CUSTECH INTERNATIONAL JOURNAL OF EDUCATION, VOL.1, NO. 1, JULY, 2024
http://custechijoe.org.ng
ISSN 1595-1839

COMPARATIVE EFFECTS OF CONCEPT MAPPING AND PROBLEM SOLVING ON SECONDARY SCHOOL BIOLOGY STUDENTS' ACHIEVEMENT IN MINNA METROPOLIS

BY

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Abstract

The study investigated comparative effects of concept mapping and problem solving strategies on secondary school biology students' achievement in Minna Metropolis.The study adopted pre-test post-test non-randomized quasi experimental research. The population of the study comprises of all senior secondary school biology students in Minna, Niger state Nigeria and target population were SS II Biology students. Intact class of 212 students (male =114, female=98) participated for the study from three randomly selected senior secondary schools in Minna, Niger. The Instrument used for data collection named Biology Achievement Test (BAT) and treatment material was Concept Mapping, Problem Solving Strategies and Conventional Lecture Method). The BAT comprises of 30 multiple choice objective questions. The Biology Achievement Test (BAT) were validated by three experts in Biology Education in both university and secondary school, because the research was carried out in colleges of education. Experimental group were given Pretest before the treatment and after treatment posttest were administered on them. Experimental group one was exposed to the use of Concept Mapping, experimental group two was exposed to Problem solving Strategy while Control group was exposed to Conventional Lecture Method (LM). Mean and standard deviation were used to analyze the research questions while ANCOVA was used analyzed hypotheses. Results; it was established that there was significant difference in the achievement of students taught biology using Concept Mapping, Problem Solving Strategy and Conventional Lecture Method. Also, there was no significant difference in achievement of male and female biology students taught using Concept Mapping and Problem Solving Strategy Conclusion; it was recommended that the use of Concept mapping and problem solving strategies for teaching and learning biology should be encouraged in secondary schools in Niger State.

Keywords: Concept mapping, problem solving, achievement

Introduction

Science is a systematic process of making enquiry about things in our environment in order to enhance the living standard of man. Many scientists define science

according to their own perception and understanding of the subject matter. Ogunleye (2012) stated that Science is a progressive human activity that has to do with having the knowledge of our world. This knowledge helps man to understand the universe. This knowledge of science makes it easy for man to explore his environment and make substantial gains from it. Thus, the primary aim of science is to make the society a better place through discovering different areas in our environments to improve upon. This could be achieved through data collection, analyzed and conclusion is drawn from; which is being applied to the natural phenomena and happenings around us. There are different science subjects offered in secondary schools, which include the following; Physics, Chemistry, Agricultural Science, Mathematics and Biology. Biology is relevant to several science courses like Biochemistry, Agriculture, medical sciences such as nursing, medicine and pharmacy. Any student that wants to offer these courses must offer Biology at the secondary school level. This is why researchers and curriculum planners' attention have been drawn to Biology as a science subject. In secondary schools (Hackett & Moyer, 2017).

The importance of Biology is enormous. The importance is most noticeable in genetic engineering, blood transfusion, food production, hybridization, marriage counseling and in-vitro fertilization (Lemberger., Hewson & Park, 2019). In spite of the relevance and importance of Biology to human lives, research findings have continued to give evidences which showed that the achievement of students in Biology is unsatisfactory to write home about (Cheema & Mirza, 2013). Also the summary of the biology NECO result of Niger state for the years under review (2017 -2022 is an indication of low achievement in Biology. According to Lakpini, (2012) the study of Biology can provide solutions to food scarcity, environmental pollution, population density, radiation, epidemic and terminal diseases, poor hygiene, family life, management and conservation of natural resources as well as biotechnology and ethics. Because of the relevance of Biology in our daily lives and in different sectors of life; it calls that the subject to be taught using teaching methods that will enhance retention and subsequently good academic achievement. Such method should include activity-based and guided discovery and concept mapping.

