ROLES OF CONCEPT MAPPING INSTRUCTIONAL STRATEGY ON ACHIEVEMENT AND RETENTION OF LOW-ACHIEVING BIOLOGY STUDENTS IN SENIOR SECONDARY SCHOOLS IN MINNA METROPOLIS

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Abstract

The study investigated the roles of concept mapping instructional strategy on achievement and retention of low-achieving Biology students in senior secondary schools in Minna Metropolis. Quasi experimental design was adopted in the study. A sample of 86 low - achievers of secondary school (SS1) from two senior secondary schools in Minna Metropolis were used for the study. The instrument used for data collection was the Biology Achievement Test (BAT) and was validated by experts in Science Education, Biological Science experts and Biology teachers. The internal consistency was determined using Pearson Product Moment Correlation formula to be r=0.85. The results indicated that there was significant difference in the mean achievement scores of low-achieving Biology students taught using concept maps and those taught using conventional lecture method. Based on these findings, it was concluded that the use of concept maps was more effective in enhancing low-achieving students' achievement in Biology than the conventional lecture method. It was recommended that re- training of teachers on the use of concept mapping instructional strategy to enhance the achievement and retention of low-achieving Biology students should be encouraged.

Keywords: Concept, Mapping, Concept Mapping, Achievement, Retention, Low-Achievers.

Introduction

A concept map is a graphic organizer which uses schematic representation hierarchically to organize a set of concepts, connected by means of words in order to build meaningful statement. It shows meaningful relationship between concepts in the shape of propositions and it reveals each student's comprehension and knowledge structure (Novak & Gowin, 1999). Concept mapping is a way to help students and educators to see the meanings of learning materials". It reveals the way in which we could assimilate the concept structure with the source of knowledge, on which the map prepares when it is made by a working group and being shared by all students, it gives colorful pressure of their reflexive thought (Novak & Gowin, 1999). And it can become an excellent process of building knowledge in a social environment that is cooperative and constructivist. Concepts maps are vital tools for a cooperative activity that will lead to a very meaningful learning (Novak, 2002). The desire to improve science achievement through the use of more effective instructional strategies and the increasing awareness in recent years of teaching –learning processes has directed to a lot of attention to understanding of how student learn. The efforts in assisting the learner to learn have led to the development of meta-cognitive strategies to enhance meaningful learning (Umaru, 2010). Umaru (2010) attributed students' failure to perform well in external examinations in science and other related disciplines to their inability or lack of interest and competent towards science subject as they assume them difficult to pass. Conversely, Ndioho (2007) noted that student's positive attitudes to science correlate highly with their science achievement especially among low-achievers.

Udeani (2006) defined low-achiever as one who has reached his potential and yet achieves quite poorly in school subjects. Umaru (2010) maintained that slow learners are those who

Gender issues in Biology education were first brought to the wider attention of the research community in the 1970s (Aiyedum, 2000). Much researchers such as, address females to be disadvantageous with respect to achievement, participation, and affective outcomes (Udeani & Okafor, 2012; Umaru, 2010). It became evident in the late 1990s that in some countries, including Australia, the gender gap appeared to be unequal with respect to achievement. For some affective measures, anticipated gender-stereotyped results, based on previous research, have been challenged (Udeani, Lederman, & Umaru, 2010). Late in the 1990s, educational issues with respect to boys surfaced and became a funding focus in Australia and the UK. Boys' literacy levels are well below girls' and research and funding attention to this was fully justified. However, boys were not disadvantaged with respect to Biology and science, particularly with respect to participation rates (Udousoro, 2011) and males remained more advantageous than females (Udeani & Okafor, 2012).

This study was propelled by poor performance of low-achieving Biology students in senior secondary school in Minna Metropolis. This development indicates a significant breakthrough in science education research in the identification and creation of a learning environment where all students can learn equally and effectively too. However, a question may be asked as whether these instructional approaches will produce the same effects on students in their study of different school science subjects especially Biology which in the focus of this study. The teaching strategies that have been adopted to teach low-achievers has not yielded substantial record of performance, hence a more interactive strategy that will salvage the persistent decline in the performance of this group of learners became imperative. Therefore, the strategy that was considered to salvage the problem may be the use of concept maps, hence the study investigated the roles of concept maps on achievement and retention of low-achieving Biology students in Minna Metropolis.

