

EFFECTS OF CONCEPT-MAPPING INSTRUCTIONAL STRATEGY ON SENIOR SCHOOL STUDENTS' ACHIEVEMENT IN BIOLOGY, LAGOS STATE, NIGERIA***Mulkah Adebisi AHMED****Fatimah Abiola SHITTU****Lukman YAHAYA**

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ABSTRACT

Concept mapping instructional strategy is one of the innovations in the teaching and learning of science and biology in particular. Previous studies have reported that teachers and students experienced difficulties in the use of concept mapping. Hence, this study investigated the effects of Concept-mapping instructional strategy on senior secondary school students' achievement and retention in biology in Lagos, Nigeria. Quasi-experimental research design was adopted for the study. The population comprised all senior secondary school two biology students. Two intact classes of SS II students were involved in the study. The research instruments used were Biology Achievement Test (BAT) and Concept-Mapping Based Lesson Plan (CMBLP). The reliability of the instruments was 0.75 and 0.82 respectively. Three research questions with corresponding three hypotheses guided the study. Analysis of Co-variance (ANCOVA) statistical tool was used tested the hypotheses at 0.05 level of significance. The results of the study showed that: (i) the experimental group performed better than the control group, that is: concept-mapping affects students' achievement and retention; and (ii) there was no gender influence on students' achievement. Based on results, it recommended among others that teachers should be encouraged to adopt the use of concept-mapping instructional strategy in teaching senior school biology. Also, male students should be encouraged to better their achievement and retention just like their female counterparts.

Keywords: Concept-Mapping, Instructional Strategy, Academic Achievement, Retention Ability.

INTRODUCTION

Biology as a branch of science is a study of living organisms and vital processes (Martin & Robert, 2015). Biology is a very important subject that enables one to understand oneself and the environment. The knowledge of biology is vital to the study of medicine, pharmacy, nursing, dentistry and agriculture, industry, biotechnology, and other fields like genetic engineering and hybridoma technology (Abimbola

& Omosewo, 2006). Biology is a broad field that offers a lot of opportunities to science students and also provides the society with lots of benefits, hence there is a need for the effective teaching of biology in our secondary schools to better harness its benefits.

Biology has witnessed high enrolment compared to any other science subject in the final year of external examinations without a corresponding increase in students' academic performance in it (Sakiyo, 2014). Despite the efforts of both federal and state governments to encourage biology education, students' failure in biology in Senior School Certificate Examinations (SSCE) is still high (Agboghoroma & Oyovwi, 2015; Moses, Gospel, & Femi, 2016; Sakiyo, 2014). The major reasons for this poor achievement was attributed to negative attitude of teachers and students, poor reading habit, inadequate laboratory facilities, the nature of the curriculum which is overloaded and poor methodology in science education (King'aru, 2014; Ofoegbu, 2004).

In a bid to cover the syllabus, teachers result to limiting themselves to the traditional way of teaching (lecture method) which involves mostly the cognitive domain of learning to the detriment of affective and psychomotor domains (Arokoyu & Obunwo, 2014). Kangu (2015) corroborated Nwogbor's (2001) submission by reporting that teachers shy away from the more effective activity-oriented teaching strategies like inquiry, concept mapping, Vee-mapping, and laboratory method in preference to lecture method which they thought is easy but sometimes inadequate and inappropriate.

It is against the backdrop of students' poor achievement that conscious effort is being continuously made to determine suitable strategies that will facilitate effective learning and understanding of biology concepts. Many activity-based learning strategies can help students to improve on their performance and prepare them for future. Concept-mapping is one of the numerous teaching tools, which can be used in determining the nature of students existing ideas (Adloan, 2012; Kinchin, 2000); Concept mapping serves as a tool to help learners organize their cognitive frameworks into more powerful integrated patterns. In this way, it serves as a meta-cognitive tool that empowers the learner to take charge of his/her learning in a highly meaningful pattern. It is a graphical tool for organizing and representing relationships among concepts (Colosimo & Fitzgibbons, 2012; Novak & Canas, 2008). It includes concepts usually enclosed in circles or boxes, the most important concepts are usually linked by highly informative linking statements which are settled on the labelled, they are called proposition (Kinchin, 2000). Several researchers over the year, had tried to examine the effectiveness of concept maps on students' academic performance.

