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Editorial

The sixth (6) Volume, Number One – Vol. 6(1), 2017 of the JET is a special edition of the Department of Lifelong and Continuing Education, University of Lagos, Akoka, Nigeria. The Edition is poised to report cutting edge research findings and discuss educational issues of interests.

The articles in the Journal are contemporary and challenging with the implications for national development, global emancipations, empowerment and awareness creation.

The Editorial Board of JET wishes to solicit through this avenue well researched studies and articles for future publications. We will like to thank the reviewers and assessors of the articles published here for their time and other resources well spent. To the contributors, the Board says well done and thank you and please continue to research and send qualitative papers to JET. We solemnly promise a continued improvement in the subsequent editions of JET.

Prof. C. O. Oladapo
Editor-in-Chief
A JOURNAL OF THE DEPARTMENT OF LIFELONG AND CONTINUING EDUCATION, UNIVERSITY OF LAGOS

Mission
The mission of the Journal of Educational Thought (JET) is to sever society through promotion of excellence in educational research. JET is aimed at generating and disseminating new knowledge to service providers, practitioners and policy makers in the diverse fields of education and development studies.

The Journal provides a forum for publishing and disseminating a balanced mix of well-grounded research studies in education. The scope of JET covers empirical and theoretical research studies that contribute to knowledge and practice, research reviews, case studies, book reviews, field work reports as well as pedagogical and andragogical issues in all fields, levels, and forms of education and training. In addition, the Journal publishes articles that address education and training in relation to other disciplines and development studies.

Editorial Policy
All manuscripts submitted for consideration in the Journal must conform to JET GUIDELINES. In preparing the articles, contributors should follow the American Psychological Association (5th or 6th Ed.) The manual provides instruments on referencing – including electronic media, tables, figures, metrification and non-sexist language.

All manuscripts will undergo a very stringent double-blind peer-review process, where both the identities of authors and reviewers remain undisclosed in order to guarantee the highest quality of the journal. All manuscripts (except for Editorials, Commentaries and Book Reviews) will be sent out for review and at least two review reports per manuscript will be collected. All reviewers will be carefully selected by the Journal Editors for each submitted manuscript.
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- All articles should be preceded by an abstract of 180-200 words and should not exceed 300 words.
- Authors should include the list of between four to six key words below the abstract.
- Articles should be written in English language with Times New Roman 12 font and not exceed 6000 words in length including references, tables and figures.
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- Articles beyond the recommended number of pages usually between 10-15 pages will attract extra charge per page.
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USING CONCEPT MAPPING TO UNCOVER STUDENTS’ KNOWLEDGE STRUCTURE IN CHEMICAL BONDING CONCEPTS

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Abstract
The study investigated the use of concept mapping integrated instructional strategy to uncover the knowledge structures of senior secondary school chemistry students’ regarding chemical bonding concepts. The sample was made up of one hundred (100) Senior Secondary 2 (SS 2) Chemistry students (48 male and 52 females) from two senior secondary schools randomly selected from Eti Osa Local Government Area. Relevant data were collected using Chemical Bonding Achievement Test (CBAT). Data collected in order to answer the three research questions raised and the hypotheses formulated were analysed using the mean, standard deviations, and T-test statistical tools at p< 0.05 level of significance. It was found out that integrated instructional strategy can be used to uncover students’ cognitive structure and retention of knowledge. It was recommended that workshops and seminars should be organised by education authorities to sensitize science teachers in order to acquire the necessary skills and competences required for effective use of concept mapping instructional strategy and the teacher training institutions should include the concept mapping instructional strategy in the chemistry method course and other science method courses.

Key words: Concept mapping, students’ knowledge, chemical bonding
Introduction
Different methods have been used in teaching chemistry over the years at the secondary school level but the effectiveness of any of these methods as measured by the performance of the students involved has not been really encouraging (Okebukola, 2005).

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. The performances also in this subject among male and female students vary significantly in favour of male students (Otor, 2011; Gyuse, 1990). Iyang and Ekpenyong (2000), Mari (2002), Njoku (2007) and Olayiwola (2007) all reported cases of students’ poor differential performance among gender.

