European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available on-line at: www.oapub.org/edu

10.5281/zenodo.160986 Volume 2 | Issue 6 | 2016

EFFECTS OF CONCEPT MAPPING AND EXPERIMENTAL TECHNIQUES IN TEACHING BIOLOGY IN SECONDARY SCHOOLS IN FEDERAL CAPITAL TERRITORY ABUJA, NIGERIA

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Abstract:
The study was aimed at determining the Effect of Using Concept Mapping and Experimental Techniques in Teaching Biology in Senior Secondary Schools in Federal Capital Territory Abuja. The objective of the study was to compare the mean performance scores of students taught Biology using concept maps, experiments and lecture method, determine their retention level and find out their attitude towards the methods. The design of the study was quasi experimental pre-test posttest control group design. The population consisted of 6,208 SS2 Biology students of the Federal Capital Territory, from which 192 were selected from three schools within Karshi zone of Abuja Municipal Area Council. The major instruments used for data collection were Biology Achievement Test pre-test and post-test (BAT), Biology Achievement Retention Test (BART) used after 2 weeks of instruction and Concept Mapping Attitude Scale Towards Biology Questionnaire (CMASTBQ) and Experiment Attitude Scale Towards Biology Questionnaire (EASTBQ).The treatment package included Concept Mapping Instructional Package (CMIP), Lesson Plan for Experiments and Lesson Plan for Control Group. The items used for the pre-test, post-test and retention test were adopted from Educational Resource Centre (ERC) Abuja. The research questions analyzed using mean and standard deviation while the null hypotheses were analyzed using Two sample t-test, Covariance Analysis (ANCOVA) and Pairwise comparison at 0.05 alpha level of significance. The findings of the study showed that the use of experiments in teaching significantly improved the performance of students in Biology more than the use of

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concept mapping and lecture method. The use of concept mapping though enhances performance of students is not significantly better than the lecture method. The use of experiments makes for better retention levels than the use of concept mapping and lecture method. Students have a more positive attitude toward the use of concept mapping for teaching Biology than experiments. Based on the findings of the study, the use of experiments in the teaching of Biology are indispensable if the teaching and learning of the subject is to be effective and meaningful.

Keywords: concept mapping, experimental techniques, lecture method, attitude

Introduction

Biology occupies a unique position in the school curriculum; this is because Biology is central to many sciences related courses such as Medicine, Pharmacy, Agriculture, Nursing, Biochemistry, Dentistry, Microbiology, Laboratory Technology and all other related courses. It therefore becomes binding on anyone wishing to offer any of the courses listed or related to such to offer Biology as one of the prerequisite subjects in the secondary school to gain admission into the University. Although Biology is a prerequisite to these courses, poor achievement in Biology is alarming according to reports from Ajaja (2002) and Ahmed (2008), randomly collated WAEC results by the researcher from 10 schools in six area councils of Federal Capital Territory, between 2006 – 2010 in 2011 and also the researcher's many years of experience in internal biology examinations attest to this poor performance. These consistent poor performances in Biology external examinations among Senior Secondary Schools students have given a lot of concern to educators, curriculum planners and students themselves (Okoye, 2004).

Scientists and science educators have however come to a conclusive agreement as many researches have been on going on how to involve students in the learning process and science educators have come up with concept maps as one of such teaching learning techniques (Okoye & Okechukwu, 2006; Kinechin, 2000a,b; Markow & Lenning, 1998). According to Novak and Canas (2006), concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually endorsed in circles or boxes of some type and relationships between concepts are indicated by a connecting line linking two concepts. Words on the line, referred to as linking words or linking phrases specify the relationship between two concepts. The technique of concept mapping according to Wikipedia encyclopedia (2011) was developed by Joseph D. Novak as a means of representing the emerging science of knowledge of student by

his research team at Cornell University in the 1970s. It has subsequently been used as a tool to increase meaningful learning in the sciences and other subjects as well as to represent the expert knowledge of individuals and teams in education, government and business. Concept maps have their origin in the learning movement called constructivism. In particular, constructivists hold that learners should actively construct knowledge.

