Department, University of Nigeria Nsukka. The reliability index was found to be 0.96. Descriptive statistics (mean and standard deviation) were used to answer the research question while Analysis of Covariance (ANCOVA) was used to test the hypothesis at $p < 0.05$ level of significance. The result of the study revealed that PBL method improved students' retention in electrochemistry better than the conventional method. The researchers recommended that both teachers and students should be exposed to PBL method through workshops and seminars. among others. Teachers should use PBL method effectively in the classroom to make learning less abstract, reduces forgetting, aids retention and transformation.

Keywords: National transformation, electrochemistry, method, problem-based learning

Introduction

Education is the bedrock of national transformation. National transformation is a fundamental change in the building block of a nation, change in the social and economic, infrastructural and political settings of a nation (Peterside, 2012). National transformation must be seen and felt in every aspect of a nation including its educational system. In the quest for national transformation, the values that are projected in our classroom cannot be overlooked. Our educational institutions ought to have meritocracy (competence) as an entrenched value in its makeup not certification as the leading value. Secondary education will be transformative when; it enhances material wealth, it is used to solve societal problems, and the entrepreneurial aspect of the subject is demonstrated to concretize the students' experiences. There is need for economic and social development in the nation. Adequate knowledge and advanced skills are needed for national transformation. Our educational system cannot be transformative without adequate knowledge and advanced skills in the Chemistry.

Chemistry is the study of matter and its transformation. Chemistry is a physical science that focuses on the study of substances (elements and compounds), their properties, behavior, structures and applications (Onissiphorou, 2022). Chemistry is the fulcrum on which all other Science and Technology disciplines and careers are hinged for national development (Njoku & Ezinwa, 2014). According to the Federal Republic of Nigeria (FRN, 2013) Chemistry is crucial for effective living in this modern age of science

and technology. Chemistry education has utilization value in developing, understanding and appreciating nature, critical thinking and logical reasoning, and potential to sustain students' interest in the formal school systems. The Chemistry concept to be addressed in this study is electrochemistry.Electrochemistry is a great enterprise which nations depends on in order to advance technologically. Electrochemistry is a branch of Chemistry that studies the relationship between electron transfer and electrical currents generated during the processes (Freemantle, 2000). Considering its applications in the society and industry, the students need to be given enough time to explore and engage actively in the learning of electrochemistry. Electrochemistry has been identified as one of the difficult concepts in chemistry (Chief Examiners' report, West African Senior Secondary Certificate Examinations (WASSCE) (2013-2023).The implication of students failing in electrochemistry is that the national pace of economic development will continue to be retarded by very low electrical energy generation. Hence, there is need to find ways of helping secondary school students learn and retain electrochemistry concepts more effectively and fruitfully. Students' retention in electrochemistry may be predicted by several factors such as method of teaching, gender, peer group etc.

Methods of teaching are systematic procedures designed to shape the learning environment in an attempt to attain the selected learning goals and objectives. Methods of teaching may be learner centered or teacher centered (Oyelekan, et. al, 2016). The teacher centered (conventional) method include demonstration (Okeke & Ikokwu, 2017) and lecture method (Akpoghol, et. al, 2016). It is stereotyped, encourages rote memorization and is still prevalent at this level. It enables large course content to be covered within a limited time (Ezeudu,2011). The learner centered method include Co-operative learning (Ene, 2015 and Ibe,2016); Collaborative learning (Ogbonne & Offorma,2013); Peer tutoring (Igboanugo, 2013; Njoku & Ezinwa, 2014); Problem solving (Akpoghol, Samba & Asemave, 2013 and Onyi, 2014) Problem based learning (Olo, et al 2015; Ayalew,2016; Onyi, 2021) and Science technology society (Igboanugo,2018). The learner -centered method makes students active participants during chemistry instruction. It helps students to meet multiple learning goals and break the phobia of learning a difficult concept.

There is need to transform Chemistry teaching and learning with active learning teaching method in order to make it learner centered and activity-based. The situation is disturbing and calls for a paradigm shift in the method of instruction to enable the learner to be knowledge based. With the onset of the knowledge-based era, Chemistry education has become more complex, challenging and competitive. Students need critical thinking, creativity problem-solving and socialization skill in order to thrive in todays' society. However, most younger students don't learn now without concrete effort through well planned activities. Thus, there is need to assist and motivate these younger students through well planned activities to do self-directed learning for them to delve deeper into key concepts. Researches by Festus and Ekpete (2012), Olo, et.al, (2015) and Ayalew (2016) has shown that PBL method is helpful in leading students into deep understanding of science concepts through its various activities. It is therefore imperative to determine the effect of Problem based learning (PBL) method on student 'retention in electrochemistry.

