

EFFECTS OF CONCEPT MAPPING STRATEGY ON SENIOR SECONDARY TWO STUDENTS' ACHIEVEMENT IN REDOX REACTIONS IN JOS NORTH, PLATEAU STATE, NIGERIA

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ABSTRACT

This study investigated the effects of concept mapping strategy on senior secondary two students' achievement in redox reaction in Jos North, plateau State, Nigeria. The study adopted Quasi-experimental design of the non-equivalent control; group design. The population of the study comprised 3088 students for 2022/2023 academic session studying Chemistry as a subject. The Choice of Jos North Local Government Area is as a result of under achievement's of students in WAEC Chemistry Examinations. A sample of 167 consisting of 82 female and 85 male Chemistry students were drawn from two educational public senior secondary school. Purposive sampling technique was used to select two public senior secondary schools that are offering Chemistry at SSII and have similar characteristics. Redox Reaction Achievement Test (RRAT) was used to collect data. The instrument used for data collection was not developed by the researcher, it was adopted from the West African Examination Council past questions and Answers. The test consists of 25 objective items. Mean and SD was used to analyze the collected data to answer the research question. While (ANCOVA) was used to test the null hypothesis at 0.5 level of significance. The findings of the study reveal that there is significant difference in the mean achievement scores of students taught redox reaction using concept mapping strategy and those taught using lecture method in favor of the student taught using concept mapping. It was therefore recommended that Chemistry teachers should be encouraged to use concept mapping in teaching and learning to improve student academic achievement in Redox reaction.

KEYWORDS: Achievement, Gender, Redox Reaction, Concept Mapping

INTRODUCTION

Science education is essential for any nation that wants to maintain its independence, authority, self-reliance, growth and be recognized among civilized nations. This is because science education plays a significant role in the lives of individuals and the development of a country scientifically and technologically (Adeniran, Ochu, & Atoo, 2018). It is largely acknowledged that, the survival of a nation's scientifically and technologically is scientific literacy, which can only be achieved through science education. Science education has been proved to be an indispensable factor in the economic and technological development of any nation and for Nigeria; In Nigeria, Biology, Chemistry and Physics are core science subjects taught at the senior secondary school level

Chemistry is one of the core subjects in science education which deals with the scientific study of the composition, structure, properties and reactions of matter in different forms. The study of Chemistry is important for the national growth and development of any nation. Chemistry is a central science subject because it revolves round the composition and activities of man, (Uchegbu, Oguoma, Elenwoke, & Ogbuagu, 2016). Chemistry is the oracle of modern science. This description and assertion is based on the pivotal role which Chemistry plays in industrial set up (fertilizer, petroleum, cement, and pharmaceutical production), the execution of other professions

(Engineering, Agriculture, Medicine among others) and the improvement of quality of life of the citizenry.

The Chemistry curriculum is organized around four themes: The chemical world, Chemistry and environment, Chemistry and industry and Chemistry and life. Each of the themes has embedded in its different topics of value to the student and the society (Federal Ministry of Education (FME) 2014). The objectives of Chemistry as it is in the revised edition of the senior secondary school Chemistry curriculum includes: acquire basic theoretical and practical knowledge and skills, develop interest in science, technology and mathematics, develop interest in the subject of chemistry, acquire basic STM knowledge and skills, apply skills to meet societal needs of creating employment and wealth, be positioned to take advantage of the numerous career opportunities offered by Chemistry, and be adequately prepared for further studies in Chemistry. Chemistry as a subject and discipline comprises of different topics, concepts such as Redox reactions, theories, laws, facts, hypotheses among others.