Okoronka (2018) investigated the effects of concept mapping instructional strategy and gender on secondary school students' achievement in Physics. The study was on difficult Physics concepts and the sample comprised of 130 senior school II students that were randomly sampled from two senior secondary school students in Yola metropolis. Findings from the study revealed that there was a significant effect of concept mapping instructional strategy on achievement and as such students that were exposed to concept maps achieved significantly better than their counterparts that were taught using the conventional teaching strategy. Meheux (2017) also examined the effects of concept mapping teaching strategy on senior school students' achievement in Physics. The study revealed among other things, that there was a significant difference in the achievement of students that were taught Physics using concept mapping instructional strategy and those taught using the expository method in favour of the concept map group. Similarly, Ogonnaya et al. (2016) examined the effects of concept mapping instructional strategy on students' achievement in basic science. The study was quasi experimental and the sample for the study was made up of 122 students selected from two secondary schools in Ebonyi State, Nigeria. Findings from the study revealed that students that were exposed to concept mapping instructional strategy achieved significantly better than their counterparts that were exposed to conventional teaching strategy. Cheema and Mirza (2013) carried out a study on the effect of concept mapping on students' academic achievement, they found out that concept mapping, when used as a learning tool, improves the academic performance of students as it allows active involvement in learning, discussion, sharing of concepts and removal of misconceptions. Also, students exposed to concept maps performed greatly than their counterparts who have been exposed to the traditional lecture method (Nnamdi & Okechukwu, 2006; Sor, Jamabo, & Igwe, 2018).

The ability to remember what has been previously learnt by students often lead to better comprehension and understanding, hence studies have also tried to examine retention ability among students. Bawaneh (2019) examined the effectiveness of mind maps on tenth grade students' achievement and retention of electric energy concepts in Jordan. Findings from the study revealed that mind maps have significant effect on students' achievement and retention in electricity when compared with the conventional teaching method. Similarly, Adeniran, Ochu, and Atoo (2018) investigated the effects of concept mapping strategy on students' retention in basic science in Markurdi, Nigeria. The sample for the study was made up of 310 junior secondary two students selected from four government secondary schools. Findings from the study revealed that students taught basic science with the use of concept maps achieved significantly better and had a higher mean retention score than their counterparts taught using conventional method. Awodun (2017) in another study reported that students taught with concept mapping strategy recorded a significantly higher retentive-mean scores than those that were taught using the conventional teaching method. Studies on the influence of gender on the academic achievement of students has been inconclusive over the years. According to Udeani and Okafor (2012) and Sor et al. (2018), males have higher academic achievement in science than females when they were subjected to concept mapping strategy. On the other hand, studies by these researchers (Okoronka, 2018; Ogonnaya et al., 2016; Chawla, 2015; Sakiyo, 2008) found no significant difference in student's achievement based on gender.

Having critically reviewed literatures on concept learning as improved strategy to enhance students' performance in biology, thus, this study investigated the effects concept-mapping instructional strategy, will have on senior school students' academic achievement in digestion and respiration in biology where retention ability and gender of the students are investigated.

STATEMENT OF THE PROBLEM

Many factors were reported to have contributed to the students' poor academic achievement in biology, but Orji and Ebele (2006) attributed students' poor achievement to the ineffective methods of biology instruction adopted by Nigerian secondary school teachers. There have been various studies on the poor achievement of students in science subjects amongst which biology is one of its branches, and the factors influencing the poor achievement such as inadequate instructional materials and physical facilities, time constraints in teaching science, poor methodology in science teaching and improper use of teaching strategies (Oyekan, 2011; Jolif, 2018). Generally, students memorize the content and reproduce the same just to get a task done easily this usually avail them opportunity to grasp the concept being taught (Dhaaka, 2012; Oswaal Books, 2017).

Ugwu (2019) corroborated Egolum and Nwafor (2012)'s report of the West African Examinations Council, Chief Examiners Report of (2002 & 2003) by stating that the expected result of utilizing the use of traditional teaching methods has not been achieved, this situation of poor achievement thereby calls for an alternative instructional method that will guarantee effective teaching and learning. Hence, a concept-mapping instructional strategy could be an approach to effectively teach these concepts which may enhance students' achievement and retention in biology. Therefore, the main objective of this study was to investigate the effect of concept-mapping instructional strategy on Senior School Students' Achievement in Digestion and Respiration in Biology in Lagos state, Nigeria, and also to check if its use as an instructional strategy could enhance students' retention ability.

