CONCEPT- MAPPING: AN INSTRUCTIONAL STRATEGY FOR RETENTION OF ORGANIC CHEMISTRY CONCEPTS

AROKOYU, A.A. (Ph.D) (Corresponding Author)
and
OBUNWO, JULIANA C.

DEPARTMENT OF CURRICULUM STUDIES AND EDUCATIONAL TECHNOLOGY, FACULTY OF EDUCATION
UNIVERSITY OF PORT HARCOURT, NIGERIA.

Abstract

The study analyzed students' retention of organic chemistry concepts. The Population for the study was all senior secondary school 3 students in Obio-Akpor, Rivers state. The sample was made up of ninety (90) Senior Secondary 3 (SS 3) Chemistry students split into 2 groups namely experimental and control. The research instruments were validated Organic Chemistry Aptitude Test (OCAT), Organic Chemistry Retention Test (OCRT) consisting of 10 items each and a lesson note on concept mapping. Reliability of the instruments were 0.72 and 0.81 based on a pilot study conducted. Two research questions and two hypotheses guided the study. Data collected were analyzed using the mean, standard deviations, and t-test statistic at $p< 0.05$ level of significance. The results of the study showed that the experimental group performed better than the control group. This shows that concept mapping enhances performance and retention of knowledge. It was recommended that workshops and seminars should be organized by education authorities to sensitize science teachers in order for them to acquire the skills and competences required for effective use of concept mapping strategy.

KEY CONCEPTS: concept mapping, cognitive structure, retention test, learning process, instructional strategy

Introduction

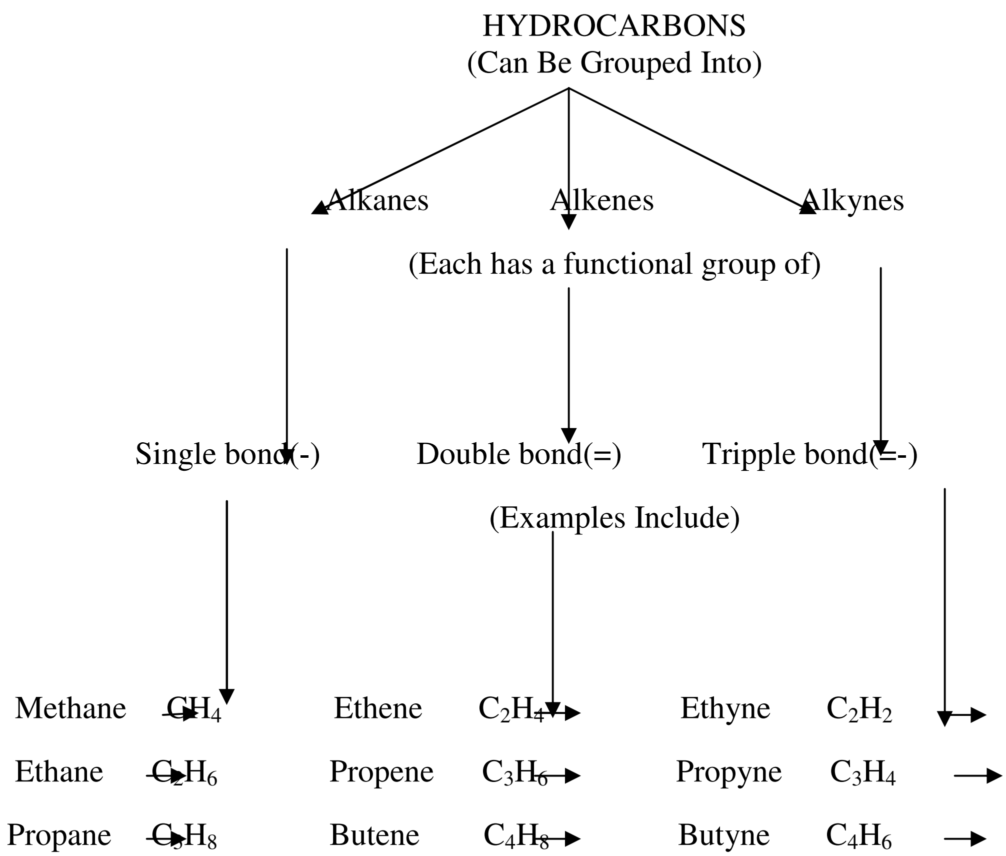
One of the aims of secondary education is to equip students to live practically in this modern age of science and technology, (Federal Republic of Nigeria, 2004). To this end, students at the senior secondary level of education are required to study one or all of the basic science subjects (biology, chemistry, and physics) as core subjects: chemistry is required as a prerequisite to the study of courses such as Medicine, Engineering, pharmacy, Science Education, et cetera. This gives chemistry unique position indeed. Besides, the study of chemistry as a subject helps to develop in the learner such process skills as critical observation, analysis, experimentations, manipulation of variables and equipment which are very important in scientific investigations.