Concept maps are diagrams that show the relationship existing between concepts. Concept mapping according to Esiobu and Soyibo (2015) concept mapping is a word used to mean some kind of object, event or idea; key to human learning and meaning making, a mental impression or mental construct people have of words, objects, or events; source of human understanding, what we think with in science. The principle of concept mapping is that it provides a visual means of showing connections and relationships between a hierarchy of ideas ranging from the very

concrete to the abstract (Abdulsalem, 2016). Concept mapping helps in understanding ideas by showing the connections with other ideas (Ajaja, 2011). The history of development of concept mapping as an instructional tool can be traced to the early work of Ausubel and others in the 1970s (Ajaja, 2011). Furthermore, Ajaja noted that since its introduction, concept mapping has become a very useful tool in teaching and learning and particularly biology as a subject in secondary school. Similarly problem-solving is another strategy of teaching and learning of biology at senior secondary school level. Problem-solving is defined as a cognitive process towards achieving a particular purpose when the subject does not have a solution (Greiff*et al*., 2013). The lack of problem-solving capacity limits the usefulness, knowledge, skills and power of biology ideas, in solving environmental, sicknesses and diseases, such as HIV and AIDS, problems etc. (Uyen, *et. al*, 2021). Moreover, focusing on problem-solving aspects in lessons contributes to the development of students' higher-order thinking.

Statement of the Research Problem

Despite the importance attached to Biology in National policy on education FRN (2009), students record poor achievement in the 2017 and 2022 Senior Secondary School Certificate Examination, where by over 58% of students fail and 42% of students' scores above average. It has been observed that poor performance in the sciences in general and Biology in particular is caused by poor quality of science teachers, overcrowded classrooms, lack of suitable and adequate science equipment, large class size (Ibrahim, 2013). Following this assertion the researcher projected among other factors to be teaching method. In spite of application of various interactive method of teaching to improve the teaching and learning of biology, the trend persisted. As a result the researcher sought to investigate comparative effects of concept mapping and problem solving strategies on secondary school biology students' achievement in Minna Metropolis.

Aim and Objectives of the Study

The aim of this research is to investigate comparative effects of concept mapping and problem solving strategies on secondary school biology students' achievement in Minna Metropolis.

The specific objectives are to:

1. Examine the mean achievement scores of students taught biology using Concept mapping, problem solving and Conventional lecture method?
2. Find out the mean achievement scores of male and female students taught biology with Concept mapping and problem solving?

Research Questions

The following research questions were raised to guide the study:

1. What are the mean achievement scores of students taught biology using Concept mapping, problem solving strategies and Conventional lecture method?
2. What are the mean achievement scores of male and female students taught biology with Concept mapping and problem solving?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

H_{01}: There is no significant difference in the mean achievement scores of students taught biology using Concept mapping, problem solving strategies and Conventional lecture method.

H_{02}: There is no significant difference in the mean achievement scores of male and female students taught biology with Concept mapping.

H_{03}: There is no significant difference in the mean achievement score of male and female students taught biology with problem solving.

Methodology

The study adopted quasi experimental research design (a pre-test post-test non-randomized experiment and control groups design). This design was adopted because the sample of the study could not be randomised in order not to disrupt the normal classroom setting. The population of the study comprises senior secondary school biology students in Minna, Niger state Nigeria and target population were SS II Biology students. Intact class of 212 students (male =114, female=98) were used for the study from three randomly selected senior secondary school in Minna, Niger. The instrument used for data collection named Biology Achievement Test (BAT) and treatment material was Concept Mapping, Problem Solving Strategies and Conventional Lecture Method). The BAT comprises of 30 multiple choice objective questions. The Biology Achievement Test(BAT) were validated by three experts in Biology Education in both university and secondary school, because the research was carried out in senior secondary school. Experimental group were given Pretest before the treatment and after treatment posttest were administered on them. Experimental group one was exposed to the use of Concept Mapping, experimental group twowas exposed to Problem solving Strategy while Control group was exposed to Conventional Lecture Method (LM). Mean and standard deviation were used to analyze the research questions while ANCOVA was used analyzed hypotheses. Conclusion it was established that there was no significant difference in the achievement of students taught biology using Concept Mapping, Problem Solving Strategy and Conventional Lecture Method.

Research Question One: What are the mean achievement scores of students taught biology using Concept mapping, problem solving strategies and Conventional lecture method?

Table 1

Mean and Standard Deviation of Pretest and Posttest Achievement Scores of Experimental Group I and II and the Control Group

Group	N	Pretest		Posttest		Mean Gain/Loss
		$\bar{X}$	SD	$\bar{X}$	SD	
Exper-Gr1	76	40.24	17.23	77.63	14.729	37.39
Exper-Gr 2	61	64.18	23.67	83.43	8.663	19.25
Control Group	75	58.76	22.15	58.39	22.837	-0.37

Table 1 displays the means and standard deviation of experimental group one exposed to Concept mapping and experimental group two exposed to problem solving and the control group exposed to conventional lecture method at pretest and posttest. The mean achievement scores of experimental group one at posttest were higher (X = 77.63, SD = 14.729) than the pretest mean scores (X = 40.24, SD = 17.239), indicating a major change in their achievement. For experimental group two, the mean achievement scores on the posttest were higher (X = 83.43, SD = 8.663) than the pretest scores (X = 64.18, SD = 23.677), indicating a major change. However, in the control group, the mean achievement scores on the posttest were lower (X = 58.39, SD = 22.837) than the pretest scores (X = 58.76, SD = 22.154), indicating a negative change. This implies that the changes that occur at pretest and posttest are attributed to the intervention given to the experimental group I and II. Thus, students taught biology using concept mapping and problem solving stategyachieved higher than those taught with conventional lecture method.

