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Analyses of Learning Outcome in Chemistry among SS111 Students' in Urban and Rural Setting: Using Concept Map Technique

Obomanu, Balama Joseph.
Faculty of Education , University Of Port Harcourt
Nigeria. E-mail: baljek@yahoo.com

Ekenobi, Theodore Njeribe.
Faculty of Education ,University Of Port Harcourt
Nigeria.E-mail: ekenoitheodore@yahoo.com

Abstract

Our study examined the academic achievement of senior secondary school chemistry students in chemistry (redox reaction) concept according to school location. A quasi-experimental, pre-test/post-test control group design was used to determine if any significant difference exists in the academic achievement between urban and rural schools. A total of 218 SS2 chemistry students from four intact classes were involved in the study. A Redox Reaction Concept Achievement Test (RRCAT) instrument with reliability coefficient of 0.988 was used to measure students' achievement before and after treatment. The results showed that school location was an insignificant factor in the academic achievement of chemistry students taught redox reaction with concept mapping instructional strategy. The implications of these findings were discussed and relevant recommendations made.

Key words: Teaching outcome, Cognitive achievement, Chemical system, Integrated knowledge structure.

1 Introduction

The majority of our students essentially engages in rote learning and therefore appears to have difficulty in the understanding of some scientific concepts. Nakhleh (1992) and Boujaoude & Barakat (2000) emphasized that college students' knowledge of science is often characterized by lack of coherence and attributed this to the abstract and highly conceptual nature of science which seems to be particularly difficult for students.

Incidentally, efforts by teachers to improve students' learning seem not to yield encouraging results as students' have continued to show weakness in the knowledge and understanding of chemical concepts and principles which are the basic ingredients of science. Furthermore, Francisco, et-al (1998), Gabel (1999), Ezeliora (2004) and Okoli (2006) reported that poor teaching methods adopted by science teachers during instruction is one of the causes of students' colossal failure in science examinations and remarked that these teaching methods and techniques do not seem to make learning sufficiently easy for students. Moreover, Decanato, et-al (2006) submitted that the abstract nature and the difficulty in learning some concepts are so stable and coherent internally that conventional instruction has little effect on them. Therefore, since one of the roles of the science teacher, is to structure students' learning to ensure that specific concepts are meaningfully learnt and internalized, it is imperative for science teachers to adopt a strategy that will perhaps make instruction more efficient, effective and meaningful by actively involving students in the learning process, and hence reducing rote memorization.

According to Novak and Wandersee (1991), Novak (1998), concept map technique promotes meaningful learning and enhances achievement and retention. It is a technique used for representing knowledge in the form of organizational chart, providing networks of related concepts or ideas that allow learners to gain an insight to the details of knowledge domain at a glance. (Fig 1 below)