However, the performances of students in chemistry in the senior secondary school certificate Examinations,(WASSC, NECO and GCE) have not been encouraging, probably due to ineffective teaching and learning of the subject. Documented research reports suggest a number of factors to that effect. According to Ayodele (2002), obstacles to effective teaching and learning of chemistry include negative attitudes of teachers and students, lack of requisite mathematical skills and the nature of the curriculum. The presence of too many topics to be taught and the inadequate periods allotted with other factors impart on the teaching-learning strategies. In the bid to cover syllabus, teachers resort to tradition of lecture method which involves mostly the cognitive domain of learning to the detriment of the affective and psychomotor domains. This practice has not yielded effective science learning, (Ukwa, 2003). It is against this backdrop of students' poor performance which could be a resultant effect of poor presentation of strategies (though coupled with other factors), that conscious efforts are being continuously made to determine suitable strategies that will facilitate effective learning and understanding of chemistry concepts.

Katcha (2010) investigated the effects of Vee-mapping (which is a simpler form of concept mapping) instructional strategy on students' achievements in biology. He found out that students exposed to Vee-mapping performed better than those taught with the conventional lecture method; his result shows a mean score of 48.14 for the experimental group and a mean score of 39.48 for the control group. In a related study, (Etiubon (2010) investigated the relationship between availability of laboratory equipment and students' performance in chemistry and revealed that students exposed to studies with adequately equipped laboratories performed better (with mean score of 47.50) than their counterparts who studied with little or no laboratory materials (with mean score of 38.68). The second group of students was taught more theoretical chemistry and less practicals; that is, instruction was more lecture-based than activity-based. Activity-based strategies are known to enhance acquisition of science attitudes (Akporehwe & Onwioduokit, 2010).

Concept mapping is one of such activity-based instructional strategies. It helps students to learn meaningfully, thus assisting them to overcome the problem of misconception, (Novak & Canàs, 2008; Novak & Gowin, 2010). The strategy utilizes concept-mapping which is a graphical representation of the relationship among terms, (Vanides, Tomita & Primo, 2005), and shows the interconnections among networks of related concepts (Jiang, 2004). A concept map exercise should be done by students before a topic is taught and another after the topic has been presented. This way, students themselves can determine what they have learnt and where they need further effort to grasp a concept.

In preparing a concept map, the more general, more inclusive concepts should be at the top of the map, with progressively more specific, less inclusive concepts arranged below. For instance



Source: Researchers' design 2012.

This is because meaningful learning (which concept mapping promotes) proceeds more easily when new concept or meanings of concepts are subsumed under broader, more inclusive concepts (Novak & Gowin, 2010). This agrees with Ausubel's (1960) structuring of learning from more inclusive (complex) materials to less inclusive (simpler) ones, leading to meaningful learning.