Nwagbo (2008:4) stated that, the use of practical activities (approach) in the teaching of Biological concepts should therefore be a rule rather than an option to Biology teachers. Practical work is a central theme of lessons in the natural sciences (Galton and Eggleston, 1979; Holstein & Lunelta, 1982 cited in Abimbola, 1994). Laboratory work is seen as an integral part of most science courses and offers students a learning environment that differs in many ways from the "traditional" classroom setting (Fisher, Harrison, Henderson & Hofstein, 1998). It is hard according to Ozay, Ocak and Ocak (2009) to imagine learning about science, without doing laboratory work or fieldwork. Student experimentation underlines all scientific knowledge and understanding. They provide students with opportunities to think about, discuss and solve real problems. No science can be properly taught without students' experiments.

The student experiment should be the central part of science teaching. Students' experiments are performed to find relations among concepts or to verify hypothesis. Studies from Ibe (2004) and Nwagbo and Chukelu (2011) have also indicated that active participation of students give rise to more meaningful and effective learning. The Biology teacher should therefore make Biology a student based learning by making experiments part of Biology teaching so as to improve students' performance.

According to Yara (2009) in Omirin and Oladosu (2010) attitude of the teacher and his teaching method can influence students' attitude. And attitude as they say is the key to success. Franseca (2010) opined that one of the factors that affect students' learning performance is the way they face knowledge, namely their attitude to the subject. Such attitudes as profound feelings, relatively stable are derived from positive or negative experiences across time on learning a subject (Estrad, 2002 in Franseca, 2010). Buttressing this, studies from Markow and Lonning, (1998), Simpson, (1978), Wilson, (1983) and Soyibo, (1985), in Adesoji (2008) reported that students' positive attitude to science correlate highly with science achievement.

The foregoing therefore underscores the need to look into the effect of concept mapping and experimental techniques in teaching Biology.

Objectives of the Study

This study sought to achieve the following objectives:

1. Compare the mean performance scores of students taught biology using concept map, experiments and lecture method.
2. Determine the retention level of students taught biology using concept maps, experiments and lecture method.
3. Find out the attitude of students towards biology when taught using concept maps and experiments.

Research Questions

The following research questions were asked:

1. What is the difference in the mean performance scores of students taught biology using concept maps, experiments and lecture method?
2. What is the retention level of students taught biology using concept maps, experiment and lecture method?
3. What is the attitude of students towards Biology when taught using concept maps and experiments?

Hypotheses Testing

The following hypotheses were tested at 0.05 level of significance.

$H0_1$: There is no significant difference in the mean performance scores of students taught biology using concept map, experiments and those taught using lecture method.

$H0_2$: There is no significant difference in the retention level of students taught using concept map, experimental techniques and those taught with lecture method.

$H0_3$: There is no significant difference in students' attitude towards biology when taught using concept map and experiments.

Sample

Two co-educational senior secondary schools were purposely sampled for the study. The schools sampled include Government Secondary School (GSS) Nyanya, Abuja and Government Day Secondary School (GDSS) Karu, Abuja. Two arms of SS 2 classes were randomly sampled and used for the study. That is SS 2A of Government Secondary

School GSS (Nyanya) was used as the experimental class 1 (experiment) while SS 2B of the same school was used as experimental class 2 (concept mapping). Also, SS2A students of the respondents made up Government Day Secondary School, Karu was used as the control school.

Instruments

The main instruments used to collect data for the study was the;

- Biology Achievement Test (BAT) for Pre-test and Post-test,
- Biology Achievement Test for Retention (BATR) Adopted from the Education Resource centre. It consisted of 25 objective questions option A-D, covering five topics drawn from SS1and SS2 syllabus,
- Also 10-item questionnaire on Concept Map Attitude Scale Towards Biology Questionnaire (CMASTBQ) and
- Experiments Attitude Scale towards Biology Questionnaire (EASTBQ) of 4-point Likert scale type was validated for use by a psychologist.