Problem based learning (PBL) method involves students' active engagement and social learning. PBL is an instructional approach where ill structured problems serve as the context and the stimulus for students to learn course concepts and metacognitive skills. The students are required to identify what they need to acquire and apply in order to solve the problems. PBL is an instructional approach in which students learn through solving

problems and take greater responsibility of their own learning (Mauffette, Kandibinder & Soucisse, 2012). PBL enables learners develop a wide range of soft skills (research skills, negotiation, teaming, reading, writing, oral communication) and higher order thinking skills (critical thinking, creative thinking and problem-solving skills) to solve an identified problem. It offers learners greater learning opportunities to explore and manipulate materials. The greater the manipulation, the deeper the understanding of the learnt material and the more likely you are to retain information. PBL involves knowledge construction and self-recitation which enhances retention. Retention is the ability to retain and consequently remember items or things learnt or experienced by an individual at a later time. According to Orji, Ezema and Ike (2017) retention is the process of maintaining the availability of a replica of the acquired new meaning or some part of them. Retention of learning is the repeat performance of knowledge or behavior earlier acquired, which is elicited by a learner after an interval of time. Retention is affected by degree of reinforcement, the method of learning and the learners' memory capacity among others. Chemistry students fail to retain what is taught to them due to overloading of students working memory (Anike, et al, 2013; O'Dwyer & Child, 2010), abstractness of the concept especially electrochemistry (Ezeudu, 2013) as well as reduced brain activation region (Scholastic, 2009).

The study theoretically is anchored on Bruners' (1960) and Deweys' (1960) constructivist theory. Bruner sees the acquisition of knowledge as an active process and learners actively construct their knowledge. Students should learn through their own active involvement, infer to have understandings that give them competence in problem-solving situations. PBL method involves the presentation of a challenging problem to the learner. Deweys' progressivism (1960) noted that learning should be through problem solving rather than inculcation of knowledge. Deweys believe that experience occurs best in problematic situation ie when learners are given opportunity to interact and learn through interaction as well as the freedom to find solution to the problem. Thus, PBL method enables the students to acquire basic theoretical and practical knowledge and skills for a better retention in Chemistry. The purpose of the study is to determine the effect of PBL method and conventional method on students' retention in electrochemistry. One research question was formulated to guide the study thus: What is the effect of PBL method and conventional method on mean retention scores of students' in electrochemistry? One null hypothesis was formulated at 0.05% alpha level to guide the study thus: There is no significant difference in the mean retention scores of students taught electrochemistry using PBL method and those taught using conventional method.

Methods

The study employed quasi-experimental research design. Quasi-experimental research design is a design modified to allow for the investigation of additional independent variables (Frankel, Wallen & Hyun, 2015). The participants of the study are all the senior secondary II (SSII) science students from Enugu Education Zone in Enugu State. The population of the study was 2042 SSII science students. The sample size for this study was 215 SSII science (chemistry) students. Purposive sampling technique was used to select four schools out of the 32-government-owned secondary schools in the zone. Two schools were assigned to experimental group and control group respectively. In each school one intact class was drawn and used for the study. Data were collected using 20-item short structured questions titled Electrochemistry Achievement Test (EAT). The instrument (EAT) was validated by three experts two from Chemistry unit and one from

Measurement and Evaluation unit all from Department of Science Education University of Nigeria Nsukka. Kuder Richardson's formula (K-R_{21}) was used to determine the consistency of the items in the instrument using twenty students from another zone whowere trial tested. A reliability index of 0.96 was obtained. Descriptive statistics (mean and standard deviation) were used to answer the research question while Analysis of Covariance (ANCOVA) was used to test the hypotheses at $P < 0.05$ level of significance. Chemistry teachers from the sampled schools were trained for one week as research assistants for the study. Pretest, post-test and retention test were administered.

Results

Table 1: Mean and Standard Deviation of Post-test Scores and Retention Scores of students taught Electrochemistry using PBL and Conventional method

Variable Group	n	Post-test $\bar{x}$	SD	Retention $\bar{x}$	SD	Mean gain Score
PBL	110	60.75	7.35	62.36	7.89	1.61
CM	105	58.38	6.38	59.05	6.75	0.67

Table 1 shows that the experimental group had a post-test mean score of (M=60.75, SD=7.35) and a retention mean score of (M=62.36, SD=7.89) with a mean gain score of 1.61. The Table also indicated that the control group obtained a mean post-test mean score of (M=58.38, SD=6.38) and retention mean score of (M=59.05, SD=6.75) with a mean gain score of 0.67. This indicated that the experimental group retained more than the control group. This shows that the treatment was effective to a reasonable extent.