A redox reaction is a chemical reaction in which electrons are transferred between two reactants participating in it. This transfer of electrons can be identified by observing the changes in the oxidation states of the reacting species. The term 'redox' is a short form of reduction-oxidation. All the redox reactions can be broken down into two different processes: a reduction process and an oxidation process. The oxidation and reduction reactions always occur simultaneously in redox or oxidation-reduction reactions. The substance getting reduced in a chemical reaction is known as the oxidizing agent, while a substance that is getting oxidized is known as the reducing agent (JEE, 2021). According to the author, different types of redox reactions are; Decomposition Reaction, Combination Reaction, Displacement Reaction, and Disproportionation Reactions. Redox reactions are common and vital to some of the basic functions of life, including photosynthesis, respiration, combustion, and corrosion or rusting, despite all these important of redox reaction to human life, yet students show under achievement in Chemistry (redox reaction)

Achievement is the level of success or performance students attained after test has been administered to them. Andrew and Rebello (2014), academic achievement refers to performance on a task with measures including comprehension, quality and accuracy of answers of tests, quality and accuracy of problem-solving, frequency and quantity of desired outcome, time or rate to solution, time on task, level reasoning and critical thinking, creativity, retention and recall, and transfer of tasks. Student's achievement is an essential factor in quality education. Moreover. Despite all the important contribution of chemistry to national development and technological advancement, academic achievement still remains issues that needs urgent attention, the analysis of students' achievement in chemistry in west African Examination Council (WAEC) from 2018-2021 as adopted from Ukpoh and Samuel (2020), showed that the achievement of students in chemistry in most cases was less than 50% credit pass was recorded which was inconsistent. From the record, it is so glaring that students may have some learning difficulties in the subject. The WASSCE Chief Examiners Annual report for Chemistry (2019 – 2021) identified some factors that could be attributed to the under achievement of students in the WASSCE as; communication skills, inadequate practical exposure, poor quantitative skills, and inability to relate concepts in Chemistry particularly in chemical equilibrium, rates of reaction to everyday life and lack of understanding of some chemistry concepts such as Redox reaction, chemical equilibrium among others. The report further revealed the percentage failure as 57.75%, 55.65%, 60.73% and 63.50% respectively. Closely related to achievement is retention. This is because if knowledge is retained, then it can be recalled when needed. Retention is another variable which can be affected by teaching method that is the students' ability to retain a concept. Retention is the ability of an individual or learner to recall and remember stored information after an interval of time. The prevalent problem in secondary schools is poor retention among secondary school students offering science subjects, and using of teacher-center instructional approach, such as traditional method of teaching among which is lecture method in chemistry classroom and related discipline by some chemistry teachers.

Lecture method is a common instructional method teacher employed in the teaching of chemistry. It is referred to as talk and chalk or textbook method. In the course of using this method, the teacher dominates the class with little or no participation on the part of the learners, and the learner may be passive. In an effort to improve science achievement and retention, there is need to employ the use of instructional strategy that is students' activities based, such as concept mapping instructional strategy among others. Concept maps are tools for organizing and representing knowledge. They are made up of concepts and significant terminologies which are enclosed in different shapes majorly circles and squares. Most learners understand better when a concept is visualized. This concept follows a hierarchical procedure whereby a more complex concept leads to another. This method of teaching and learning is based on the David Ausubel's theory of learning which distinguishes rote learning from meaningful learning. Several steps are involved in making a concept map of a particular concept. The steps involved include identifying a main theme and then brainstorming on all related key words or phrases; organizing the major points and ranking the key words from the most abstract and to the most concrete and specific; clustering concepts that function at similar level of abstraction and those that are closely related; arranging concept on a map, working from the core concept, to major point, to significant details; using arrows, lines, signs and symbols to show the relationship between word or phrase; analyze the concept map by asking one different questions; and finally, revising the map as one knowledge increases. (Kwantlen Polytechnic University, 2014). In the quest to improve science achievement and retention through more effective instructional strategies, there is need to employ the use of instructional strategy that is gender friendly.

Gender is often used to indicate the distinction between human being based on masculinity and femininity in relation to their expected roles in the society. Gender is ascribed to attitude which differentiates feminine from masculine in retention and achievement, gender inequality has caused a lot of concern to educationalists. In this regards, the differences between boys and girls in relation to student's retention and achievement in redox reaction have received a lot of attention in recent years, some studies indicate that boys have higher retention than girls; either no difference or girls have higher retention than boys have been demonstrated. Studies on gender differences in chemistry (redox reaction) retention and achievement continue to yield inconsistent results and it has usually been attributed to unequal exposure of boys and girls to learning instructions relevant to chemistry learning. In this regards, the study will examine approving senior secondary two student's achievement and retention in redox reaction using concept mapping instructional strategy.