Data Analysis

Hypothesis I: There is no significant difference in the mean scores of students taught Biology using concept map, experiments and those taught using lecture method.

The result of the covariance analysis model is summarized in Table 4.7.

Table 4.7: Covariance analysis on performances by students from the three methods of teaching

Source	Sum of Squares	DF	Mean Square	F	Sig.
Pre Test	.030	1	.030	.002	.966
Grouping	407.258	2	203.629	12.505	.000
Error	2914.763	179	16.284		
Total	44373.000	183			

The data presented in table 4.7 show that the F- value for grouping is 12.505, at .000 significance which is less than 0.005. The null hypotheses are therefore rejected at less than 0.05. A post hoc test was conducted on the mean scores to determine the method that had significantly higher score than the other. The pair wise comparison was carried out on the mean scores using the Least Significant difference procedure as summarized in Table 4.8.

Table 4.8: Pairwise Comparisons of performance scores by students taught with the three methods

(I) Methods	(J) Methods	Mean Difference (I-J)	Std. Error	Sig.
Concept mapping	Experiments	-3.627(*)	.764	.000
	Lecture	-.622	.736	.399
Experiments	Concept mapping	3.627(*)	.764	.000
	Lecture	3.005(*)	.772	.000
Lecture	Concept mapping	.622	.736	.399
	Experiments	-3.005(*)	.772	.000

*The mean difference is significant at .05 level.

The result in the table revealed that scores of students taught Biology with the use of experiments performed significantly higher than those taught with concept mapping and lecture method. Between students taught with Concept mapping and Lecture method, no significant difference was observed in their performance.

Hypothesis II: There is no significant difference in the retention level of students taught using concept map, experimental techniques and those taught with lecture method.

Significant difference in the retention ability of the students was tested here with Covariance analysis procedure. The result of the covariance analysis model is summarized in Table 4.10.

Table 4.10: Analysis of covariance on mean retention levels by students exposed to the use of concept mapping, experimental techniques and lecture method

Source	Sum of Squares	DF	Mean Square	F	Sig.
Pre test	163.709	1	163.709	165.892	.000
Grouping	9.696	2	4.848	4.913	.008
Error	185.526	188	.987		
Total	4429.000	192			

The data presented in table 4.10 show that the F- value for grouping is 4.913 with significance at.008 which is less than 0.005. The null hypotheses is therefore rejected at less than 0.05. A post test was conducted on the mean scores to determine the method whose retention score was significantly different from the other. The pair wise comparison was carried out on the mean scores using the Least Significant Difference procedure. The result is summarized in Table 4.11.

Table 4.11: Mean comparison between retention levels by the different methods used in the teaching of the subject

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.(a)
Concept mapping	Experiments	-.530(*)	.197	.008
	Lecture	.072	.176	.684
Experiments	Concept mapping	.530(*)	.197	.008
	Lecture	.602(*)	.206	.004
Lecture	Concept mapping	-.072	.176	.684
	Experiments	-.602(*)	.206	.004

Based on estimated marginal means

*The mean difference is significant at .05 level.

The test revealed that the retention level obtained among students taught with use of experiments was significantly different from those of the Concept mapping and the Lecture methods. Between the retention level of those taught with the Concept mapping and the lecture method, no significant difference was observed.

Hypothesis III: There is no significant difference in students' attitude towards biology when taught using concept map and experiments.

The attitude of the students towards the use of the concept mapping and the use of experimental technique for the teaching of Biology was compared here with the two sample t-test. The result of the test is summarized in Table 4.12.