Research Question Two: What are the mean achievement scores of male and female students taught biology with Concept mapping?

Table 2

Mean and Standard Deviation of Pretest and Posttest Achievement Scores of Male and Female Students Taught Biology with Concept Mapping

Group	N	Pretest		Posttest		Mean Gain/Loss
		$\bar{X}$	SD	$\bar{X}$	SD	
Male	35	40.00	15.88	81.49	6.44	41.49
Female	41	40.44	18.51	74.34	18.63	33.9

Table 2 displays the means and standard deviation of male and female students in experimental group one treated with Concept Mapping at pretest and posttest. The mean achievement scores of the posttest for male group was higher (X = 81.49, SD = 6.441) than the pretest scores (X = 40.00, SD = 15.882). The mean gain was 41.49 indicating a major difference in their achievement. For the female group, the mean achievement scores of the posttest were higher (X = 74.34, SD = 18.639) than the pretest scores (X = 40.44, SD = 18.512). The mean gain was 33.9 indicating a major difference in their achievement. This implies that there is a difference in the achievement of male students taught biology using Concept mapping with their female counterparts.

Research Question Three: What is the mean achievement score of male and female students taught biology with problem solving?

Table 3

Mean and Standard Deviation of Pretest and Posttest Achievement Scores of Male and Female Students Taught Biology with Problem Solving

Group	N	Pretest		Posttest		Mean Gain/Loss
		$\bar{X}$	SD	$\bar{X}$	SD	
Male	26	44.46	17.68	85.88	7.78	41.42
Female	35	78.83	15.52	81.60	8.93	2.77

Table 3 displays the means and standard deviation of male and female students in experimental group two treated with problem solving at pretest and posttest. The mean achievement scores of the posttest for male group was higher (X = 85.88, SD = 7.789) than the pretest scores (X= 44.46, SD = 17.684). The mean gain was 41.42 indicating a major difference in their achievement. For the female group, the mean achievement scores of the posttest were minimally higher (X = 81.60, SD = 8. 932) than the pretest scores (X = 78.83, SD = 15.529). The mean gain was 2.77 indicating a minimal difference in their achievement. This implies that there is a difference in the mean achievement scores of male students taught biology using problem solving with their female counterparts favouring males.

Hypothesis One: There is no significant difference in the mean achievement scores of students taught biology using Concept mapping, problem solving strategies and Conventional lecture method.

Table 4

Summary of ANCOVA Result of Mean Achievement Scores of Students Taught Biology using Concept Mapping, Problem Solving Strategies and Conventional Lecture Method.

Source	Sum of Squares	df	Mean Square	F-value	P-value
Corrected Model	24261.034a	3	8087.011	28.352	.000
Intercept	149692.545	1	149692.545	524.795	.000
Covariate (Pretest)	38.442	1	38.442	.135	.714
*Achievement	23996.720	2	11998.360	42.064	.000
Error	59329.947	208	285.240		
Total	1197626.000	212			
Corrected Total	83590.981	211			

S = Significant at 0.05 level

Table 4 ANCOVA statistic was run to examine the difference between three different levels of achievement for experimental groups I, II and the control group at posttest in secondary school in Minna, Niger State. The table revealed that $F_{(3,208)} = 42.064$, P-value = 0.000 at $P < 0.05$, indicating a significant difference in the mean achievement of students taught biology using Concept Mapping, Problem Solving Strategyand Conventional Lecture Method. Therefore, hypothesis one was rejected. The finding implies that students taught biology using Concept Mapping, Problem Solving Strategyand Conventional Lecture Method differ significantly in their mean achievements.