PURPOSE OF THE STUDY

The main purpose of the study was to determine the Effect of Concept-Mapping Instructional Strategy on Senior School Biology Students' Achievement in Digestion and Respiration in Biology in Lagos, Nigeria. Specifically, the study is determined to find out;

1. Whether the students taught biology using concept mapping instructional strategy achieves better than those taught using the traditional method.

2. The retention ability of the students taught biology using concept-mapping instructional strategy.
3. The difference in the performance of male and female senior school biology students when taught with concept-mapping instructional strategy.

Research Questions

The following research questions were raised to guide the study:

1. Is there any difference in the academic achievement of the biology students taught with concept-mapping instructional strategy and those exposed to the traditional method?
2. What difference exists in the retention ability of the students taught biology with concept-mapping instructional strategy and those taught with traditional methods?
3. Is there any difference in the performance of the male and female students when taught biology with concept-mapping instructional strategy?

Hypotheses

The following research hypotheses were formulated and tested in this research study.

- Ho₁: There is no significant difference between the academic achievement of the students taught using concept mapping instructional strategy and the students taught with the traditional method.
- Ho₂: There is no significant difference in the retention ability of students' taught using concept mapping instructional strategies and those taught with the traditional method.
- Ho₃: There is no significant difference between the male and female students' performance in biology when taught with concept-mapping instructional strategy.

METHODOLOGY

The study adopted the quasi-experimental pre-test, post-test, non-equivalent control group design. The study was conducted in Oshodi/Isolo Local Government Area (LGA), Lagos State, Nigeria. The target population of the study was all SS II students in senior secondary schools in Lagos State offering biology. The choice of SS II students was because the class is stable, it is neither facing the problem of being freshly introduced to senior secondary biology or nor preparing for any end of the course or terminal examination (as is the case with SS I or SS III). The sample for the study was 149 with 69 males and 80 females Biology students from the two public co-educational secondary schools selected for the study. Two intact classes of 71 and 78 SS II classes were randomly selected from the two schools and were assigned into the experimental and control groups respectively. The choice of the schools was based on the fact that they shared the same characteristics in terms of the entry condition of students, geographical location, and presentation of candidates for external examinations.

Two instruments were used for data collection, namely: Biology Achievement Test (BAT) for pre-test and post-test and Biology Achievement Retention Test (BART) used after 2 weeks of instruction. The BAT used for the pre-test was renumbered for the post-test to avoid testing experience, it has 30-item multiple-choice objective test with four options (A-D). The instrument was adapted from the West African Examinations Council (WAEC) biology past questions from 2010 to 2016 with little moderation, hence, there was need validation and reliability. To ensure the reliability of the research instrument, the instruments (BAT) and (BART) were pilot tested. The test-retest method was used to determine the reliability coefficient and results yielded 0.75 and 0.82 respectively. The data collected was analysed using mean and standard deviation for research questions while the hypotheses were tested using analysis of covariance (ANCOVA) statistics.

The first week was used to administer the pre-test to both experimental and control groups before the treatment. The second and third week was used to administer the instructional method meant for each group with the help of the research assistants in a two 40 minutes lesson per week. The control group

was taught without the use of CMBLP but with Lecture method, while the experimental group was taught with the usage of CMBLP in each of the schools. The Post-test (BAT) was administered to the students in both the experimental group and the control group by the research assistants. After two weeks of conducting the Post-test, the research assistants administered the Biology Achievement Retention Test (BART) which is the same instrument as the Post-test (BAT) to both the experimental group and the control groups to check the retention of the students. The hypotheses were tested at 0.05 level of significance using analysis of covariance (ANCOVA).

RESULTS

The results were analysed and presented in tables.

Research question 1: What significant difference exists between the academic achievements of the biology students who were taught with concept-mapping instructional strategy and those exposed to the traditional method?

The result in Table 1 revealed that the experimental group who were exposed to concept-mapping instructional strategy had a mean gain score of 4.29 while the control group had a mean gain score of 3.71. This implies that the students taught biology using concept-mapping instructional strategy perform better than those in the control group.