HO_1: There is no significant difference in the retention mean score of students taught electrochemistry using PBL and conventional method.

Table2: Analysis of Covariance (ANCOVA) of the Students Retention Scores by Methods taught Electrochemistry using PBL and Conventional method

Source	Type 111 sum of squares	DF	Mean square	F	Sig	Remark
CorrectedModes	2083.684	4	520.921	8.198	.000	
Intercept	1219.842	1	1219.842	112.941	.004	
Posttest	2165.516	1	2165.516	168.194	.000	
Modes	222.060	1	222.060	16.024	.005	S
Error	167.817	210	121.092			
Total	796041.000	215				
Corrected Total	15426.930	214				

Result in Table 2 indicate that the F-value under methods F= 16.024, p = 0.005. Since the p value of 0.005 was less than 0.05 set as level of significance the null hypothesis (HO_1) the null was rejected. Thus, the inference drawn is that there was a significant difference in the retention scores of students taught electrochemistry using PBL and conventional method This shows that the teaching methods enhanced students' retention in electrochemistry with PBL having more positive effect on students' retention than the conventional method.

Discussion

The findings of the study showed that the students taught electrochemistry using PBL instructional approach had an improved retention better than that taught electrochemistry

using conventional method. This is because PBL method is less interdependent making the students not to rely on each other ideas and knowledge thereby offering learners greater learning opportunities to explore and manipulate materials during their self-directed study. The greater the manipulation, the deeper the understanding of the learnt material and the more likely you are to retain information. Also, PBL method gave the students opportunity to construct their knowledge personally and integrate the new knowledge in problem solving situations for meaningful learning to occur rather than knowing how to just solve problem in order to pass assignment and examination. Meaningful learning leads to transformation. This also buttress earlier studies by Purdy and Abraham (2002) that retention takes place more effectively when there is interaction between the learner and the material through an appropriate instructional approach. This supports the assertion by Nworgu (2016) who noted that an appropriate method of instruction helps learners to actively construct knowledge and acquire experiences and understanding which leads to recalling and retention. It also buttresses earlier study that improved instructional strategy which makes students active participants in the learning process enhances retention (Ezeudu, 2013).

Conclusion

Based on the findings of this study, it was established that PBL method improved students' retention in electrochemistry better than conventional method. The study supported the growing pool of evidence that students' retention in electrochemistry depend on the method of teaching.

Recommendations

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

1. Chemistry teachers should adopt PBL method because it makes learning less abstract, reduces forgetting and aids retention of knowledge.
2. State Government in collaboration with State Ministry of Education should organize and sponsor regular training workshops, conferences and seminars to train both in-service and new entrants on the need to promote students' retention through the use of PBL method.

REFERENCES

Akpoghol, T., V. Ezeudu, F. O. Adzape, J. N.& Ofor, E. E. (2016). Effects of lecture method supplement with music and computer animation on senior secondary school students' academic achievement in electrochemistry. *Journal of Education and Practice,*7 (4), 75-86.

Akpoghol, T., Samba, R. M., O. & Asemave, K. (2013). Effects of problem-solving strategy on students' achievement and retention in secondary school chemistry in Makurdi Metropolis. *Journal of Curriculum & Teaching*, 7 (1), 529-57.

Anike, M. A., Chris, H.D., Peter, K., Ivan, T. & Floris, P. D. (2013). Shared representation for working memory and mental imaginary in early visual cortex. *Current Biology*, 23(15), 1427-1432.

Ayalew, T. E. (2016). The impact of problem-based learning integrated with co-operative learning on students' achievement and attitudes in organic chemistry. *(An unpublished Ph.D. thesis). University of South Africa.*

Brunner, J. S. (1966). *Towards a theory of instruction.* Cambridge, Mass: Belkapp press

Dewey, J. (1960). *Experience and Education. The Kappa Delta Piseries*. London: Colleer Macmillan

Ene, C. C. (2015). Effect of co-operative learning strategy on students' achievement, interest and acquisition of science process skills in Chemistry practical activities. (*Unpublished M.ed Thesis*) *Department of Science Education, University of Nigeria Nsukka*.