The question that comes to mind is this: “Is chemistry really a difficult subject to teach and learn? The burden of evidence revealed that most concepts in chemistry are indeed difficult to learn by most students (Johnstone and Otis 2006). Considerable research has been undertaken to explore the learning problems that students were experiencing. The common underlying trend became apparent as it relates to the way humans process new information. The secondary school knowledge of chemistry is often characterised by lack of coherence. Instead of having a well-structured and integrated domain-specific knowledge structures; students consider the different concepts as isolated elements of knowledge. Most students do not possess a well-founded basic framework in which newly acquired concepts can be integrated (Fatokun & Idagboyi, 2012). This lack of integration is suspected to be the basis of student’s difficulties concerning concept formation and application of acquired knowledge in exercise and practical work (Brandt et al, 2001).
Okebukola (2005) itemised almost the entire concepts in the senior secondary school syllabus as areas commonly found difficult to teach by graduate teachers. These concepts include nuclear chemistry, organic chemistry, reactions and electrolysis. According to Pearson (2010) one consequence of the difference in bonding in salt and sugar is their different behaviours in water. NaCl dissolves in water to yield ions in solution (NaCl is an electrolyte), whereas sucrose dissolves in water to yield aqueous sucrose molecules (sucrose is a non-electrolyte). The properties of substances are determined in large part by the chemical bonds that hold their atoms together. What determines the type of bonding in each substance, and just how the characteristics of these bonds gives rise to different physical and chemical properties? The key to answering these questions constitute the basic concepts of chemical bonding.

According to Novak and Canas (2006) “concepts are the building blocks of knowledge in all fields” and this can trigger in individuals either for “static thinking (surface or rote thinking) or dynamic thinking (deep or meaningful thinking)” Novak (1998) says by the age of 30 months a child recognises the concept labels by concept formation and meaning building is concept assimilation that is never finished in a life time.

Yager (1991) asserted that science educator should remember transferring knowledge does not lead to understanding unless the knowledge is tied, or embedded into the missing spaces of the existing schemas thus leading to “self-organisation and reorganisation”. He also reminds the science educator that “knowledge is not transferred by means of words without first and agreement of meaning and some experiential base. In the class room setting when the teacher and the student negotiates and constructs meaning for a body of knowledge, knowledge acquisition do not occur as the transfer of “nuggets of truth” (Kelly, (1955) as cited by Duit, (2007)) but the learner becomes an active participant in the construction of knowledge, thus meaningful learning occurs.
Graphic organisers are visually powerful learning tools (strategy) to construct meaning and thus help in meaningful learning. Concept maps are graphic organizers constructed by J.D. Novak of Cornell University (USA) in 1972 while trying to make sense of the children’s domain of knowledge before and after instruction. The method has turned out to be effective for teachers for organising the knowledge before and during instruction and for the students to find meaning with the concepts learned in any knowledge domain.

Katcha (2010) for instance, 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. 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). Activity-based strategies are known to enhance acquisition of science attitudes and students performance (Akporehwe & Onwioduokit, 2010).

Ausbel’s learning theory (Ausbel, 1960) suggests that hierarchical structures should be used in promoting understanding and recall. Ausbel and Novak worked extensively on cognitive structuring. Novak and his coworker have developed the idea of concept map as an exemplary learning/teaching strategy (Novak, 1981). Concept mapping was introduced by Novak of Cornell University and his collaborations in the late 70’s. It is based on Ausbel’s theory of subsumption of new ideas or concepts into an organized structure, a pre-existing knowledge. It is believed that the new concepts are given meaning through assimilation into existing framework.

Construction of good concept mappings by students depends to a large extent, on effective planning and sequential teaching by the teacher (Ikeobi, 2010). The thought out, carefully spaced and the
delivery of lesson should reflect the inter-relationship between various concepts. Concept mapping is a diagram that depicts suggested relationships between concepts. It typically represents ideas and information as boxes or circles, which it connects with labeled arrows in a downward branching hierarchical structure. Concept mapping provides opportunity for students to work in groups thereby encouraging cooperative learning.