Research Questions

The following research questions were raised to guide this study:

(i) What are the differences in the mean achievement scores of low-achievers in Biology when exposed to concept mapping instructional strategy?

(ii) Would there be any differences in the mean achievement score by gender of low-achievers in Biology when exposed to concept mapping instructional strategy?

(iii) What are the differences in mean the retention scores of low-achievers in Biology when exposed to concept mapping instructional strategy?

(iv) Will there be any differences in the mean retention scores by gender of low-achievers in Biology when exposed to concept mapping instructional strategy?

Research Hypotheses

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

Ho_1: There is no significant difference between the achievement scores of low-achievers exposed to concept mapping instructional strategy and those exposed to conventional lecture method.

Ho_2: There is no significant difference between the achievement scores of male and female low-achievers exposed to concept mapping instructional strategy.

Ho_3: There is no significant difference between the retention scores of low-achievers exposed to concept mapping instructional strategy and those exposed to conventional lecture method

Ho_4: There is no significant difference between the retention scores of male and female low-achievers exposed to concept mapping instructional strategy.

Methodology

The research design adopted for this study was quasi-experimental design. Specifically, pretest, posttest, non-equivalent, control group design (Udeani & Okafor, 2012). This design was adopted to avoid disruption of the class arrangement, programmes and routines, therefore, intact classes were used for the study. Thus, Senior Secondary one (SSI) classes were used as experimental and control groups. The independent variable is the teaching method while the dependent variables are achievement and retention. The experimental and control groups were given the pretest, posttest and retention test. Experimental group was subjected to treatment using concept mapping strategy and the control group was taught using conventional lecture method. The research design layout is shown below.

Table 1: Research design layout

Where,

O_1, O_4 - Pretest scores of experimental and control group; O_2, O_5 - Post test scores experimental and control group; O_3, O_6 -Retention scores of experimental and control group.
X - Concept Mapping Strategy (CMS). - No Treatment (CLM).

Population of the Study

The population for this study was all Senior Secondary School low-achieving Biology students in Minna Metropolis totaling 4,275 in Coeducational schools in Minna Metropolis in 2016/2017 academic session.

Sample and Sampling Techniques

The sample used for the study was 86 students drawn from two Senior Secondary Schools, the two schools were randomly sampled from nine schools in the Metropolis. The two schools used were randomly assigned to experimental and control group. Experimental school had 46 students of which (25 males and 21 females) and control school had 40 students (22 males and 18 females). In identifying the low-achievers the researcher used the students' academic records and teachers rating inventory collected from their form masters and were grouped into three subgroups, namely, high, average, and low-achieving students. Those whose scores ranged between 35%- 49% were selected and used for the study. This categorization was done on Niger State categorization platform (2015-2016). The total number of the low-achievers was 12 students in experimental school (7 males and 5 females), while the control group made up of 15 students (9 females and 6 males) respectively.

Instrumentation

Two instruments were used for the study. The instruments include: (i) Concept maps, developed by the researcher in collaboration with an expert in Science Education and (ii)Biology Achievement Test (BAT). The topic was photosynthesis in plant (Mechanisms of photosynthesis, materials, conditions necessary for photosynthesis and importance of photosynthesis). It consisted of 20 item multiple choice objective questions. The questions were used for pre-test, post-test, and retention test respectively which consisted of four options (A-D) of which one of the option is the only correct answer. The items were developed based on the test blue print as shown on table 3.2.