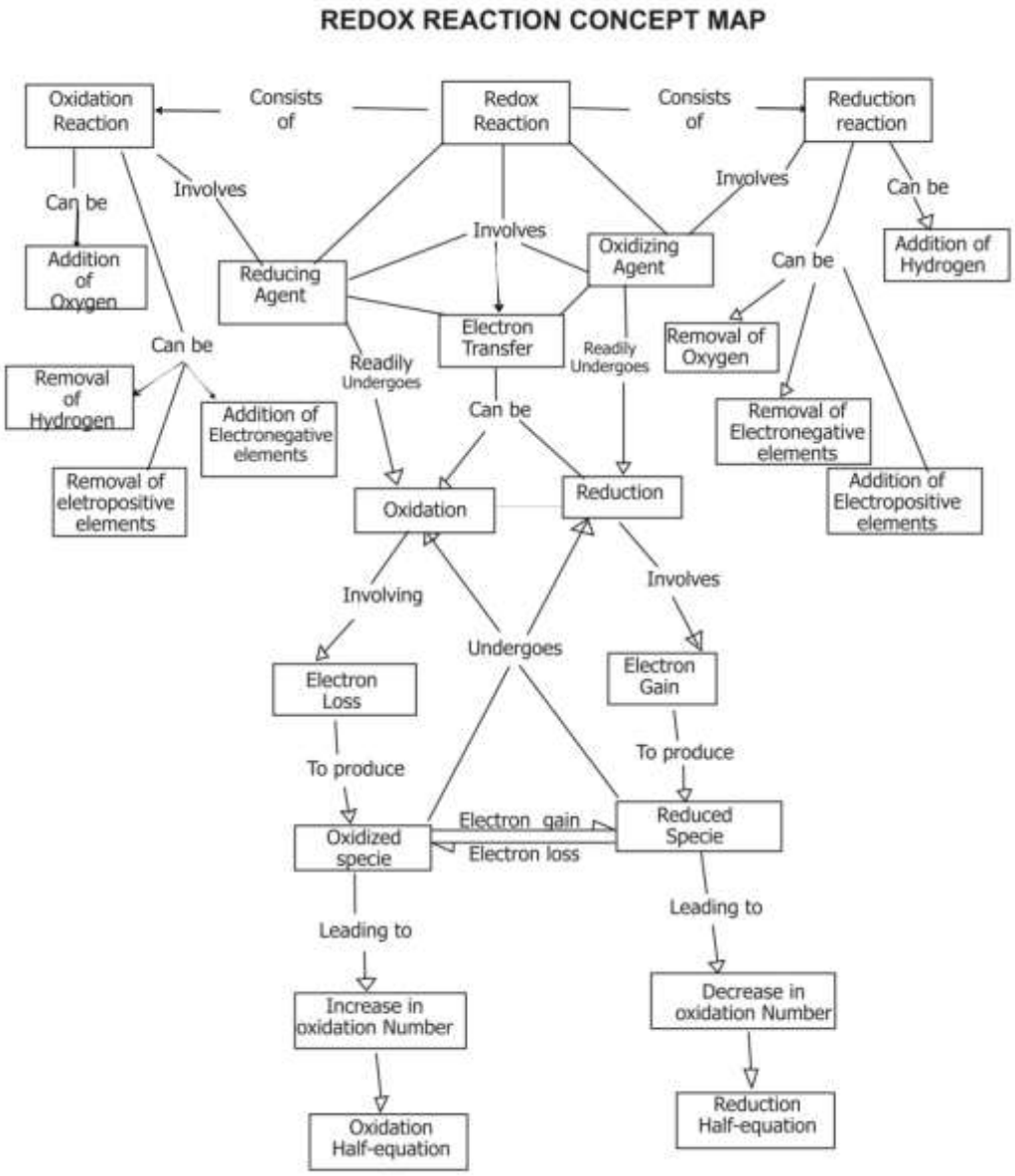

Fig 1. Concept map on Redox reaction

By implication, concept map as a strategy build explicit links and relations between concepts and stimulates the construction of integrated knowledge structures leading students to achieve higher in tests that measure higher cognitive levels. (Boujaoude & Attieh, 2008).

In biochemical systems and in the senior secondary school chemistry curriculum according to Ekenobi, (2004) and Mumuni & Mumuni, (2006), redox reaction is a very important concept which involves two opposing processes which occur simultaneously to complement one another. It is an electron bookkeeping process involving the transfer of electrons from one specie (called the reducing agent) to another (the oxidizing agent) leading to change in electrical charges of the species involved through the process of electron loss and gain respectively.

Redox reaction as a concept in senior secondary school chemistry has posed unique and formidable challenges to students as explicated by Adesoji (1992), Inyang and Ekpenyong (2000). Besides, studies have shown that school location or type can affect students' academic achievement. For instance, Oyedokun & James (2001) and Orukotan & Balogun (2001) reported that urban school students with available science facilities performed better than their rural counterparts where such facilities are lacking. While on the contrary, Okonkwo, (2000) reported that school location had no significant effect on the academic achievement of students in mathematics.

Specifically in this study, students' achievement in chemistry (redox reaction) was viewed against the background of schools in urban and rural settings using the concept map technique.

2. Research Hypotheses

In this study the following null hypotheses were tested:

H_{01}: No significant difference exists in the mean scores achievement of urban located schools students taught with concept mapping technique and those taught using the conventional method.

H_{02}: No significant difference exits in the mean scores achievement of rural located schools students taught with concept mapping technique and those taught with conventional method.

H_{03}: No significant difference exits in the mean scores achievement of students' in urban and rural settings taught using concept map technique.

3. Research Design.

The study adopted a quasi-experimental, pre-test/post-test control group design.

