Research Paper

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Effect of Concept Mapping Teaching Strategy on Students' Achievement in Environmental Concepts in Chemistry

Chemistry

KEYWORDS : Concept mapping, Teaching Strategy, Environment, Chemistry

Chinwe Nwagbo University of Nigeria, Nsukka.

Ifeoma Okonkwo Girls' Secondary School, Nnewi, Nigeria

ABSTRACT

This study investigated the effect of concept map-ping teaching strategy on students' achievement in en-vironmental concepts in Chemistry. The influence of gender on students' achievement was also investi-gated. The design was quasi-experimental, specifically the non-equivalent control group design. The sample consisted of 313 Senior Secondary two Chemistry stu-dents, randomly drawn from four schools. Two re-search questions and two null hypotheses guided the study. Environmental Chemistry Concepts Achieve-ment Test (ECCAT) was used for data collection. Data were analyzed using mean, standard deviation and Analysis of Covariance. Results revealed that students in the experimental group (concept mapping) had sig-nificantly higher achievement mean score than those of the control group (lecture method). It was concluded that concept mapping is better than lecture method in enhancing students' achievement in environmental concepts in chemistry. The result also revealed that the male students significantly achieved higher than the females. The implications of the findings were high-lighted.

Introduction

The need to use activity-oriented and learner-centred strategies of teaching is emphasized in the Nigerian National Policy on Educations (Federal Republic of Nigeria (FRN), 2004), which states that:

- Educational activities shall be centred on the learner for maximum self-development and fulfillment.
- The education system shall be structured to develop the practice of self-learning.

These imply that the use of strategies in which the learner plays the most active part and interact with each other to construct their own knowledge is advocated. Such activity oriented teaching strategies include guided inquiry, discovery and concept mapping among others. Concept mapping teaching strategy is employed in this study.

Concept mapping is a meta-cognitive tool developed by Novak and a team of researchers from the Cornell University in 1972. It is a graphical arrangement of key concepts to show meaningful relationships among the selected concepts or ideas being studied. The development of this strategy was based on Ausubel's assimilation theory, which in turn is based on the principle that the single most important factor influencing learning is what the learner already knows. It relates directly to such theoretical principles as prior knowledge, subsumption, progressive differentiation, cognitive bridging and integrative reconciliation. According to Inomesia & Unuero (2003), it is a structural visual means of representing concepts and their relationships. Novak (1991) defined concept maps as diagrams indicating inter-relationships among concepts as representation of meaning or ideational framework specific to a domain of knowledge.

The creation of concept maps involves the incorporation of new meaning into prior knowledge. The strategy is hinged on the fact that concepts do not exist in isolation but are rather inter-related with others to make meaning. Concepts are arranged and presented in a hierarchical order, with the most general concepts at the top of the map and the less general and more specific concepts arranged below. Concepts are usually enclosed in circles or boxes and the relationship between and among concepts are indicated using cross links or connecting lines that link them. The relationship between the concepts are articulated in linking phrases or words on the connecting lines e.g. 'give rise to', 'results in', 'is required to', and 'contributes to' among others. The number of hierarchical levels addresses the degree of subsumption; the number of branching indicates progressive differentiation while the number of cross-links indicates the degree of integration of knowledge. Maps generated by a learner report his/her conceptual organization of the topic, in this case, the environmental concept in chemistry.

Chemistry is a pre-requisite for many science and technology related courses such as medicine, engineering and computer science among other courses in tertiary institutions. Furthermore, chemistry cannot be isolated from our lives since human beings have on daily basis been in contact with chemical products, processes and technology such as cosmetics, drugs and soaps among others. Chemistry also plays pivotal role in industrial set ups like fertilizer, petroleum, cement and pharmaceutical and in the execution of other professions such as engineering, medicine and agriculture. By implication, the development and sustenance of any form of technology will be difficult without laying a solid foundation for effective and efficient chemistry education.