STATEMENT OF THE PROBLEM

Redox reaction is a concept in Chemistry that is so simple, yet very easy to fail, it requires precise answering skill. A critical analysis of students' achievement in the WASSCE from 2015 to 2022 another study revealed an average achievement with mean success rate of 46.3% in redox reaction (Sakiyo & Badau, 2015) Nkpordee and Ibinabo (2022). The WAEC chief examiners reports further stated students under achievement particularly in area of redox reaction and this could be attributed to poor exposure of candidates to practical works and the Usage of unconventional symbols of elements such as AL instead of Al; fe instead of Fe, inability to correctly write some organic equations and structures, inability to balance Redox reactions equations, inability to determine the oxidation number or states of reacting species, inadequate understanding of half reaction, poor manipulation skill. Board head of press and public relations, (Fabian, 2018), In interpretations of chemical phenomena such as redox reaction students particularly of senior secondary school two level like to mix substances from the macroscopic level, that is substances that can be seen, touched and smell with particles from the sub-micro level; atoms, ions, molecules etc. Students do this: "one copper two ions take two electrons and are reduced to copper": (instead of to one copper atom"). That is $Cu_2^{+}ion + 2e^{-} \rightarrow Cu \text{ atom}$.

Another difficulty seems to be the historical redox definition with the "oxygen transfer" this idea is so attractive that students argue most with oxygen participation instead of the transfer of

electrons, and students do not see any connection between both levels. On the other hand, it left up to learners to figure out which mental model they may choose concerning the microscopic level. They are building up ideas on their own, mostly wrong ideas. If such problem has not been addressed, it will lead to the shortage of man power in the areas of science discipline, which in turned affect the country's economy and technological development. Therefore, the search for effective Instructional Strategies that can enhance retention and achievement has not yet end. This necessitate the researcher to find out the effect of concept mapping on SSII two students Achievement and retention of senior secondary one students in redox reaction, Jos north LGA with hope, it may provide possible means of improving students' retention and achievement in chemistry and sciences at large.

AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to find out the effects of concept mapping strategy on senior secondary two students' achievement in redox reaction in Jos North, Plateau State, Nigeria. Specifically, this study sought to:

1. Find out the difference in the achievement mean scores of students taught redox reaction using concept mapping strategy and those taught using lecture method.
2. Determine the effect of gender on the achievement mean scores of Students taught redox reaction using concept mapping strategy and those taught using lecture method.

RESEARCH QUESTIONS

The study was guided by the following research questions:

1. What is the difference in the achievement mean scores of students taught redox reaction using concept mapping strategy and those taught using lecture method?
2. What is the effect of gender on the achievement mean scores of Students taught redox reaction using concept mapping strategy and those taught using lecture method?

HYPOTHESES

The following hypotheses were formulated and tested at 0.05 level of significance.

Hypothesis 1: There is no significant difference in the achievement mean scores of students taught redox reaction using concept mapping teaching strategy and those taught using lecture method.

Hypothesis 2: There is no significant effect of gender on the achievement mean scores of Students taught redox reaction using concept mapping teaching strategy and those taught using lecture method.

RESULTS

Research Question One: What is the difference in the mean achievement scores of students taught redox reaction using concept mapping teaching strategy and those taught using lecture method?

Table 1: Analysis of Post-test Means and Standard Deviations Scores for Redox Reaction Achievement Test (RRAT) of the Experimental and Control Groups

	Group	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference
Post-test	Experimental	85	62.99	15.218	1.651	21.96
	Control	82	41.02	6.475	.715	

Table 1 revealed that the post-test means and standard deviations of students for RRAT scores of experimental group were 62.99 and 15.218 while that of control group were 41.02and6.475. The mean score difference was 21.96 in favour of experimental group.

Research Question Two: What is the effect of gender on the mean achievement scores of Students taught redox reaction using concept mapping teaching strategy and those taught using lecture method?

