Effect of Mnemonic and Teaching of Oxidation and Reduction Reactions to Secondary School Chemistry Students

*Nja, Cecilia O1, Idiege, Kimson Joseph2, Obi J. Joy3

1,2,3Department of Science Education, Faculty of Education, University of Calabar, Calabar, Nigeria

The purpose of the study was to ascertain the effect of teaching with or without Mnemonic on the academic performance of secondary school students in Chemistry in Calabar Education Zone, Cross River State, Nigeria. The sample consisted of 60 students selected by stratified random sampling method. The pretest-posttest control group quasi-experimental research design was adopted in the study. The treatment lasted for a period of four weeks. The data collected with a 60-item multiple choice achievement test instrument were analyzed using independent t test. The results indicated that there was a significant difference in the academic performance of students taught oxidation reduction reactions with and without mnemonic.

Keywords; Mnemonic, Academic performance, Memory, Students Teacher

INTRODUCTION

Chemistry education (chemical education) is a comprehensive term that refers to the study of the teaching and learning of Chemistry in all schools, colleges and universities. Topics in Chemistry education include how students learn Chemistry, how best to teach chemistry, and how to improve learning outcomes by changing teaching methods and appropriate training of Chemistry instructors, within many modes, including classroom lecturers, demonstrations and laboratory activities (Coppola, 2007).

Chemistry education is a systematic process of acquiring the fundamental knowledge about the universe with the indispensable richly acquired knowledge which man can shape and reshape his/her world for their benefit. Chemistry education is the vehicle through which chemical knowledge and skill reach the people who are in need of capacities and potential for development. It also addresses the social objective of sustained development as education is now the primary means for empowerment, participation, cultural preservation, social mobility and equity (Emmanuel, 2013).

Chemistry is the study of matter and energy and the interaction between them. Chemistry is everywhere in the world around you! It is in the food you eat, clothes you wear, water you drink, medicines, air cleaners, you name it (Helmenstine, 2016). Chemistry sometimes is called the “central science” because it connects other sciences to each other such as Biology, Physics, Geology and Environmental Science.

Today, every developed and emerging country needs more scientists to achieve additional scientific and technological developments and to maintain future economic standards of living (EC High Level Group on Science Education, 2007). Other voices emphasize that scientific literacy is needed for all future citizens in order to influence techno-scientific developments in a democratic society for more sustainability (Burmeister, Rauch, and Eikls, 2012) and to enable all citizens to actively and intelligently participate in societal debates concerning any controversial socio-scientific issues (Roth and Lee, 2004).

*Corresponding author: Cecilia Nja, Department of Science Education, Faculty of Education, University of Calabar, Calabar, Nigeria. Email: njacecilia@gmail.com Tel: +2347037958296
On this basis, it is reasonable to assume that all students need a certain level of scientific knowledge and related skills in order to become scientifically literate citizens and, thus, to be able to participate in dialectical socio-scientific discussions, debates, and decision-making processes. This is especially important in our increasingly technological world (Hofstein, Elks, and Bybee, 2011). In addition, this claim supports the idea of making science education more effective and relevant.

In as much as chemistry education and Chemistry is important, Nigerian students have had a persistence low performance in Chemistry examination both in internal and external examinations. Sakiyo and Badau (2015) conducted a research on chemistry performance of students in WASSC that had credit pass and obtained the following results: 44.44%, 43.69%, 50.70%, 49.54%, and 43.13% for 2008, 2009, 2010, 2011 and 2012 respectively. From the above result, it is clear that there is a marginal decline in students’ academic performance in Chemistry. This kind of performance shows that learning chemistry is not fun rather students are running away from it.

Various factors have been attributed to students’ consistent abysmal performance in school science and mathematics subjects especially chemistry at the senior secondary level. Chief among the contributing factors being the approaches used by chemistry teachers which tend to make chemistry concepts to be too abstract and uninteresting to students as well as the general perception of chemistry topics by students. Another being that chemistry is generally perceived difficult to learn by students. Thus most often, students tend to view concepts in chemistry as being too volatile as they often are unable to remember them (Jimoh, 2005) and Jimoh, (2003).

Considering the fact that one of the main problems encountered by students in learning Chemistry is that of inability to organize taught concepts in such a way as to facilitate ease of recall, it is thus felt that one vital means of enhancing learning of chemistry is through a method that would aid students’ memory. This is where mnemonics come in as a "fun not run"; in teaching and learning of chemistry.

WHAT IS A MNEMONIC DEVICE?