In fact, (Novak & Gowin, 2010) see Ausubel's theory as a sound intellectual foundation for concepts mapping, as the strategy enhances students' meta-knowledge and meta-learning. In other words, by promoting meaningful learning, concept mapping is known to enhance assimilation, retention and retrieval of learned knowledge as the learning situation demands. This is because knowledge acquired through meaningful learning is assimilated into the existing cognitive structure and is retained longer, even much longer in many instances, (Novak, 2010). It is against this background that this study is carried out to ascertain if concept-mapping still enhances assimilation, retention and retrieval of knowledge. Will the situation be same with samples in this study?

Objectives of the study are to:

i. Find out if there is any difference in the performance of control and experimental groups in OCAT.
ii. Determine the difference in the performance of control and experimental groups in the OCRT.

Research Questions

i. Is there any difference in the performance of control and experimental groups in the OCAT?

ii. What is the difference in the performance of control and experimental groups in the OCRT?

Hypotheses

Ho_1: There is no significant difference in the performance of students of the control and experimental groups in the OCAT.

Ho_2: There is no significant difference in the performance of students in control and experimental groups in the OCRT.

Methodology/ procedure

The study adopted quasi experimental design.The population for the study comprised all senior secondary school 3 students in the 14 government-owned senior secondary schools in Obio Akpor Local Government Area (OBALGA) of Rivers State (Rivers State Post Primary Schools Board, 2010/11).The sample comprised of Ninety (90) Senior Secondary 3 students randomly selected and assigned into control and experimental groups respectively. Each group is made up of 45 students (samples). Three (3) research instruments were employed for data collection namely Organic Chemistry Aptitude Test (OCAT), Organic Chemistry Retention Test (OCRT) and a validated lesson note on concept mapping. OCAT and OCRT consist of 10-item, four options multiple choice questions based on petroleum as a mixture of hydrocarbons and adapted from standardized West African Senior Secondary School Certificate past questions.

Reliability of the instruments were 0.72 and 0.81 based on a pilot study. The OCAT and OCRT are equivalent (reshuffled) forms of each other. Two research assistants were employed in order to eliminate bias. A pre-test (OCAT) was administered to both groups to establish equivalence in terms of academic ability.

The experimental group was taught using concept mapping (that is the treatment) and the control group taught using the normal lecture method (that is no treatment). A post-test which is an equivalent form of the pre-test was administered. Then, after three weeks OCRT which is a reshuffled form of the post-test OCAT) was administered to both groups. The execution of the entire study lasted for 5 weeks.

Mean scores and standard deviations were computed for each of the groups in order to answer the research questions. The null hypotheses were tested for significance using the t-statistic of the Statistical Package for Social Sciences, (SPSS).

Presentation of Results

The results were analyzed and presented in tables.

Research question 1

Is there any difference in the performance of students in the experimental and control groups in the OCAT?

Table1: OCAT mean and standard deviation scores for the experimental and control groups.

	Experimental group	Control group	Difference in mean
Number of students	45	45	6.67
Mean	60.67	54.00	
Standard deviation	14.83	15.28	

Source: Researchers' field work, 2011

The mean score for experimental group is 60.67 and that for the control group is 54.00, indicating a mean difference of 6.67. Research question one is hereby
answered.

Research question 2
What is the difference in the performance of control and experimental groups in the OCRT?

Table 2: OCRT mean percentages for the experimental and control groups.

	Experimental group	Control group	Difference in mean
Number of students	45	45	7.33
Mean	53.33	46.00	
Standard deviation	16.65	17.63	

Source: Researchers' field work, 2011

From table 2, mean retention score for experimental group is 53.33, and 46.00 for the control group, a difference of 7.33 in favor of the experimental group. This shows that the experimental group retained the learned knowledge longer than the control group. Research question two is hereby answered.

Hypotheses: Two null hypotheses were tested.

HO_1
There is no significant difference in the performance of students of the experimental and control groups in the OCAT.

Table 3: Using t-statistic to compare mean scores for both experimental and control groups.