However, indices from various examination bodies such as the West African Examination Council (WAEC) and the National Examination Council (NECO) have shown a consistent trend of low enrolment and poor achievement of students in chemistry (WAEC, 2006-2010). The chemistry curricula contain concepts and processes ranging from physical, organic and inorganic Chemistry, where concepts from other areas of study such as environmental education (EE) are infused. The EE concepts are examined alongside the other core chemistry concepts in the same examinations. While some studies (Ifeakor 2005; Njoku, 2007; Adesoji, 2008; Longjohn, 2009 and Okeke, 2010), had examined achievement in other areas of Chemistry, EE aspects of the Chemistry curricula have not been examined for conceptual difficulties and/or poor achievements of students in national examinations. Currently environmental issues have been brought to the forefront by the United Nations Environmental Protection (UNEP) and other environmental agencies, as a result of certain prevalent environmental problems world over. Since these environmental problems necessitated the infusion of the environmental concepts into the chemistry curriculum, it becomes necessary to investigate students' achievement in this aspect of chemistry. However, the achievement of students in chemistry may be influenced by gender.

Gender is one of the factors interacting with achievement in Chemistry and other sciences (Isa, 2005; Ekwueme and Umoinyang, 2005). However, studies on how gender actually influences achievement are inconclusive. Some studies (Ifeako, 2005 & Obeka, 2007), reported that male students have higher achievements and interest scores in chemistry than females. This was attributed sex-role stereotyping, masculine image of science and female socialization process. Contrary to the above finding, Ekwueme and Umoinyang (2005) reported that gender influenced achievement in favour of females. On the contrary, Danmole and Femi-Adeoye (2004), found no significant difference in the achievement of students due to gender. They opined that achievement of both males and females can be affected by teaching and learning styles. It is based on this premise that the study also investigated the influence of gender on achievement in environmental concepts in chemistry.

Research Questions: Two research questions guided the study.

1. What is the effect of concept mapping teaching strategy on students' achievement in environmental concepts in chemistry?
2. What is the influence of gender on students' achievement in environmental concepts in chemistry

Hypotheses : Two null hypotheses guided the study

Ho_1: There is no significant difference in the achievement mean scores of students taught environmental concepts of chemistry using the concept mapping teaching strategy and those taught the same concept using the lecture method.

Ho_2: There is no significant difference in the achievement mean score of male and female students when taught environmental concepts in chemistry using concept mapping strategy and lecture method.

Research Method

The study adopted the non-equivalent control group quasi experimental design. The population consisted of all senior secondary two (SS 2) students who offer Chemistry in all public secondary schools in Nnewi Education Zone of Anambra State, Nigeria. Purposive random sampling technique was adopted in selecting four out of seven public single sex schools, which have two or more SS 2 streams. From the four schools (2 males and 2 females), two intact classes each were randomly selected and assigned to experimental and control groups respectively. The sample consists of 313 chemistry students (156 for the experimental group and 157 for the control group). The Environmental Chemistry Concepts Achievement Test (ECCAT) was used for data collection. The ECCAT is a 60- item, 4- option multiple choice objective test, developed and validated by the researchers, based on the environmental concepts in chemistry, namely: pollution and solid waste management. The reliability coefficients of the instrument, was determined using the kuder-Richardson's formula -20 (K-R- 20) and the value obtained was 0.86.

Two instructional strategies, concept mapping and the lecture method were used to deliver the same content to the groups. The regular chemistry teachers were trained for four days to carry out the teaching in the experimental and control classes. ECCAT was administered to all the groups as a pre-test before treatment, after which the questions were reshuffled before being administered as a post-test. The teaching lasted for six weeks. The pre-test and post-test scores were analyzed using mean, standard deviation and Analysis of Covariance.

Results and Discussion

The Results are presented according to the research questions and hypotheses of the study. For research question 1 which sought information on the effect of teaching strategies (concept mapping and lecture) on students' achievement mean scores in environmental concepts in Chemistry, data on Table 1 indicate that at pre-test, the students taught using concept mapping had achievement mean score of 11.13 and a standard deviation of 2.67 while at post-test, the achievement mean score was 57.39, standard deviation 3.22 and a mean gain score of 46.26. For students taught using lecture method, pre- achievement mean score was 11.11 and standard deviation of was 2.41 while post-achievement mean score was 32.31, with standard deviation of 5.13 and mean gain score of 21. 20.

Table 1: Pre-test and Post-test Achievement Mean and Standard Deviation Scores of Students in ECCAT due to Teaching Strategy.