4. Sample.

Four separate intact classes selected by stratified random sampling technique were randomly assigned, two each to the experimental and control groups respectively. A total of two hundred and eighteen (218) senior secondary two (SS2) chemistry students consisting of one hundred and nine (109) each of urban land rural located students' respectively, drawn from four co-educational secondary schools in Obio/Akpor education zone of Rivers State participated in the study.

5. Instrument.

The study used Redox Reaction Concept Achievement Test (RRCAT) constructed by the researchers. It consisted of four – option, fifty multiple choice test items in redox reaction concept which was used to gather data. The researchers made test was examined by a panel of experts and revised accordingly before being used. The 50-item test covered specific cognitive processes in redox reaction-chemistry.
A reliability coefficient of 0.988 was obtained from the test-retest scores of fifty subjects from a non-participating school in the main study, using Kuder-Richardson's formula 21. A Pre-test was administered to the two groups using RRCAT instrument to determine students' entry behavior and account for possibility pre-existing differences in overall ability.

6. Intervention

Two lesson plans on redox reaction concept were prepared by the researchers and presented to a panel of experts for their comments and suggestions. Ultimately corrections on the plans were effected before being used for the intervention. The topic focused on oxidation and reaction processes in chemistry.

6.1 Instruction with concept map teaching technique (CMTT)

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The intervention in the study is called the concept map teaching technique (CMTT) which was used for the treatment of the experimental group in six 80- minutes' lessons which lasted for three weeks.

6.2 Instruction with conventional method (CM)

Lesson plan on the concept of REDOX reaction was also developed using the conventional lecture method. For this method group, classroom activities were not based on (CMTT) but those activities typically found in all traditional classrooms teaching method which is teacher-centered. The treatment of the control group students also lasted for three weeks.

7. Data analysis.

Prior to the intervention the mean pre-test scores in REDOX reaction chemistry of the two groups were computed and compared using the two-tailed z-test for large independent samples at 0.05 alpha levels.

Table 1**:** Test of the significance difference between the mean pre-test scores of urban and rural located schools chemistry students before the intervention.

Group of students	No. of Students N	Mean score $\overline{X}$	Standard Deviation SD	Standard Error SE	Df	t-cal	t-critical
Urban located	109	26.24	6.10	0.664	216	-0.221*	1.96
Rural located	109	26.42	5.93				

* Not significant at 0.05 alpha level

Table 1 shows that urban and rural located schools chemistry students did not differ significantly in their academic achievement in a REDOX reaction concept achievement test before the intervention. The subjects were therefore homogeneous in their entry behaviour.

7.1 Hypothesis One (H_{01})

There is no significant difference in the mean scores achievement of urban located schools chemistry students taught REDOX reaction with concept mapping technique and those taught with conventional method.

Table 2**:** Test of the significance difference between the mean posttest scores of chemistry students in urban settings taught with concept mapping technique and those taught with conventional method

Group of students	No. of Students N	Mean score $\overline{X}$	Standard Deviation SD	Standard Error SE	Df	t-cal	t-critical
Experimental group (EG)	43	58.28	11.95	3.79	107	9.91	1.98
Control group (CG)	66	39.0	5..56				

* Significant at 0.05 alpha level

The analysis in Table 2 reveals that the calculated t-value of 9.91 is by far greater than the critical t-value of 1.98 at 0.05 alpha levels at 107 degrees of freedom. The null hypothesis (H_{01}) stating a non-significant difference in the mean scores achievement of chemistry students in the urban setting taught redox reaction with concept mapping technique and those taught with conventional method was therefore rejected.

7.2 Hypothesis Two (H_{02})

No significant difference exists between the mean scores achievement of rural located schools chemistry students taught with concept mapping techniques and those taught with the conventional method.

Table 3**:** Test of the significance difference between the mean posttest scores of rural located schools chemistry students taught with concept mapping technique and conventional methods

Group	No. of Students N	Mean score $\overline{X}$	Standard Deviation SD	Standard Error SE	Df	t-cal	t-critical
Experimental group (EG)	59	58.24	9.50	2.71	107	13.51*	1.98
Control group (CG)	50	36.0	7.68				

* Not significant at 0.05 alpha level

Table 3 shows that the calculated t-value of 13.51 is far greater than the critical t-value of 1.98 at 0.05 alpha level and 107 degrees of freedom. The null hypothesis (H_{02}) was therefore rejected.

