Effect of Concept Mapping Method of Instruction and Expository Method on Students' Academic Achievement in Chemistry

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Abstract

This study was designed to investigate the effect of concept mapping method of instruction and expository method on students' academic achievement in chemistry. Two research questions were posed and three hypotheses were formulated to guide the study. The pretest - posttest non equivalent control group quasi-experimental design was used. The population for the study comprised all senior secondary school class 2 (SS2) chemistry students in a single sex school in Enugu Education Zone of Enugu State. The instrument for data collection was a self developed chemistry Achievement Test on Water as Universal Solvent (CATWUS). Relevant data were collected from a sample of 275 students selected from four secondary schools (two boys' schools and two girls' schools). A reliability coefficient of 0.79 was obtained from the instrument using Kuder Richardson formula 20. Mean and standard deviation scores were used to answer the research questions, while two-way analysis of Covariance (ANCOVA) was used to test the three hypotheses at Alpha level of 0.05. The findings show that students taught using concept mapping method achieved higher than those taught using expository method. The achievement of female students was higher than that of the male students. Recommendations and conclusions were made.

Keywords: *Concept Mapping, Academic Achievement, Water, Expository Method.*

1. Introduction

Science plays a very important role in the development of any Nation. Science therefore is very crucial in shaping the way we think, explore, generate and apply knowledge about our environment. Ivowi (2003) observed that the development of the Nation depends largely on the level of scientific and technological literacy possessed by the citizenry. Chemistry is one of the branches of science which is very important in the technological development of any Nation. Chemistry contributes to the improvement of the quality of life of the citizenry.

According to Asiyai (2005) chemistry has helped in the development of modern technology through the application of its principles to modern invention. Despite the perceived importance of chemistry, students' achievement in chemistry is not encouraging. Therefore the students' persistent under-achievement in chemistry has been worrisome to the researcher. The observed failure in chemistry has been attributed to inappropriate method of instruction (Obemeata 2001). The expository method of instruction creates room for intellectual passivity and weariness of the students and encourages rote learning, rather than meaningful learning (Onyeneto 2000). This expository method enhances lack of interest in chemistry which ultimately leads to poor achievement. Therefore there is need to investigate a teaching method that concretizes instructions. Concept mapping is a teaching strategy that concretizes instructions by presenting to the students' picture of the concept in hierarchical way from simple to complex. Novak (1991) believes that concept mapping is a metacognitive aid in helping students "learn how to learn" and also as two-dimensional representation of relationship between concepts expressed simply as hierarchical arrangement of concept labels and linking words. Concept maps have been reported to be patent instructional tools for promoting what Ausubel has described as meaningful learning; meaningful learning refers to anchoring new ideas or concept with previously acquired knowledge in a nornabitary way Novak (1991).

Concept maps also serve as a useful vehicle for discussion between students and instructors. Concept Map can facilitate the preparation of lessons, the sequencing of topics, presented in a lesson and the sequencing of lessons by teachers and authors. When instructional materials are planed from concept maps, it becomes relatively easy for students to grasp the meaning of the materials; especially if the students themselves are asked to prepare their own concept of the topic (Musonda 1991).

The following research questions guided the study:

1. What are the mean scores of SS2 chemistry Students taught using concept mapping and those of their counterparts taught the same topic using expository method?

2. What are the mean achievement scores of male and female students taught water as universal solvent using concept mapping and expository method respectively?

The following null hypotheses (HO) were tested at 0.05 level of significance.

HO_1. There is no significant difference in the mean achievement scores of SS2 Chemistry students taught with Concept mapping method and those taught with expository method.

HO_2. There is no significant difference in the mean achievement scores in Chemistry between male and female students as measured by the CATWUS.

HO_3.There is no significant difference in the interaction effect of gender and teaching method on the students' means achievement scores.