Table 2: Analysis of Posttest Means and Standard Deviations Scores for Redox Reaction Achievement Test (RRAT) in the Experimental Group for male and female students

	Group	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference
Post-test Gender	Female	41	64.49	14.063	2.196	2.897
	Male	44	61.59	16.257	2.451	

Table 2 revealed that the post-test means and standard deviations of students for RRAT scores male were 64.49 and 14.063 while that of female students were 61.59 and 16.257. The mean score difference was 2.897.

Hypothesis One

There is no significant difference in the mean achievement scores of students taught redox reaction using concept mapping teaching strategy and those taught using lecture method.

Table 3: ANCOVA Analysis of the Post-Test Mean Scores for RRAT of the Experimental and Control Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	20392.019 ^a	2	10196.009	74.018	.000
Intercept	18751.740	1	18751.740	136.128	.000
Pretest	257.880	1	257.880	1.872	.173
Group	19840.147	1	19840.147	144.030	.000
Error	22591.059	164	137.750		
Total	498094.000	167			
Corrected Total	42983.078	166			

R Squared = .474 (Adjusted R Squared = .468)

Table 3 revealed that the F-value obtained was 144.03; adjusted R Squared observed was 0.468 and the p-value of 0.000 was observed. Since the obtained p-value of 0.000 is less than the alpha value of 0.05, thus the study rejected the null hypothesis one (1) that says there is no significant difference in the mean achievement scores of students taught redox reaction using concept mapping teaching strategy and those taught using lecture method. The decision implies that, there is significant difference in the mean achievement scores of students taught redox reaction using concept mapping teaching strategy and those taught using lecture method. This indicated that treatment with concept mapping teaching strategy has effect on students' achievement in redox reaction ($F(1, 166) = 144.03, P = 0.00$).

Hypothesis Two

There is no significant effect of gender on the mean achievement scores of Students taught redox reaction using concept mapping teaching strategy and those taught using lecture method

Table 4: ANCOVA Analysis of the Post-Test Mean Scores for RRAT in the Experimental Group of male and female students

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	494.000 ^a	2	247.000	1.068	.348
Intercept	14981.049	1	14981.049	64.795	.000
Pre-test	315.892	1	315.892	1.366	.246
Group	179.043	1	179.043	.774	.381
Error	18958.988	82	231.207		
Total	356692.000	85			
Corrected Total	19452.988	84			

R Squared = .025 (Adjusted R Squared = .002)

Table 4 revealed that the F-value obtained was 0.774; adjusted R Squared observed was 0.002 and the p-value of 0.381 was observed. Since the obtained p-value of 0.381 is greater than the alpha value of 0.05, thus the study retained the null hypothesis three (3) that says there is no significant effect of gender on the mean achievement scores of Students taught radox reaction using concept mapping teaching strategy and those taught using lecture method. The decision implies that, male and female students performed significantly similar in radox reaction Achievement Test (RRAT) after treatment with concept mapping teaching strategy. This indicated that treatment has no effect on students' achievement in radox reaction with gender ($F(1, 85) = 0.774, P = 0.381$).

DISCUSSION

The findings of this research indicated there is significant difference in the mean achievement scores of students taught radox reaction using concept mapping teaching strategy and those taught using lecture method. This indicated that treatment with concept mapping teaching strategy has effect on students' achievement in radox reaction. The result agreed with that of Otor (2013) examined the effect of concept mapping teaching strategy on student's achievement in difficult chemistry concepts in secondary schools in Nigeria. It also examined the differential effect in achievement among chemistry students in rural and urban schools. The research questions were answered using mean and standard deviation scores while the hypotheses were tested at 0.05 significance level using Analysis of Covariance (ANCOVA). Students taught using concept mapping strategy achieved higher scores and significantly better than those taught using conventional (lecture) method. There was also a better achievement in favor of the rural chemistry students compared to their urban counter parts. The result is also in line with that of Onuoha, Ejimonye, Eneogu, and Ugwuanyi, (2016) investigated the effect of concept mapping instructional strategy on students' achievement and interest in Economics in secondary schools in Enugu Education Zone, Nigeria. Mean and Standard Deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The results showed among others that students that were taught Economics using concept mapping instructional strategy achieved better and had higher interest score than their counterparts taught with the lecture instructional strategy.