Groups	N	$\bar{x}$	SD	SE	df	t-cal	t-critical	α-level	Remark
Experimental group	45	60.67	14.83	2.21	88	2.10	1.99	0.05	Significant
Control group	45	54.00	15.28	2.28					

Source: Researchers' field work, 2011

From table 3, calculated t-value is 2.10, and table t-value is 199. The calculated value of t is greater than the table value (2.10>1.99), hence there is statistically significant difference, and the null hypothesis is rejected, its alternative is hereby retained.

HO_2
There is no significant difference in the performance of students in experimental and control groups in the OCRT.

Table 4: Comparison of mean retention scores for experimental and control groups.

Groups	N	$\bar{x}$	SD	SE	Df	t-cal	t-critical	α-level	Remark
Experimental group	45	53.33	16.65	2.48	88	2.03	1.99	0.05	Significant
Control group	45	46.00	17.63	2.63					

Source: Researchers' field work, 2011

Table 4 shows calculated t-value (2.03) greater than critical t- value (1.99), consequently there is statistically significant difference between the mean retention scores for both groups. Hence, the null hypothesis is rejected and its reverse is therefore accepted.

Discussion of Results

The difference in mean scores shown on tables 1 and 2 are statistically significant in favor of the experimental group as shown on tables 3 and 4. This means that students taught using concept mapping showed better performance and retention than those taught with lecture method. In other words, learning is imparted more positively through concept mapping than through the traditional lecture method. This is in consonance with previous findings of Keogh & Naylor (1996); Jiang, (2004); Novak & Canás, 2008). According to Jiang, 2004, concept mapping helps to increase students' understanding of organic chemistry concepts, even isomerism. Hence, the reason for the significant difference between mean scores of experimental and control groups could be attributed to the fact that the use of concept map is activity based. Vanides, Yin, Tomita and Ruiz (2005) have shown that activity based learning such as concept mapping helps students to understand and organize what they learn better. According to these authors, concept mapping enables students store and retrieve information more efficiently.

Novak (2010), in support of Ausubel's (1960) meaningful learning theory, affirms that information learnt meaningfully is associated with advanced organizers in the cognitive structure, and can usually be recalled for weeks or even months after acquisition. Such knowledge is retained longer even much longer in many instances. One instructional strategy that enhances such retention is concept mapping. Hence the higher mean retention score for the experimental group. Conversely, the lower mean retention score for control group could have been as a result of rote memorization learning associated with the conventional, traditional (non-activity) lecture method. Information acquired by rote cannot be anchored by elements in the cognitive structure and hence form a minimum linkage with it. Retention of such knowledge is therefore hampered.

Variation in extent of retention and amount of recall depends primarily on the degree of meaningfulness associated with the learning process.

Summary of Findings

i. Students of the experimental group perform better in the Organic Chemistry Aptitude test than those in the control group.
ii. Students of the experimental group retained the Organic Chemistry concepts longer than those in the control group.

Implications of findings for science education

The use of concept-mapping to teach chemistry (science in general) has the potential to increase students' cognition at the same time imparting positively on the affective and psychomotor domains because it enhances retention. The implication of this finding for science teaching and especially chemistry is that the strategy should be adopted in the teaching of science in general and chemistry in particular. This is because concept mapping involves head-on, heart-on and hands-on activities, which foster retention of knowledge. Hence, chemistry teaching and learning should not be business as usual but business unusual in which the 3Hs (Head, Heart and Hands) are at work.

Summary and Conclusion

Consequent upon the findings, the exposure of students to concept mapping strategy enhances their performance in organic chemistry and retention of the knowledge. Retention and recall of assimilated knowledge are functions of the meaningfulness of the learning process. So learning strategies that will make learning meaningful should be adopted, a typical example being concept mapping.

Recommendations

Based on the research findings, the following recommendations are made:

1. The curriculum for training chemistry teachers should include how to develop and use concept maps to teach chemistry and indeed science subjects.
2. Science education authorities should organize workshops and seminars that will sensitize teachers concerning teaching strategies and instructional methods that will enhance knowledge impartation by the teacher, including knowledge assimilation and retention by the students.

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