Table 2: Tables of specification for biology achievement test (BAT)

Levels/ Topics	Knowledge	Comprehension	Application	Analysis	Synthesis	Total
Topic 1	4	3	2	1	-	10
Topic2	4	3	2	1	-	10
Total	8	6	4	2	-	20

Validity of the Instrument

The concept map was validated by three experts from the Department of Science Education, two from the Department of Biological Science, Federal University of Technology, Minna and four Biology tutors from Bosso Day Senior Secondary School. The BAT and making schemes were also subjected to face and content validation. The extracted content materials were used in preparing concept-maps. This consisted of lesson notes, concept map on photosynthesis. The face validity focused on the logical arrangement of the items.

Reliability of the Instrument

To determine the reliability of the instrument, pilot test was conducted using test, re-test method on a school that was within the study area, but not used for the study. The first test was administered to the students and the result was collated. After two weeks, the instrument was re-administered again on the same sets of students. The scores of the two sets were correlated and analyzed using Pearson Product Moment Correlation Analysis and the coefficient of 0.85 was obtained.

Method of Data Collection

The research assistants (Biology tutors of the schools used) were trained for two weeks on how to use concept maps and to maintain standard with respect to teacher quality variable. Pretest was administered to the students to determine the entry knowledge of the students before the commencement of the treatment. All the students in the intact classes were then taught using concept maps in two lessons of 40-minute duration each for four weeks. After four weeks of treatment BAT was administered to the experimental and control groups as posttest. BAT was reshuffled and re-administered as a retention test after two weeks of waiting period.

Method of Data Analysis

The data obtained from pretest, posttest and retention tests were subjected to data analysis, t-test Statistics was used to analysis the hypotheses at 0.05 level of significance.

Results

Table 3: Pretest scores of experimental and control groups

Group	N	df	X	S.D	t-value	p-value
Experimental	12	25	7.92	0.900	0.642	0.527 NS
Control	15		8.13	0.834		

NS – Not Significant P>0.05

Table 3 shows t-test comparison between the mean achievement scores of control group and experimental group in the pre-test. The mean and standard deviation of the experimental group are 7.92 and 0.900 while the control group are 8.13 and 0.834. This indicates that there is no significant difference in the mean score ($t= 0.642$, $df = 25$, $p>0.05$). Hence it was established that both experimental and control group were at the same level of entry knowledge before the treatment with concept mapping instructional strategy.

Hypotheses Testing

Ho_1: There is no significant difference between the achievement scores of low-achievers exposed to concept mapping instructional strategy and those exposed to conventional lecture method.

Table 4: t-test results of posttest scores of experimental and control group

Group	N	df	X	S.D	t-value	p-value
Experimental	12	25	15.25	1.712	4.053	0.000*
Control	15		12.47	1.836		

*= Significant at P<0.05

Table 4 shows the t-test comparison between the achievement scores of students taught with concept mapping instructional strategy and those taught using conventional lecture method. The mean score and standard deviation of the experimental group is 15.25 and 1.712. The p-value of 0.000 is is less than the alpha level of 0.05 while the control group are 12.47 and 1.846. This result indicates that there is a significant difference in the mean achievement scores of low-achievers taught photosynthesis using concept map than those taught with conventional lecture method. Therefore, hypothesis one was rejected. This implies that students in experimental performed better than those in control group.

Ho_2: There is no significant difference between the achievement scores of male and female low-achievers exposed to concept mapping instructional strategy.

Table 5: t-test results of posttest scores of male and female low-achievers in experimental group

Group	N	df	X	S.D	t-value	p-value
Male	7	10	15.57	1.813	0.768	0.462^{NS}
Female	5		14.80	1.643		

NS = Not Significant at P>0.05

Table 5 shows the t-test comparison between the achievement scores of male and female Low-Achievers taught with concept mapping instructional strategy. The mean score and standard deviation of the male students are 15.57 and 1.813 while that of female students are 14.80 and 1.643. The p-value is greater than 0.05 level of significance. Therefore, this indicates that there is no significant difference in the mean achievement score of male and female students taught photosynthesis using concept mapping instructional strategy. Hence the null hypothesis two which states that there is no significant difference between the achievement scores of male and female Low-Achievers taught photosynthesis with concept map was not rejected. This means that male and female performed equally better.