In a study on cognitive style and students' problem-solving competence in chemistry, Ahiakwo (2002) reported that students perform poorly in qualitative problems involving electrolysis. The study emphasized that students not only had difficulties with the recall of appropriate information but also with the methods on strategies required to reason through the problem. The study was concerned with finding out the extent to which students' cognitive style influenced their problem solving ability in some aspects of chemistry. The study addressed the issue of meaningful learning and stressed the value of prior knowledge in students learning and linking of new information to existing schemes as a necessary requirement for meaningful learning.

Many other studies have also shown the utility of such maps in diagnosing and in promoting meaningful learning since hierarchical organisation have economic representation of important ideas and relationship among them. It also facilitates the retrieval processes if it is properly adapted to the task domain. Bruner (1983) takes a different approach to learning. To him learning is a process of discovery. This begins with problem solving, a process analogous to teaching someone how to swim by throwing him into deep pool of water. The assumption is that the learner will learn the necessary skills because he needs them to survive from drowning. This often requires an internal reorganisation or cognitive restructuring of previously known ideas in order to accommodate the new experience. These two learning theories form the basic framework upon which this current study hung. Researchers have also shown that students understand and perform better when different teaching methods are
blended or integrated together to enhance learning (Sisovic and Begovic, 2000).

From the study conducted by Sisovic and Begovic (2000) in Yugoslavia, the use of concept maps in combination with demonstration experiment for teaching chemistry was illustrated. At elaborate and systematic sessions, concepts and their interrelations, as well as to formulate theoretical explanations for the observed changes they viewed or experienced. The impact of concepts mapping and visualisation on the learning of secondary school chemistry students in Belgium was conducted by Brandth et al. (2001). The researchers sought to find the effect of concept mapping and visualisation on students learning by comparing the two approaches. There were 88 students involved in the study and they were divided into two equal groups. The findings revealed that there was a significant positive effect of extra attention to visualisation on the learning achievement of students.

Without doubt, chemical bonding is an essential concept for chemists and is necessary for the understanding of chemistry. However, multiple studies have described numerous difficulties that students have with bonding concepts (Taber and Coll, 2003; Ozmen, 2004). For instance, students have difficulty understanding why bonding occurs and provide incorrect explanations for bonding phenomena (Nicolle, 2001b). Many of these misconceptions are robust and remain even after instruction (Nicolle, 2001b; Taber and Coll, 2003; Ozmen, 2004). In other studies, students confused ionic bonding with covalent bonding (Butts and Smith, 1987; Laxford and Bretz, 2014). In addition, others have shown that students were not clear about polar covalent bonding and covalent bonding and disregarded the role of electronegativity in polar covalent bonding (Peterson and Treagust, 2001). What is clear from these studies is that students’ understanding of polar covalent bonding, bond polarity and related concepts such as intermolecular forces, bonding polarity, and electronegativity is fuzzy. Some researchers have argued that the topic of polar covalent bonding is often presented in a problematic way, such
that students are left to interpret chemical bonding concepts in a multitude of ways (Bergqvist et al., 2013).

Despite the widely understood notion that covalent bonding, polar covalent bonding and ionic bonding are a continuum, chemistry educators (Levy Nahum et al., 2010; Taber et al., 2012) and textbooks (Bergqvist et al., 2013) still present this information as three distinct types of bonding. It is against this background that this study was carried out to ascertain if concept-mapping still enhances assimilation, retention, retrieval of knowledge and also to uncover student’s knowledge structures of chemical bonding concepts.

**Statement of the Problem**
Chemistry courses are required for many students across science, technology, engineering and mathematics (STEM) fields. Many topics covered in general chemistry are fundamental to chemical understanding and are built upon as students advance to other courses such as organic chemistry and biochemistry. However, many students complete general chemistry but still lack conceptual understanding of several fundamental topics such as Lewis structures (Nicolle, 2003; Cooper et al., 2010) and chemical bonding (Nahum et al., 2007; Othman et al., 2008; Luxford and Bretz, 2014).