Table 1

Mean Achievement and Standard Deviation Scores of Experimental and Control Group Students

Treatments	N	Pre-test (\bar{x})	SD	Post-test (\bar{x})	SD	Mean Score	Gain
Experimental	71	10.46	3.03	14.75	4.75	4.29	
Control	78	8.54	2.33	12.24	3.63	3.71	

Research question 2: What significant difference exists in the retention ability of the biology students when taught using concept-mapping instructional strategy and those taught using traditional methods?

The result in Table 2 shows that the experimental group who were exposed to the concept-mapping instructional strategy had a mean gain score of 2.63 while the control group had a mean gain score of 2.13. This implies that students' who were taught biology using concept-mapping instructional strategy had better retention than those in the control group.

Table 2

Mean Retention and Standard Deviation Scores of Experimental and Control Group Students

Treatments	N	Pre-test (\bar{x})	SD	Retention Test (\bar{x})	SD	Mean Score	Gain
Experimental	71	10.46	3.03	13.09	4.07	2.63	
Control	78	8.54	2.33	6.41	2.96	2.13	

Research Question 3: Does any significant difference exist between the performance of the male and female students' performance in biology when taught using the concept-mapping instructional strategy?

Table 3 indicates that male students had a mean gain score of 5.24 while their female counterparts had a mean gain score of 6.33. This implies that female students benefitted most when the concept-mapping instructional strategy was used for teaching biology.

Table 3
Mean Achievement and Standard Deviation Scores of Male and Female Students

Gender	N	Pre-test (\bar{x})	SD	Post-test (\bar{x})	SD	Mean Score	Gain
Male	31	10.41	2.57	15.65	4.29	5.24	
Female	40	10.50	3.74	16.83	5.13	6.33	

Hypotheses Testing:

HO₁: There is no significant difference between the academic achievement of the students taught using concept-mapping instructional strategy and the students taught using the traditional method.

The result in Table 4 showed that the mean performance score of students taught respiration and digestion using concept-mapping instructional strategy and those taught using traditional method differed significantly. This was indicated by the calculated *F*-value of 4.31 with *p*-value of 0.02 which is less than 0.05 level of significance. Therefore, the hypothesis which states that there was no significant difference between the academic achievements of the students taught using concept-mapping instructional strategy and the students taught with the traditional method was rejected.

Table 4
Analysis of Covariance of the Mean Achievement Scores of the Experimental and Control Group Students.

Source	Type III Sum of Squares	<i>Df</i>	Mean Square	<i>F</i>	Sig.	Partial Squared	Eta
Corrected Model	150.492 ^a	3	50.164	2.947	.036	.071	
Intercept	1139.394	1	1139.394	66.938	.000	.366	
Pretest	7.382	1	7.382	.434	.511	.004	
Groups	146.554	2	73.277	4.305	.016	.069	
Error	1974.500	116	17.022				
Total	24293.000	120					
Corrected Total	2124.992	120					

a. R Squared = .071 (Adjusted R Squared = .047)

HO₂: There is no significant difference in the retention ability of students' taught using concept-mapping instructional strategy and those taught with the traditional method.

The result in Table 5 showed that the mean retention score of students taught respiration using concept-mapping and those taught using traditional method differed significantly. This was indicated by the calculated *F*-value of 17.68 with *p*-value of .00 which is less than 0.05 level of significance. Therefore, the null hypothesis of no significant difference in the retention ability of students taught using concept mapping instructional strategies, and those taught with the traditional method was rejected.

Table 5
Analysis of Covariance of the mean retention scores of students for the Experimental and Control group

Source	Type III Sum of Squares	<i>Df</i>	Mean Square	<i>F</i>	Sig.	Partial Squared	Eta
Corrected Model	146.987 ^a	2	73.494	9.841	.000	.144	
Intercept	1081.322	1	1081.322	144.785	.000	.553	
Posttest	1.787	1	1.787	.239	.626	.002	
Groups	132.043	1	132.043	17.680	.000	.131	
Error	873.813	117	7.468				
Total	12080.000	120					
Corrected Total	1020.800	119					

a. R Squared = .144 (Adjusted R Squared = .129)

HO₃: There is no significant difference between the male and female students' performance in biology when taught using concept-mapping strategy.