Table 4.12: Two sample t-test on attitude towards the use of Concept mapping and experimental techniques in the teaching of Biology

Variables	N	Mean	Std. Deviation	Std. Error	t-value	DF	P
Experiments	64	3.72	0.386	0.048	5.707	126	.000
Concept Mapping	64	3.83	0.310	0.039			

(t-critical = 1.96)

The result revealed that students were more favorably disposed towards the use of concept mapping than the use of experimental techniques in the teaching of Biology. This is indicated by the observed mean score of 3.83 for concept mapping compared to 3.72 for experimental technique. The observed level of significance for the test is 0.000 ($P < 0.05$). With these observations, there was enough evidence to reject the null hypothesis.

Findings

The major findings from the data analysis and test of the hypotheses are summarized as follows:

1. The use of experiments in teaching significantly improved the performance of students in Biology more than the use of concept mapping and lecture method. The use of concept mapping though enhances performance of students is not significantly better than the lecture method.
2. The use of experiments makes for better retention levels than the use of concept mapping and lecture method.
3. Students have a more positive attitude toward the use of concept mapping for teaching Biology than experiments

Discussion

The result revealed that the performances from students exposed to the three different methods were significantly different. From the post hoc test conducted on the mean scores, it was revealed that the observed significant difference was between students who were taught with experiments and the other two groups (Concept mapping and Lecture). Between the lecture and concept mapping methods, no significant difference was observed. The result here is contradictory to the reports of Udeani and Okafor (2012), Okoye and Okechukwu (2006) and Ajaja (2011). The results are however in agreement with the work of Stensvold and Wilson (1992), Boujaound and Attieh (2008), Eziefe (1996), Maduabum (1989).

Possible significant variability in the retention level induced by the three methods used in teaching the subject was tested in Hypothesis II. The result revealed that all the students differed significantly in their retention level from the test. From the post hoc test conducted on the mean scores, using the pair wise comparison with the least Significant difference procedure, it was observed that students who were taught the concepts with experiments were significantly better in their retention ability than those who were exposed to the other two methods. No significant difference was however observed between students who were taught with concept mapping and those taught with lecture method. The finding here agrees with the report of Ozay, Ocak and Ocak (2009); On the insignificant difference in the retention levels of students taught with concept maps and lecture methods, it agrees with the work of Steveson and Wilson (1992) , Boujaound and Attieh (2008) and Ajaja (2011) .

Difference in attitudinal disposition of the students towards the use of the concept mapping and the experimental techniques for teaching the biology concept was conducted in hypothesis III. The result of the test revealed that the students had positive attitude towards the two methods but they were more significantly inclined to the use of concept mapping than the use of experimental techniques for teaching the subject. The null hypothesis was therefore rejected. The finding here is consistent with the works of Yara (2009), Karakuyu (2010) and Abimbade (1983) and Aiyelaagbe (1998) in Adesoji (2008).

Conclusion and Recommendations

The use of experimental techniques for teaching biology concept enhances students' performance significantly better than the use of the concept maps and the lecture method,

The use of experimental technique significantly improved students' retention of Biology concepts than the concept maps and conventional lecture method and Students have higher preference for the use of concept mapping method of teaching than the experimental techniques of teaching the subject.

Based on the findings and discussion, it could therefore, be concluded that the use of experiments in the teaching of biology helps to improve students' academic performance, retain concepts, and showing a positive attitude towards a teaching method helps to reduce tension towards the subject. Students should be made to understand the merits of experiments. Emanating from the findings and discussion, it was therefore recommended that science teachers should lay more emphasis on the use of experiments in the teaching and learning of Biology for improving performance among students Science teachers and biology teachers in particular should give effective orientation to students towards the use of the experiments in the teaching of biology concepts and should be encouraged and trained in the use of concept maps alongside with other methods in the teaching of biology. Since attitude could be circumstantial, it would be necessary to put experiments and its merits before students to encourage them towards its use in the teaching and learning of the subject. The lecture method should still be used to teach very abstract topics to enable students acquire knowledge, new information and explanation of events or things.

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