2. Research Method

The design of the study was quasi-experimental research design. The specific quasi-experimentation that was used was the pretest – posttest, non equivalent control group design. The area of the study was Enugu Education Zone of Enugu State. Population for the study comprised all Senior Secondary School class two students (SS2) who were offering chemistry in single sex schools in Enugu Education Zone. Stratified random sampling technique (specifically balloting) was used to select two boys' and two girls' secondary schools. Two intact SS2 chemistry classes in each school were selected using random sampling. In each school one intact class was assigned to Concept Mapping Method of Instruction (CMI), while the other intact class was assigned to Expository Method of Instruction (EMI). The research subjects for the study were Two hundred and seventy five (275) chemistry Students (127 girls and 148 boys). The instrument for data collection was Chemistry Achievement Test on Water as Universal Solvent (CATWUS). The instrument was face and content validated by two experts in chemistry and one in measurement and evaluation from Enugu State University of Science and Technology. The reliability of CATWUS was determined using Kuder Richardson formula 20 (KR – 20). The internal consistency index obtained from CATWUS using KR - 20 was 0.79. Some extraneous variables were controlled like intergroup variable, Hawthorne effect, Teacher variable and testing effect. All the research questions were answered using mean (X) and two–way analysis of covariance. (ANCOVA) was used to test the hypotheses at 0.05 Alpha levels.

3. Procedure

Two instructional were used for this study. They were the Concept Mapping Method of Instruction (CMI) and Expository Method of Instruction (EMI). The CMI was for the experimental group while the EMI was for the control group. All the chemistry teachers used received one week training from the researcher on the use of concept mapping method and also gave them lesson notes. In CMI lesson presentation, the teacher presented the chemistry concept which is Water as a universal solvent which was subdivided into sub-headings: Natural and treated water, hardness of water, solutions and solubility. A map was formed on the concept with linking words. The teacher used explanation and questioning to the students to form the map from general to specific.

For EMI, the instructional procedure was made up to content development, teachers' activities, students' activities and strategies used. The research subjects were given pretest for both CMI group and EMI group. The teaching commenced on the two groups after administering the pretest, the treatment lasted for a period of four weeks after which a posttest was administered to the research subjects. Data collected for pretest and posttest for the two groups were used to answer the research questions and test the hypotheses.

4. Results

Research Question 1: What are the mean scores of SS2 Chemistry Students taught using concept mapping compared with the mean scores of their counterpart taught the same topic using expository method?

Table 1: Mean Chemistry Achievement Scores of Students taught water as universal solvent using CMI and EMI.

Group	MEAN X		
	Pretest	Posttest	Gain Score
CMI	2.64	27.48	25.84
EMI	2.89	13.80	10.91

Table 1 indicates that concept mapping method of instruction (CMI) group obtained mean achievement score of 2.64 and 27.48 respectively in pretest and posttest. On the other hand, expository method group had mean score of 2.89 and 13.80 respectively in the pretest and posttest. Therefore the gain score of CMI students is higher than EMI students. This indicates that students taught with CMI achieved higher than students taught with EMI.

Research Question 2: What are the mean achievement scores of male and female students taught water as universal solvent using concept mapping and expository method respectively.

Table 2: Mean Achievement Scores of Male and Female Students Taught Water as Universal Solvent

	MEAN X			N
Group	Pretest	Posttest	Gain Score	
FEMALE	I.62	21.02	19.40	127
MALE	3.74	20.27	16.53	148
				275

Table 2 indicates that female students irrespective of method, obtained mean score of 1.62 and 21.02 in the pretest and posttest respectively. On the other hand all the male students obtained mean score of 3.74 and 20.27 in the pretest and posttest respectively, irrespective of method used. Therefore female students achieved higher than their male counterpart irrespective of the method.

Hypotheses HO_1 - HO_3were tested at 0.05 level of significance using two-way analysis of covariance (ANCOVA).

Table 2: ANCOVA for students' mean achievement scores by instructional package types and gender.