Ho_3: There is no significant difference between the retention scores of low-achievers exposed to concept mapping instructional strategy and those exposed to conventional lecture method.

Table 6: t-test results of retention scores of experimental and control groups

Group	N	df	X	S.D	t-value	p-value
Experimental	12	25	15.50	1.508	5.431	0.000*
Control	15		12.47	1.356		

*= Significant at P<0.05

Table 6 shows the t-test results of retention score of low-achievers taught with concept mapping instructional strategy and those taught using the conventional lecture method. The mean score and standard deviation of the experimental group are 15.50 and 1.508 while control group are 12.47 and 1.356. This results indicates that there is a significant difference in the mean achievement score of the low-achievers taught photosynthesis with the concept mapping instructional strategy and those taught using conventional lecture method. The p-value is less than 0.05 level of significance, Therefore, hypothesis three is rejected. This implies that students in experimental groups performed better than control groups at retention test.

Ho_4: There is no significant difference between the retention scores of male and female low-achievers exposed to concept mapping instructional strategy.

Table 7: t-test results of retention scores of male and female low-achievers in experimental group

Group	N	df	X	S.D	t-value	p-value
Male	7		15.86	1.574		
		10			0.987	0.348^{NS}
Female	5		15.00	1.414		

NS: Not Significant at P> 0.05

Table 7 shows the t-test comparison between the mean retention score of male and female low-achievers exposed to concept mapping instructional strategy (CMIS). The mean score and standard deviation of the low-achiever's male students are, 15.86 and 1.574, while that of female students are 15.00 and 1.414. This result indicates that there is no significant difference in the mean retention score of male and female low-achievers taught photosynthesis using concept mapping instructional strategy (CMIS). The p-value of 0.348 is greater than 0.05 level of significance. Therefore, hypothesis four was not rejected. This implies that male and female students retained the concept of photosynthesis equally better.

Discussion

The result of the result of hypothesis one shows that the experimental group did better than the control group. This means that the use of concept map can enhance students' achievement in Biology at Senior Secondary School Level. This result is in line with the findings of Kalu-Uche (2010); Udeani et al (2010) which provided evidence attesting to the efficacy of concept mapping in facilitating meaningful learning in Biology. This was achieved due to the knowledge construction features of the concept maps in learning.

The result of hypothesis two shows that there is no significance difference in the mean achievement scores of male and female Biology low-achievers exposed to concept maps. This means concept maps can be used to enhance both the male and female academic performance. This finding is in line with that of Aiyedun (2000); Udeani et al (2012) who found out that there was no significant difference in the performance of male and female students exposed to concept mapping instruction in teaching the concept of ecology.

The results of hypothesis three shows that there is significance difference in the retention scores of experimental and control groups. The results show that the experimental group performed better than the control group in terms of their retention because of the features of concept maps that was used which enabled the students to recall what was taught. This means that the use of Concept maps enhanced the knowledge retrieval of the students. Thus the finding is in agreement to the findings of Miandoab et al (2012) who found out that concept maps enhanced students' retention in learning Genetic concepts in Biology.

The results of hypothesis four shows that there is no significance difference in the retention scores of male and female. This means concept mapping instructional strategy can be used to enhance both the male and female academic performance. This finding is in line with the finding of Kalu-Uche (2010). Who found that there is no significance difference between male and female low-achievers in their retention abilities when taught Biology using concept mapping instructional strategy and conventional lecture method.

Conclusion

Concept Mapping Instructional Strategy (CMIS) has a positive effect on the experimental group than control group, Low-achievers taught with Concept Mapping Instructional Strategy (CMIS) has no significant effect on gender achievement, and retention (males and females) in Biology than Conventional Lecture Method (CLM) and concept map has significant effect on retention, the experimental group performed better than the control group.

Recommendations

Based on the findings, the following were recommended:

(i) The concept mapping instructional strategy should be used by Biology tutors as a veritable for teaching.

(ii) The tutors should be trained on using the concept mapping instructional strategy to enhance the achievement and retention of low – achieving Biology in schools.

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