Science teachers have applied various methods and strategies like discovery, field trips, lecture, and discussion (Akinsola and Igwe, 2002) for teaching chemistry, yet there has been poor performance among secondary school students in the certificate examination throughout the country. Certain difficult chemistry concepts have also been identified contributing to students poor performances (Okebukola, 2005) and topics such as covalent bonds and electronegativity are considered difficult.

With these concerns in mind, chemical educators are giving more thought about what to teach, how to teach, and the appropriate order of topics in general chemistry (Cooper, 2010; Cooper and Klymkowsky, 2013). It seems that concept mapping strategy could be an approach to effectively teach these concepts and enhance student’s
achievement in chemistry. To this end, this study seeks to further investigate how concept maps can be used to assess how students make connections among various interrelated concepts and also to find out if concept mapping would uncover student’s understanding and knowledge structures of chemical bonding concepts.

Purpose of the Study
The use of concept-mapping to investigate the knowledge structures of secondary school chemistry students’ regarding chemical bonding concepts is the major purpose of this research study. To achieve this purpose, the following specific objectives were pursued:

i. To ascertain if concept mapping integrated instructional strategy can uncover students’ knowledge structures regarding aspects of chemical bonding?

ii. To determine if students’ achievement in chemical bonding is influenced by gender when taught using concept mapping instructional strategy.

Research Questions
i. How well can concept mapping instructional strategy uncover students’ knowledge structures regarding aspects of chemical bonding?

ii. What is the effect of gender on student’s achievement when taught chemical bonding using concept mapping instructional strategy?

Research Hypotheses
i. Concept mapping will have no significant effect in uncovering the student’s knowledge structure regarding aspects of chemical bonding.

ii. There is no significant effect of gender on students’ achievement when taught chemical bonding using concept mapping instructional strategy.

Research Method
A pre-test post-test quasi experimental control group design was adopted as appropriate research design for this study to give room for
the manipulation of the independent variable. The target population of this study comprised the entire senior secondary school chemistry students in Eti Osa Local Government Area. The study sample consisted of one hundred (100) participants from two randomly selected senior secondary schools from the target population.

Chemical Bonding Achievement Test (CBAT) was used for data collection. The CBAT consists of two sections; Section A: sought information on respondents’ bio data such as school, sex etc. Section B: consisted of 20 multiple choice test items selected from SSCE past questions on chemical bonding. The test items were distributed among the six cognitive levels of Blooms’ taxonomy using table of specification.

The two groups (experimental and control) involved in the study were given CBAT as a pre-test in order to established if they both have the same entry knowledge for the topics chosen. The pre-test administration took place a month before the treatment to avoid carry-over memory and transfer effects. Experimental group was subjected to concept mapping integrated instructional package while the control was taught using lecture method.

Results and Discussion
Data obtained from the study were subjected to statistical analysis using mean, standard deviation for the research questions and t-test for the hypotheses at 5% level of significance.

Research Question one: How well can concept maps uncover students’ knowledge structures regarding aspects of chemical bonding?

Table 1: Descriptive Analysis of Students’ Achievement in Chemical Bonding

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>50</td>
<td>5</td>
<td>18</td>
<td>11.56</td>
<td>3.376</td>
</tr>
<tr>
<td>Control</td>
<td>50</td>
<td>2</td>
<td>15</td>
<td>9.98</td>
<td>3.588</td>
</tr>
</tbody>
</table>
Table 1 shows that the mean achievement score of the experimental group achievement test was 11.56 with a standard deviation of 3.376 which is higher than the mean achievement of the control group of 9.98 with standard deviation of 3.588 and also the wide gap between the minimum score and maximum score of the students shows that concept mapping can uncover the students’ knowledge on chemical bonding.

To ascertain how well concept map can uncover students’ knowledge structures regarding aspects of chemical bonding the null hypothesis one is tested.

Hypothesis one: Concept mapping will have no significant effect in uncovering the student’s knowledge structure regarding aspects of chemical bonding.