7.3 Hypothesis Three (H_{03})

There is no significant difference in the mean scores achievement of students' in urban and rural settings taught using concept map technique.

Table 4: Test of the significance difference between the mean posttest scores of urban and rural located schools chemistry students taught with concept map technique.

School location	No. of Students N	Mean score $\overline{X}$	Standard Deviation SD	Standard Error SE	Df	t-cal	t-critical
Urban location	43	58.28	11.95	4.85	100	0.0182*	1.96
Rural location	59	58.24	9.50				

* Not significant at 0.05 alpha level

Table 4 reveals that the calculated t-value of 0.0182 is less than the table t-value of 1.98 at 0.05 alpha level and 100 degrees of freedom. The null hypothesis (H_{03}) stating a non-significant difference was therefore accepted.

8. Results and discussion

The objective of this study was to investigate whether school location would significantly affect senior secondary school students' academic achievement in REDOX reaction concept when concept map technique is applied as intervention. First of all, the mean pretest scores in REDOX reaction of the Urban (26.24) and Rural (26.42) groups were not significantly different (p value = 1.96, a= 0.05).
Indicating that the subjects were therefore homogeneous in their entry behavior.

The mean posttest score of EG group was numerically higher than the posttest mean score of the CG group. The calculated t-value of 9.91 was by far greater than the critical t-value of 1.98 at 0.05 alpha levels at 107 degrees of freedom. The null hypothesis (H_{01}) stating a non-significant difference in the mean scores achievement of chemistry students in the urban setting taught REDOX reaction with concept map technique and those taught with conventional method was therefore rejected (table 2) indicating that concept map as a strategy build explicit links and relations between concepts and stimulates the construction of integrated knowledge structures leading students to achieve higher in tests that measure higher cognitive levels. (Boujaoude & Attieh, 2008).

For the Rural setting the mean posttest score of the EG group was also numerically higher than the mean posttest score of the CG group. The calculated t –value of 13.51 was greater than the critical t-value of 1.98 at 0.05 alpha levels (table 3). Invariably supporting the findings of Novak & Wandersee (1991), Novak (1998), which provided evidences that concept mapping promotes meaningful learning of concepts and remarkably enhances the capacity of learners to acquire, retain and use knowledge.
The mean posttest scores of urban and rural located schools chemistry students taught with concept map technique, the calculated t-value of 0.0182 was less than the table t-value of 1.98 at 0.05 alpha level and 100 degrees of freedom (table 4). The null hypothesis (H_{03}) stating a non-significant difference was therefore accepted. That is, school location was found to be an insignificant factor in the academic achievement of chemistry students taught redox reaction with concept mapping technique. This may have resulted from sampling error or that the states of affairs in the State government-owned senior secondary schools are the same for both urban located and rural located schools. Nevertheless, this outcome supports the finding of Okonkwo (2000) which indicated that school location has no significant effect on the academic achievement of students in Mathematics. It however contradicts the findings of Oyedokun & James (2001) and Orukotan & Balogun (2001) which reported that urban schools students performed better than their rural schools counterparts in the sciences.

9. Conclusions

The following conclusions were drawn from the findings of this study:

1. Concept mapping technique was a very purposeful and effective instructional strategy for meaningful learning and understanding of redox reaction and other abstract and difficult concepts. It stimulated learning in a meaningful way, promoting higher retention ability and use of knowledge, leading to remarkable academic achievement as against rote learning which conventional method engenders.

2. School location was an insignificant factor on the academic achievement of chemistry students. Urban located and rural located schools SS2 chemistry students' taught with concept mapping technique gained equally meaningful conceptual understanding of redox reaction concept.

3. The use of concept mapping technique provided an expanded chemical activity that facilitated the creation of new knowledge structures leading to the attainment of meaningful scientific literacy.

10. Recommendations

1. Concept mapping technique would remarkably empower students to take charge of their learning by structuring their thinking and ability to retain and apply knowledge thereby drastically reducing students' tendencies for examination malpractices. Therefore, teachers' are advised to use it in addition to other creative activities during instruction.
2. Textbooks authors should endeavour to adopt the use of concept mapping technique in presenting materials in their books.

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