Source Model	Sum of Squares	DF	Mean Square	F	Significance	Decision
Created model	16161.975	4	4040.494	135.841	0.000	S
Intercept	40264.276	1	40264.278	1353.685	0.000	S
Pretest	212.015	1	2121.015	71.309	0.000	S
Method	13759.391	1	13759.391	462.591	0.000	S
Gender	502.478	1	502.478	16.893	0.000	S
MethodGender	911.445	1	911.445	30.643	0.000	S
Error	8030.934	2.70	29.744			
Total	141098.00	275				

S= Significant, NS= Not Significant at 0.05 level of probability.

HO_1.There is no significant difference in the mean achievement scores of SS2 Chemistry Students taught with concept mapping method and those taught with expository method.

For hypotheses HO_1 table 2 shows that method was found significant at 0.000 which is less than 0.05 set for the study. Since the computed level of significance is less than 0.05 set for the study, the null hypothesis is rejected. The researcher therefore concludes that there is a significant difference in the mean scores of chemistry students taught with CMI and those taught with EMI.

HO_2. There is no significant difference in the mean achievement scores in Chemistry between male and female students as measured by the CATWUS.

For hypothesis 2, Table 2 shows that gender was found significant at 0.000 which is less than 0.05 set for the study. Since the computed level of significance is less than 0.05 set for the study, the null hypothesis is rejected. The researcher therefore concludes that there is a significant difference in the mean score of male and female students in CATWUS.

HO_3. There is no significant difference in the interaction effect of gender and teaching method on the students mean achievement scores.

For hypothesis 3 Table 2 shows that for the two-way interaction, method and gender was foundsignificant at 0.000 which is less than 0.05 set for the study. The null hypothesis is rejected. The researcher therefore concludes that there is a significant interaction of instructional package, types and gender on chemistry achievement.

5. Findings

For research question one which sought to find the mean score of students taught with CMI and EMI in Chemistry, the result in Table 1 indicates that CMI group deferred with EMI group in the mean score by 25.84. This means that those in CMI group achieved higher than those in EMI group in Chemistry. The findings is in line with Novak (1991)who observed that concept maps help students to grasp the meaning of the materials easily; that is promote meaningful learning.

For research question two which sought to find the influence of concept mapping on male and female students in chemistry. The finding agrees with the work of Ocho (1997) which observe that female students achieved better than male in Science.

For hypothesis one, the findings presented in Table 2 shows that method is significant at 0.000 which is less than 0.05 set for the study. The null hypothesis is rejected. There is a significant difference in the mean score of chemistry students taught with CMI and those taught with EMI. The researcher is of the view that CMI ensures meaningful learning. The finding is in agreement with Musonda (1991) who believes that concept map helps students "learn how to learn".

For hypothesis two, Table 2 shows that gender was found significant at 0.000 which is less than 0.05 set for the study, there is a significant difference in the mean achievement score of male and female students in CATWUS. The finding regarding gender is in line with Ocho (1997) which found female performed better than male in science achievement.

For hypothesis three, Table 2 shows that the result of the analysis of covariance test of interaction revealed that for the two-way interaction, method and gender was found significant at 0.000 which is less than 0.05 set for the study. The null hypothesis is rejected. There is a significant interaction effect of instructional package; types and gender on students' mean achievement scores in chemistry. The finding is in line with Ugwu (1995) who found that there is an interaction effect between method and gender as measured in chemistry achievement in CATWUS.

6. Conclusion

Concept mapping method of instruction was found more effective than expository method on students' achievement in Chemistry. Female Chemistry students achieved higher than their male counterparts.

7. Recommendations

Based on the results of the study, the following recommendations were made

1) Since concept mapping has been found to enhance achievement in chemistry; chemistry teachers should be encouraged to employ it more the teaching of the subject. By so doing the achievement of the subject could increased.
2) Teacher training tertiary institutions should include the concept mapping learning strategy in their chemistry curriculum and impart the usage of the same to the students.
3) Effort should be made to equip the teachers with the skills. This calls for state and federal government and ministries of education to organize seminars, workshops and or conferences for chemistry teachers on how to use concept mapping in teaching chemistry in particular and other subject in general.

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