EFFECTIVENESS OF CONCEPT-MAPPING INSTRUCTIONAL STRATEGY ON ACADEMIC PERFORMANCE IN BIOLOGY AMONG SECONDARY SCHOOL STUDENTS IN KATSINA STATE

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Abstract

This study examined the effectiveness of concept-mapping instructional strategy on academic performance in Biology among secondary school students in Katsina state. Two objectives with their corresponding research questions and hypotheses guided the study. The study employed a quasi-experimental research design involving a pre-test, treatment and post-test. The population of the study comprises of 4,992 SSII Biology students from 22 public senior secondary schools in three local government areas of Kankia zonal education quality assurance, Katsina state. A sample of 107 students were purposively selected and participated in the study. Ecology Achievement Test (EAT) was used as the research instrument. Using PPMC, a reliability index of 0.85 was established. Mean and standard deviations were used to answer the research question, while t-test for independent samples was used to test the hypothesis at 0.05 level of significance. The finding revealed that students taught ecology concept using concept mapping instructional strategy performed significantly better than those taught using conventional lecture method (P-value = .000 < 0.05 and t = 0.59, p > 0.05 respectively). The study concluded that concept mapping instructional strategy enhances students' academic performance in ecology. Based on the finding and the conclusion drawn, the study recommended that teachers should utilize concept mapping instructional strategy in teaching Biology as it was proved effective on students' academic performance.

Keywords: Concept-Mapping Instructional Strategy, Academic Performance, Ecology.

Introduction

Concept mapping instructional strategy is a diagram demonstrating the links among concepts. It is a graphical tool for knowledge organization and representation. In order to share and learn Biology concepts through practice and reinforcement, students who perform better and those who perform worse are paired into small groups (Fuchs, et al., 2022). Additionally, Abdulkadir, et al., (2019) stated that concept maps represent a diagrammatic 2-D dimensional, 3-D spatial or graphical displays, which in form of labeled nodes to show relationship among pairs of concepts. According to Birabil (2020), a concept map is a visual organizer that might improve students' comprehension of ideas.

Furthermore, concept mapping teaching-learning strategy in which concepts are connected with other words to form a meaningful statements are represented diagrammatically for better understanding among students. Sketching a graphic representation of a topic usually aids in visualizing key concept and organize ones' knowledge noticeably the conventional teaching methods. At a first glance, a concept map looks like a flow chat in which the key words are placed in boxes connected by directional arrows (Ahmed, 2019). When concept mapping teaching learning strategy is used in the classrooms, students' are well prepared to represent ideas graphically. This enables the teacher to visualize students understanding and the organization of their knowledge about those particular concepts represented.

A concept map may therefore be hierarchical or cyclic. According to Canas, Derbentseva and Safayeni (2017), cyclic concept maps are regarded as suitable for illustrating knowledge of functional or dynamic interactions between ideas, whereas hierarchical concept maps are thought to be suitable for illustrating hierarchical or static information. The purpose of a concept map is to "represent meaningful learning between the concepts in the form of propositions" by including concepts and showing the connections between them.

Numerous studies have been conducted on the concept mapping instructional strategy to discover its efficacy in boosting the students' academic performance in various subject areas. For instance, Wokocha (2020) investigated the effect of concept mapping teaching strategy on students' achievement and retention in Basic Science in Imo State. The researcher found that students in the experimental group taught Basic Science concepts using concept-mapping teaching strategy achieved significantly and retained significantly higher than their counterparts taught using lecture method. Similarly, no significant difference in found in terms of academic achievement between male and female students taught using concept-mapping and lecture instructional methods. The researchers concluded that concept mapping instructional strategy better than the conventional teaching method and recommends that teachers should be using it to teach Basic science concepts inter-relationships with real-life situations to develop reflective thinking abilities.

Conventional lecture method is an instructional strategy which involves the teacher telling the students factual information to learn through chalk and talk with their little or no students' participation throughout the lesson (Ijoyah, Moji & Ijoyah, 2015). The major advantages of conventional method re that it is time saving, easy to prepare and many students can be taught at the same time (Ijoyah, et al., 2015). According to Ijoyah, et al., (2015), conventional method is not tailor for students learning need and individual differences, rather it made students as passive listeners instead of active participants in class activities.