Table 2: T-test Analysis of Students’ Achievement in Chemical Bonding

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>df</th>
<th>t-cal</th>
<th>t-tab</th>
<th>Sig.(2tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>11.56</td>
<td>3.38</td>
<td>98</td>
<td>2.13</td>
<td>1.68</td>
<td>0.038</td>
</tr>
<tr>
<td>Control</td>
<td>9.98</td>
<td>3.58</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 shows that the t-calculated of 2.13 is greater than the t-tabulated of 1.68 (2.13>1.68) and also the significant value of 0.038 is less than 0.05. Hence, the null hypothesis is rejected which means that concept mapping had a significant effect in uncovering the students’ knowledge structure regarding aspects of chemical bonding.

Research Question Two: What is the effect of gender on student’s achievement when taught chemical bonding using concept mapping instructional strategy?
Table 3: Descriptive Analysis of Experimental Group Achievement Based on Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>21</td>
<td>6</td>
<td>18</td>
<td>11.81</td>
<td>3.219</td>
</tr>
<tr>
<td>Female</td>
<td>29</td>
<td>5</td>
<td>18</td>
<td>11.38</td>
<td>3.767</td>
</tr>
</tbody>
</table>

Table 3 shows the achievement of the experimental group considering different gender. From the table, there is slight difference in the mean achievement scores of both the male and the female students. The hypothesis formulated on effect of gender was further tested to establish whether the difference is significant.

Hypothesis Two: There is no significant effect of gender on students’ achievement when taught chemical bonding using concept mapping instructional strategy.

Table 4: T-test Analysis of Experimental Group Achievement Test Based on Gender

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>df</th>
<th>t-cal</th>
<th>t-tab</th>
<th>Sig.(2tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>11.81</td>
<td>3.129</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>11.38</td>
<td>3.767</td>
<td>49</td>
<td>0.44</td>
<td>.676</td>
<td>0.66</td>
</tr>
</tbody>
</table>

From table 4, calculated t-value is 0.44, and table t-value is 1.676. This shows that the calculated t-value is less than the table t-value (0.44<1.676). Hence, there is no statistically significant difference due to gender and the null hypothesis is accepted.

Discussion of findings

The difference in mean scores shown on table 1 is statistically significant in favour of the experimental group as shown on table 2. 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 agreement with previous findings by Keogh & Naylor (1996); Jiang, (2004); Novak & Canás, 2008).
According to Jiang, 2004, concept mapping helps to increase students’ understanding of chemistry concepts, even bonding. 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. Conversely, the lower mean retention score for control group could have been as a result of rote memorisation 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.

It was also discovered that a slight difference still exist in the performance of the male and female students (Table 3) but the difference is not significant(Table 4), hence both male and female students perform the same when exposed to the same condition of teachings or learning. This means that gender is not a factor to be considered when introducing the students to any teaching method or strategy. The finding is in agreement with the result of Adigun and Yusuf (2004), who reported that gender will not have a significant difference on the secondary school chemistry achievement in chemistry.
Conclusion
Consequent upon the findings, it is concluded that the exposure of students to concept mapping integrated instructional strategy enhances their achievement in chemical bonding and retention of the knowledge. The findings of this study reveal that concept mapping have a significant effect in uncovering the students’ knowledge structure regarding aspects of chemical bonding. Concept map is important instructional materials which will help improve the students’ performance in chemistry and other science subjects. Burner asserted that students learn science best through discovery and Casdels et al. (2001) affirmed that concept mapping should be used mostly in teaching chemistry. This is in agreement with Inekwe (2010) who concluded that new and novel teaching strategies often enhance learning and productivity. However, gender does not determine the effect of concept mapping on the students’ achievement.

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

The curriculum for training chemistry teachers should include how to develop and use concept maps to teach chemistry and indeed all science subjects.

Federal Government through the Ministry Education should organise 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.

Since concept mapping is found to be an effective teaching strategy for improving students’ achievement in chemistry therefore, chemistry teachers should be ready to accept and use it as one of the effective strategies that could be used in chemistry classroom.
The teacher training institutions should include the concept mapping strategy in the chemistry method course content. This will ensure that pre-service chemistry teachers know the value of and how to use the concept mapping instructional strategy.

References


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