The word “mnemonic” derives from the Greek goddess of memory - Mnemosyne, and means “memory enhancing”. Mnemonic ("nee-moh-nick") techniques, also called mnemonic strategies, mnemonic devices or mnemonics, are systematic procedures designed to improve our memory. Hence, mnemonics strategies ought to be understood as systematic procedures for intensification of memory. The main idea of mnemonic strategies is application in developing better ways to encode (take in) information, so that it will be much easier to retrieve (remember). Therefore, mnemonic devices can be attended as learning strategies which can often enhance the learning and later recall of information (Guthrie, 2002, and Mastropieri, 1998). The main task in developing mnemonic strategies is to find a way to connect new information to information students have already locked in long-term memory. If pupils or students make an enough strong connection, the memory will last a very long time, because the mnemonic strategy had carefully linked it to things that will be very familiar according to these procedures can be extraordinarily effective. Moreover, the mnemonic strategies can be incorporated for the elements that require recall, what is both advantage and disadvantage of this method.

The vital role of mnemonics as an effective pedagogical technique had long been established. As an example, Butcher (2000), explains that the mnemonic techniques had long been in use by the ancient Greeks and Romans to improve their memory. Congos (2004), [citing a study by Miller (1967)] asserted that mnemonics increased recall and that students who regularly used mnemonic devices increased test scores by as much as 77% Mastropieri, and Scruggs (1998), inform that mnemonics can be modified to fit a variety of learning content and especially beneficial to students with learning difficulties. Hayden reported of medical students’ use of mnemonics in committing anatomical terminologies to memory. According to Mcalum and Seay psychologists believe that mnemonic techniques are so effective in learning because they impose meaning and structure to material that otherwise would be unstructured or less meaningful. Among others, studies by Wang, Thomas, and Ouellette (1992), Iza, and Gil (1995), Hayden (1995), and Mastropieri, and Scruggs(1998) have justified the positive effects of the usage of mnemonic devices in facilitating learning as well as its effects on students’ abilities to recall learnt facts.

THEORETICAL BASIS OF MNEMONICS AS A TEACHING METHOD

Constructivism is a learning theory and epistemology that has influenced much of science education lately. It states that students construct their knowledge of the world through their past experiences. Students do not learn much just by sitting in class listening to the teacher, memorizing repackaged assignments, and spitting out answers. They must talk what they are learning, write about it, relate it to past experiences, and apply it to their daily lives. They must make what they learn part of their knowledge. Ausubel (1968) strongly asserted that “If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly” (p. vi).

Meaningful learning requires the learner to assimilate new concepts and propositions into existing cognitive structures. Reviews of psychological foundations of learning and memory states: the human memory is not a
single “vessel” to be filled, but rather a complex set of interrelated memory systems… all incoming information is organized and processed in the working memory by interaction with knowledge in long-term memory. The limiting feature here is that working memory can process only a relatively small number of psychological units (five to nine) at any one moment. This means that relationships among two or three concepts are about the limit of working memory’s processing capacity. For example, if a person is presented with a list of 10-12 letters or numbers to memorize in a few seconds, most will recall only 5 to 9 of these. However, if the letters can be grouped to form a known word, or word-like unit, or the numbers can be related to a phone number or something known, then 10 or more letters or numbers can be recalled. In a related test, if we give learners 10-12 familiar but unrelated words to memorize in a few seconds, most will recall only 5-9 words. If the words are unfamiliar, such as technical terms introduced for the first time, the learner may do well to recall correctly two or three of these. Conversely, if the words are familiar and can be related to knowledge the learner has in her/his cognitive structure, e.g., months of the year, 12 or more may be easily recalled (Novak and Cañas, 2008). 

Ausubel (1968) theory of learning and Novak and Canas’ (2002) assertion of the value of using familiar words and concepts to facilitate meaningful learning of bulky facts and as well as to aid ease of recall, implies therefore that mnemonics would serve as that scaffold providing the link between what is already familiar and easy to recall and that which is to be learnt. This no doubt would enhance the utilization of the retention of the knowledge for long periods of time as long as that scaffold can be remembered. Asides being an effective aid to learning and recalling of scientific facts, one other significant advantage of mnemonic devices is that they can be used in a wide array of situations involving learning of large pieces of information, “from behaviour to academics to careers to hobbies” While acknowledging that mnemonics are considered as cognitive strategies, Spackman(2013) lament that the use of mnemonics fell into disuse and are not taught in schools today. They then ascribe ignorance of the techniques being a possible factor responsible for lack of its usage.