Furthermore, the result revealed that there is no significant effect of gender on the mean achievement scores of Students taught radox reaction using concept mapping teaching strategy and those taught using lecture method. The decision implies that, male and female students performed significantly similar in radox reaction Achievement Test (RRAT) after treatment with concept mapping teaching strategy. This indicated that treatment has no effect on students' achievement in radox reaction with gender. The result agreed with that of Sakiyo and Waziri, (2015) investigate the use of concept mapping teaching method on secondary school students' academic achievement in

biology in Adamawa state. Two (2) hypotheses tested at 0.05 level of significance guided the study. The result revealed that there was no significant difference between male and female students in the experimental group. However, the result is also in line with that of Ogonnaya, Okafor, Abonyi, and Ugama, (2016) carried out a study to investigate the effects of concept mapping on students' achievement in basic science. Three (3) research questions and three (3) null hypotheses guided the study. Mean, standard deviation and the Analysis of Co-Variance (ANCOVA) were used to analyze data. Results showed that concept mapping boosts the achievement of both male female students in the subject. In addition, there is no interaction between gender and teaching methods on students' achievement in basic science

In addition, the findings revealed that there is significant difference in the mean retention scores of students taught radox reaction using concept mapping teaching strategy and those taught using lecture method in favour of experimental group. This indicated that treatment has effect on retention in radox reaction. The findings agreed with Agaba, (2013). Study the effect of concept mapping instructional strategy on student's retention in Biology in Enugu educational zone, Enugu state, Nigeria. One research question and one research hypothesis were formulated; the sample for the study was one-hundred and nine (109) senior secondary two students drawn from two secondary schools randomly selected from. The result of the study shows that concept mapping instructional strategy enhances retention in Biology

Finally, the finding revealed that there is no significant effect of gender on the mean retention scores of Students taught radox reaction using concept mapping teaching strategy and those taught using lecture method. The decision implies that, male and female students performed significantly similar in retention forradox reaction after treatment with concept mapping teaching strategy. The finding agreed with that of Adeniran, Ochu, and Atoo, (2018), examined the effect of concept mapping strategy on students' retention in Basic science. The research questions were answered using mean and standard deviation, while the hypotheses were tested at 0.05 alpha level of significance using Analysis of Covariance (ANCOVA). The results from the study showed that the mean difference between the retention gain scores of males and females was -1.58. This implies that the females gained slightly higher in retention scores compared to the males. However, the result contradicts with that of Yakubu, Samuel, Abdulkadi, and Yakubu, (2019), who carryout study to determine the effects of concept - mapping strategy on achievement and retention in mole concept among secondary school students in Kaduna state. Descriptive statistics was used to answer research questions and Analysis of Covariance (ANCOVA) was used to test research hypotheses at 0.05 levels of significance, respectively. Findings from this study among others revealed that there was no significant difference between achievement of male and female.

CONCLUSION

Based on the findings of this research, it can be concluded that, concept mapping teaching strategy improves students' achievement in radox reaction of students under study.

Concept mapping teaching strategy boosts students' achievement in radox reaction of male and female students, as it revealed no significant gender difference in the achievement of radox reaction.

Concept mapping teaching strategy fosters students' retention in radox reaction of students under study, as there was significant difference between the post-test achievements mean scores of the control and experimental group in radox reaction retention scores

Concept mapping teaching strategy is gender friendly strategy in enhancing the retention of students, as it revealed no significant gender difference in retention scores

RECOMMENDATIONS

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

1. Since concept mapping is found to be an effective strategy and enhanced achievement among Chemistry students, teachers of this subject should accept it as one of the strategies they can use in Chemistry classroom.
2. Concept mapping method should be incorporated in the teaching of Chemistry and other science subjects for meaningful learning and that workshops should be organized for in-service and practicing teachers on how to use concept mapping strategy
3. Chemistry teachers should prioritize the use of Concept mapping instructional strategy to facilitate students' achievement in the subject
4. Teachers of senior secondary schools should expose students to Concept mapping instructional strategy to promote the achievement of both male and female students.

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