Teaching Strategy	Pre-test			Post-test		
	N	$\overline{X}$	SD	$\overline{X}$	SD	Mean Gain
Concept mapping	157	11.13	2.67	57.39	3.22	46.26
Lecture	156	11.11	2.41	32.31	5.13	21.20

This implies that the experimental group appears to have performed better than the control group in the achievement test. To ascertain whether the observed differences were significant, hypothesis 1 was tested at 0.05 level of significance.

For hypothesis 1, which tested no significant difference in the achievement mean scores of students taught using concept mapping and lecture method, data on Table 2 show that the treatment (teaching strategies) as main effects is significant on students' achievement on ECCAT. This is shown by the calculated f value of 2.521 which is significant at 0.000. Since this value is less than the 0.05 level of significance, the null hypothesis is rejected.

Source	Sum of squares	df	Mean squares	F	sig	Decision
Converted model	67352.987a	12	5612.749	430.342	.000	
Intercept	56272.986	1	56272.986	4.32	.000	
Pre ECCAT	426	1	.426	.033	.875	
Method Gender	65758.938 495.672	2 1	32879.469 495.672	2.521 38.004	.000* .000*	Reject Reject
Error	5921.309	454	13.043			
Total	1186715.000	467				
Corrected total	73274-296	466				

***=significant at p<0.05**

This means that there is significant differences in the achievement mean scores of students taught with concept mapping and those taught with lecture method. Therefore, concept mapping is significantly superior to the conventional lecture method in enhancing achievement. The finding of this study gives further credence to the findings of Ezeudu, (1995); Ezeugo and Agwagah, (2000); Imoko, (2005) and Okonkwo, (2011); who had earlier reported that students exposed to concept mapping demonstrated a greater and in-depth understanding of concepts than those exposed to lecture method.

For research question 2, which sought information on the influence of gender on student' achievement on the environmental concepts in Chemistry, data in Table 3 show that at pre-test, the achievement mean score for males was 10.6 with standard deviation of 2.61 while that of females was 11.69 with standard deviation of 2.67. The post-test mean score after treatment, for males was 47.79 with SD of 12.51 while that of females was 47.89 with SD of 12.53.

TABLE 3 Mean and Standard Deviation of Student's Achievement Scores by Gender

Gender	Pre-test			Post-test		
	N	$\overline{X}$	SD	$\overline{X}$	SD	Mean Gain
Males	152	10.60	2.61	49.79	12.51	39.19
Females	161	11.69	2.67	47.89	12.53	36.20

The males recorded mean gain score of 39.19 while the females had 36.20. This implies that the males scored higher than the females in the post-test. As a result of the observed differences in the mean achievement scores of male and female student, hypothesis 2 was tested at 0.05 confidence level, to see if the observed difference was significant.

For hypothesis 2, data in Table 2 show that gender is significant on student's achievement in ECCAT. This is revealed by the calculated f value of 38.004 with probability level of .000 which is less than 0.05 level of significance. The null hypothesis of no significant difference was therefore not accepted. This implies that there is significant difference in the influence of gender on achievement of male and female students, in ECCAT, in favour of the males.

The result of this study is consistent with the findings of previous researchers (Ifeakor 2005 & Obeka, 2007), who reported that male students achieved significantly higher than their female counterparts. The result is not consistent with those of (LongJohn, 2009 and Ekwueme & Imoinyang, 2006) who reported that females achieved significantly higher than the males. The higher achievement of males in this study may be attributed to socio-cultural factors that hinder female achievement in science.

Educational Implications of the Findings

The findings imply that more teachers would opt for concept mapping teaching strategy for better curriculum delivery. Teachers would be able to provide learning environment that would benefit all students irrespective of gender. For chemistry students, the strategy would enable them construct knowledge, explore and elaborate their views, connecting their thoughts physically, to achieve better results. Curriculum planers also would be able to carefully appraise the curriculum content and implementation strategies ensuring that adequate provisions are made for the use of concept mapping.

Based on the foregoing, the following recommendations were proffered:

- Chemistry teachers should endevour to use concept mapping strategy for chemistry lessons in order to motivate students to learn meaningfully for better achievement.
- Professional organizations like STAN and the Ministries of Education should organize workshops and seminars for Chemistry teachers to update their knowledge on the use of the concept mapping strategy for instructional delivery.

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