Hypothesis Two: There is no significance difference mean achievement score of male and female students taught Biology with Concept Mapping

Table 5

Summary of ANCOVA Result of Mean Achievement Scores of Male and Female Students Taught Biology with Concept Mapping

Source	Sum of Squares	Df	Mean Square	F-value	P-value
Corrected Model	965.592a	2	482.796	2.303	.107
Intercept	71397.268	1	71397.268	340.518	.000
Covariate (Pretest)	1.870	1	1.870	.009	.925
*Gender	962.480	1	962.480	4.590	.035
Error	15306.092	73	209.672		
Total	474298.000	76			
Corrected Total	16271.684	75			

S = Significant at 0.05 level

Table 5: ANCOVA statistic was run to examine the difference between male and female students' achievement for experimental groups I in secondary school in Minna, Niger State. The table revealed that $F_{(2,73)}$ = 4.590, *P*-value = 0.035 at *P*< 0.05, indicating a significant difference in the mean achievement scores of male and female students taught biology using Concept Mapping. Therefore, hypothesis two was rejected. The finding implies that male students taught biologyusing Concept Mapping differ significantly in their mean achievement with their female counterparts who received the same treatment condition. Thus, the Concept Mapping favours male students higher than the female students in learning biology insecondary school in Minna, Niger State.

Hypothesis Three: There is no significance difference in the mean achievement score of male and female students taught biology with Problem Solving

Table 6

Summary of ANCOVA Result of Mean Achievement Scores of Male and Female Students Taught Biology with Problem Solving

Source	Sum of Squares	Df	Mean Square	F-value	P-value
Corrected Model	532.159a	2	266.079	3.887	.026
Intercept	33011.519	1	33011.519	482.192	.000
Covariate (Pretest)	258.295	1	258.295	3.773	.057
*Gender	.045	1	.045	.001	.980
Error	3970.759	58	68.461		
Total	429059.000	61			
Corrected Total	4502.918	60			

NS = Not Significant at 0.05 level

Table 6: ANCOVA statistic was run to examine the difference between male and female students' achievement for experimental groups II in secondary school in Minna. The table revealed that $F_{(2,58)}$ = 0.001, *P*-value = 0.980 at *P*> 0.05, indicating a non significant difference in the mean achievement of male and female students taught biology using Problem Solving. Therefore, hypothesis three was not rejected. The finding implies that both male and female students taught biology using Problem Solving does not differ significantly in their mean achievement. Thus, the Problem Solving is gender friendly for learning biology insecondary schools in Minna, Niger State

Major Findings of the Study

There was significant difference in the mean achievement scores of students taught biology using Concept mapping, problem solving strategies and Conventional lecture method.

There was significance difference mean achievement score of male and female students taught Biology with Concept Mapping
There was no significant difference in the mean achievement of male and female students taught biology using Problem Solving.

Discussion of the Findings

There was significant difference in the mean achievement scores of students taught biology using Concept mapping, problem solving strategies and Conventional lecture method. This could be as a result of the teaching strategies used in teaching the experimental groups. This is in agreement with the findings of Cheema, (2013) and Ishaku (2015), these researchers concluded from their investigations that students taught using innovative teaching method as context-based, problems solving strategies performed better than those taught using expository method in terms of achievements. There was significance difference mean achievement score of male and female students taught Biology with Concept Mapping. This is contrary to the findings ofJung-Chuan *et al* (2012) who examined effects of different teaching strategies (text-based concept mapping vs. image-based concept mapping) on the learning outcomes and cognitive processes of mobile learners. Their finding revealed that there was no significant difference in students learning achievement. There was no significant difference in the mean achievement of male and female students taught biology using Problem Solving. This is in agreement with the findings of Jegede and Fatoke (2014) and Ishaku (2015) who found out that there was no significant difference in the achievement of male and female students taught chemistry using problem-solving strategy

Conclusion

The study investigated comparative effects of concept mapping and problem solving strategies on secondary school biology students' achievement in Minna Metropolis. From the findings of the study and discussions that followed, the following conclusions were made: The use of Concept mapping and problem solving strategies were very effective in enhancing the academic achievement of senior secondary schools students in Biology. Probably, these two methods or strategies were active and students centered. Also, Concept mapping and problem solving strategies can improve students' achievements more than instructional delivery lecture method. Based on the findings of this research, it was found that male had higher mean than the female and the two strategies can give equal learning opportunities to both male and female in learning of Biology.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Concept mapping and problem solving strategy should be encouraged in schools for teaching of biology.

2. Teachers should be trained on the use of concept mapping and problem solving strategy method of instructional delivery that can bring better results in teaching and learning of biology.
3. Workshop seminars, symposia and conferences should be organized periodically to acquaint new biology teachers with recent research findings that would lead to effective and meaningful teaching and learning.

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