Ezeudu, F. O. (2011). Nigeria at 50. The way forward for enhancing chemistry teachers' quality to meet the challenges of 2020 and beyond *International Journal of Educational Research (INJER*).11(1), 84-95.

Ezeudu, F. O. (2013). Influence of Concept maps on achievement and retention of senior secondary school students in Organic chemistry. *Journal of Education and Practice* 4(19),35-43.

Federal Republic of Nigeria (2013). *National policy on education* 6th ed. Lagos; NERDEC

Festus, C. & Ekpete, O. A. (2012). Improving students' performance and attitude towards chemistry through problem-based problem-solving techniques. *International Journal of Academic Research in Progressive Education and Development* 1(1),167-174.

Frankel J. R., Wallen, N. E. & Hyun, N. N., (2015). *How to design and evaluate research in education* (7th ed.). New York Routledge.

Freemantle, M. (2000). *Chemistry in Action (*2nd ed.). London: Thomson Learning.

Ibe, E. (2016). Effects of co-operative learning on students' achievement in science and their perception of their psychosocial learning environment. *Journal of Science Teachers Association of Nigeria JSTAN 51(1),19-40.*

Igboanugo, B. L. (2018). Effects of Science Technology Society instructional approach with teacher experience, gender and school location on students' achievement and interest in chemistry. *(Unpublished Ph.D Thesis).Department of Science Education, University of Nigeria Nsukka.*

Mauffette Y. Kandbinder P. & Soucisse, A. (2012). The problem in problem-based learning is to motivatestudents.RetrievedonJune25,2012from*http.//www.openupusa.com/openup/chapters10335215440.pdf*

Njoku, Z. C. & Ezinwa, U. S. (2014). Comparative effect of peer teaching and lecture method on students' achievement and interest in some difficult concepts in chemistry. *Journal of the Science Teachers Association of Nigeria.49(1),60-71.*

Nworgu, B. G. (2016). *Averting pedagogical failure in science: Insight from Educational Measurement and Evaluation.*103rd Inaugral Lecture of University of Nigeria Nsukka.Feb.25,2016.

O'Dweyer, A. & Childs, P. (2010). Second level Irish Pupils' and teachers view of difficulties in Organic chemistry. *Journal of Science and Technology Education.19(21), 1-2.*

Ogbonne, U. T.& Offorma, G. C. (2013). Effect of collaborative learning method on secondary students' interest in English. *International Journal of Educational Research,*13(1), 423-430.

Okeke, S. O. C. & Ikokwu, P. I. (2017). The effect of concept mapping and simulation play method on students' interest in organic chemistry. *Journal of Science Education, School of Science Nwafor Orizu College of Education Nsugbe,Anambra State.13(1),290-296.*

Olo, E. Abonyi, O. S., Okafor, G. & Omebe, C. (2015). .Effect of problem-based learning approach on junior secondary school students' achievement in algebra. *Journal of Science Teachers Association of Nigeria.50(1),57-68.*

Onissiphoronu, K. (2022). 10 Basic concepts of chemistry. https://www.chemicals.co.uk/blog/10-basic-concepts-of-chemistry.

Onyi, I. E. (2014). Effect of Problem-solving instructional approach on students' achievement and interest in some chemistry concepts. *Unpublished M.Ed, Thesis .Department of Science Education ,University of Nigeria Nsukka.*

Onyi, I. E. (2021). Two modes of constructivist instructional approach on students' academic achievement, retention and interest in electrochemistry. *Unpublished Ph. D, Thesis Department of Science Education, University of Nigeria Nsukka.*

Orji, E. I., Ezema, M. J. & Ike, P. N. (2017). Effect of instructional teaching technique on students' achievement and retention in senior secondary school physics. *African Journal of Science, Technology and Mathematics Education.*3(1),106-113.

.Oyelekan, S. O., Ayodele, A. S., Eze, P. N.& Obielumani, J. O. (2016). *Hand book on core subject teachers training programme.* Awka: Anambra state press.

Peterside, D. (2012). *National transformation: The youth link.* A paper presented at National Youth Economic Summit (NYES), 30th Nov. 2012.

Purdy, J. E. & Abraham, M. R. (2000). Immediate and long-term retention for pictorial and verbal stimuli perceptual and motor skills. *Journal of Theory of Research and Development* 26(4),230-241.

Scholarstic, J. D. (2009).*25 Quiz formative assessment for a differentiated classroom*. Bensenville: Scholarstic testing service.

West African Examination Council (WAEC) 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 & 2023. *Chief Examiners Reports for May/June Senior Certificate Examination:* Yaba, Lagos: Amao press ltd.