RESEARCH METHODOLOGY

The research design was pretest-posttest control group quasi-experimental design. The study was carried out in Calabar Education Zone of Cross River State, Nigeria. The sample consisted of 60 Senior Secondary School II Chemistry students from two schools in one Local Government Area in Calabar Education Zone, selected using the stratified random and purposive sampling methods. There were 30 students each in the experimental and control groups. The experimental groups were taught using Oxidation /Reduction reactions using the following mnemonics:

- LEO says Ger! or Leo the lion, Ger! can be used to represent Loss of electron is oxidation; Gain of electron is reduction.
- Oil Rig: Oxidation is loss; Reduction is gain (of electrons) Cations and anions

Cations are positively (+) charged ions while anions are negatively (−) charged. This can be remembered with the help of the following mnemonics.

- Cats have paws ⇒ Cations are pawsitive.
- Ca+ion: The letter t in cation looks like a + (plus) sign.
- An anion is a negative ion. (Anegativeion ⇒ Anion).
- Cation vs. anion: positive vs. negative

The t in cation looks like a plus sign: “ca+ion”. Cation is positive, anion is negative.

Oxidation vs. reduction: electrochemical cell and electron gain/loss

AN OIL RIG CAT: At the ANode, Oxidation Involves Loss of electrons.
- Reduction Involves Gaining electrons at the CATode.

‘LOAN’- Left Anode Oxidation Negative [on the left on side of the cell reaction (in written form), Oxidation takes place

LEO says GER: “Loss of Electrons, Oxidation; Gain of Electrons, Reduction”.

- The word oxidant and anode, both begins with vowels. Also, both reduction and cathode begin with consonants.
- Fat Cat: electrons flow From Anode To Cathode.

The control group was taught using conventional teaching method without mnemonics. A 60-item five-response option objective test (Chemistry achievement test, CAT) developed by the researchers was used as the pretest and posttest. The CAT items which were drawn to cover all the sub-topics of Oxidation Reduction reactions on a well-planned test blue-print were rearranged with its options in pretest and posttest to have different numbering so as to give a vague impression that the tests were different. The reliability of CAT was estimated to be 0.68. Treatment lasted for a period of four weeks. The first author taught the experimental groups while the normal teachers taught the control groups. The data collected with CAT were analyzed using independent t test.

Findings

Table 1: Independent t test of influence of mnemonics on chemistry students’ academic performance in oxidation reduction reactions

<table>
<thead>
<tr>
<th>Variable: mnemonics</th>
<th>N</th>
<th>X</th>
<th>SD</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>With</td>
<td>30</td>
<td>17.33</td>
<td>1.73</td>
<td>8.26</td>
</tr>
<tr>
<td>Without</td>
<td>30</td>
<td>10.20</td>
<td>4.41</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

p>0.05; df =58; critical t =2.0
DISCUSSION

From the analysis of data obtained, it was revealed that students taught chemistry using mnemonics had a higher mean of 17.33 in oxidation reduction reactions test when compared to their counterparts’ mean of 10.20 taught without mnemonics. The independent t-test value of 8.26 was higher than the critical 2.0 at 0.05 confidence level with 58 degrees of freedom. Therefore, the null hypothesis stating that there is no significant difference in the academic performance of chemistry students when taught with and without mnemonics was rejected.


CONCLUSION AND RECOMMENDATIONS

Findings of this study have shown that Mnemonic is more effective at improving students’ performance in chemistry. The results revealed that Mnemonic Instruction had the higher mean score than the Conventional Teaching method. The study showed the importance and significant role played by instructional materials (mnemonics) on students’ achievement, especially in Chemistry. They have positive influence in achievement in Chemistry.

The reason is that Mnemonic Instruction enables students to remember factual information, answer questions and demonstrate comprehension. It would also provide a visual or verbal prompt for students who may have difficulty retaining information. Also, it influences how learners interpret new information and decide what aspects of that information are relevant and irrelevant. Based on the findings of the study, it has been recommended that teachers should facilitate the use of Mnemonic instructional strategies in schools to enhance positive attitude of students towards chemistry and improve their performance in the subject. They should also include varieties of Mnemonics into their instructional strategies to effectively cater for the diverse abilities of students. Periodic and regular training, seminars and workshops should be organized for teachers to update their knowledge on current and creative ways of making mnemonics at secondary school level. Teacher education programs would in the same vein incorporate the use of mnemonic devices as one of the teaching methods to be taught in chemistry methodology courses. It would also be important to include the use of mnemonic devices as parts of the contents of chemistry teacher retraining programs. Students should be taught on how to produce their own mnemonics.

REFERENCES


Blumenthal, P. (2015). Political inequality (how government works to help the rich and not you. The HuffPost


Emmanuel B. (2013). The place of Nigeria certificate in education chemistry in UBE Basic Science programme .STAN 54th Annual conference proceeding, 177-181


List of chemistry mnemonics. From Wikipedia, the free encyclopedia. edited on 2 June 2017, at 05:1.


Accepted 26 August 2017


Copyright: © 2017 Nja et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are cited.