Table 6 shows that there was a statistically significant difference in the performance of students based on their gender when taught using concept-mapping instructional strategy $t(69)=0.11$, $p=0.91$. Since the p -value was greater than the 0.05 level of significance, hence, hypothesis 3 is not rejected. The implication of this is that the female students performed better than their male counterparts as they have a higher mean score.

Table 6

Analysis of Covariance of the Mean Achievement Scores of Male and Female Students showing Results for the Experimental and Control Groups

Source	Type III Sum of Squares	<i>Df</i>	Mean Square	<i>F</i>	Sig.	Partial Squared	Eta
Corrected Model	3.862 ^a	2	1.931	.088	.916	.003	
Intercept	833.583	1	833.583	37.977	.000	.400	
Pretest	3.758	1	3.758	.171	.681	.003	
Gender	.080	1	.080	.004	.952	.000	
Error	1251.122	57	21.950				
Total	14191.000	60					
Corrected Total	1254.983	59					

a. R Squared = .003 (Adjusted R Squared = -.032)

Discussion of Results

The findings from the study revealed that students who were taught digestion and respiration using concept-mapping instructional strategy achieved better than those taught using the traditional method. It was found that the main gain score of students who were taught respiration and digestion with concept-mapping instructional strategy was higher than that of the control group. The pedagogical implication of this finding is that concept mapping instructional strategy can be employed by biology teachers to teach digestion and respiration and other difficult biology concepts that have been identified in literature. This result is in agreement with the previous studies of other researchers (Okoronka, 2018; Meheux, 2017; Ogonnaya et al., 2016; Arokoyu & Obunwo, 2014); Ezeudu, 2013; Udeani & Okafor, 2012; Jibrin & Zayum, 2012) whose findings indicated that concept mapping instructional strategy is more effective in teaching abstract and difficult science concepts than the traditional teaching method. The finding also revealed that concept-mapping instructional strategy helped to improve students' academic performance in the target concept, this might be due to the fact concept mapping-instructional strategy is interactive, student-centred in nature, and allows for students' participation.

The result of this study also revealed that there was a significant difference in the retention of students taught with concept-mapping instructional strategy and those taught with the traditional method. The implication of this finding is that concept maps can be employed in teaching science concepts as it has the tendency of enhancing conceptual understanding by the students, which in turns allow the students to retain concepts that have been taught earlier. This finding agreed with those of Bawaneh (2019), Adeniran et al. (2018), and Awodun (2017) who reported that the use of innovative strategies such as concept-mapping students' retention ability was enhanced. Hence, the reason for the significant difference between mean scores of experimental and control groups could be attributed to the fact that students in the experimental group were actively involved in the construction of the map, hence this might promote better retention.

The finding of the study revealed no significant difference in the mean gain scores of female and male students taught respiration and digestion with concept-mapping instructional strategy when tested at 0.05 level of significance. This means that the strategy is equally beneficial for both sexes, hence it could be applied in a mixed gender classroom to increase the achievement of all students. This result disagrees with the works of Sor et al. (2018), and Udeani and Okafor (2012) whose results revealed

that there was a statistically significant difference observed between genders due to concept-mapping instructional strategy which was in favour of the female student. The findings are in agreement with the researches of (Okoronka, 2018; Ogonnaya et al., 2018; Chawla, 2015) who observed that male and female students achieved almost equally when exposed to innovative teaching strategy.

CONCLUSION

The study investigated the effects of concept mapping instructional strategy on students' achievement in biology. Based on the findings from the research, it was concluded that concept mapping instructional strategy had a significant effect on students' achievement in biology. The use of concept map as an instructional strategy was, therefore, deemed to be more effective than the use of the traditional teaching method. Also, students exposed to the use of concept-mapping instructional strategy had higher retention ability than those in the control group. Based on this finding, it was therefore, concluded that concept maps can be used to enhance conceptual understanding by students. Finally, it was also concluded that male and female students benefitted almost equally when the concept-mapping instructional strategy was used for teaching biology.

RECOMMENDATIONS

Based on the research findings, the following recommendations were made:

1. Teachers should use many activity-based strategies such as concept mapping while teaching biology so that all students could achieve and retain their learned concepts of digestion and respiration better.
2. The use of concept mapping instructional strategy should be encouraged among teachers and learners to improve the ability to recall and retain information.
3. The instructional strategy should be used in mixed-gender classrooms, as it has been established to be gender friendly.

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