Students' academic performance denotes the degree or extent at which learning outcomes have been achieved after been taught in a specified period of time (Abdulkadir, et al., 2019). In addition, Eravwoke (2017) discovered that the classroom comprises of students with different aptitude levels (fast, average and slow learners) that in turn influences their academic performances. Sakiyo and Waziri (2015) carried out study on the concept mapping strategy: an

effective tool for improving students' academic achievement in Biology. The result revealed that, concept mapping method enhanced students' academic achievement in biology.

Gender differentiates feminine and masculine attributes in terms of abilities that best suit natural dispositions. It is amongst the numerous factors, which interrelate with student performance in Biology and other science subject taught in our school setting. Nevertheless, the effect of gender on academic performance rests an argumentative topic, with researchers presenting diverse and incongruous findings. In a study conducted by Mari (2019) and Onah and Nnadi (2022) revealed that male students performs significantly better in science subjects than their female counterparts. Equally, few studies have established that gender influences academic performance in favor of female students.

Nevertheless, some researchers argued that there exist no significant difference in the academic performance between male and female students (Eravwoke, 2017). For instance, Sakiyo and Waziri (2015) conducted a study that investigated the concept mapping strategy: an effective tool for improving students' academic achievement in Biology. The result revealed that there was no significant difference between male and female students in the experimental group. Therefore, suggests that both male and female students' academic performances can be significantly influenced by teaching and learning methods employed by teachers, supporting for the modification of instructional approaches to enhance the academic performance of all students irrespective of gender. Hence, this study is designed to study examined the effect of concept-mapping instructional strategy on academic performance in Biology among secondary school students in Katsina State irrespective of their varying abilities and gender.

Statement of the problem

Many thought about the students' poor performance in science related subjects, could be the frequent use abstract nature of concept, teaching methodology, ability to retain knowledge or gender influence. Apparently, most teachers find it very difficult to teach some ecology concepts because of its abstract nature, lack of teaching aids and complexity. The situation calls for a search for innovative teaching technique that will facilitate effective and meaningful learning among secondary school students. Since the fundamental characteristic of meaningful learning is the integration of new knowledge with the students previously learned concepts.

Furthermore, the researcher observed that majority of the Biology teachers in senior secondary schools under Kankia zonal education quality assurance are using the traditional teaching methods in conducting their lessons obviously ineffective and teacher-centred approaches that rarely incorporates the three learning domains (cognitive, affective and psychomotor). This could be attributed to other factors such as continuous recruitment of unqualified teachers, lack of well-equipped science laboratories for practical sessions, overcrowded classrooms, and infrastructural facilities. In view of this, this study proposes the teaching of Biology using innovative as well as student-centred teaching strategies that are more effective. Therefore, the problem of this, study examines the effectiveness of concept mapping instructional strategy if

properly utilized could help to improve students' academic performance in Biology in Kankia education zone of Katsina state, Nigeria.

Objectives of the Study

The study was guided by the following objective:

1. To determine the difference in the academic performance of students taught ecology using concept mapping instructional strategy and those taught using conventional lecture method in Kankia zonal education quality assurance.
2. To examine whether the academic performance of male and female students differ when taught ecology using concept mapping instructional strategy in Kankia zonal education quality assurance.

Research Questions

To achieve the stated objectives, the following research questions were raised:

1. What is the difference in the academic performance of students taught Biology using concept mapping instructional strategy and those taught using conventional lecture method in Kankia zonal education quality assurance?
2. What is the difference between the academic performance of male and female students when taught Biology using concept mapping instructional strategy in Kankia zonal education quality assurance?

Hypotheses

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

1. There is no significant difference in the academic performance of students taught Biology using concept mapping instructional strategy and those taught using conventional lecture method in Kankia zonal education quality assurance.
2. There is no significant difference between the academic performance of male and female students when taught Biology using concept mapping instructional strategy in Kankia zonal education quality assurance.

Methodology

The study employed a quasi-experimental and control group design involving pre-test and post-test. In the beginning, a pre-test (O_1) was administered to equate the aptitude levels of students in the experimental and control groups prior to administration of treatment. After this, the experimental groups (EG) with 56 students was taught ecological concepts using concept mapping instructional strategy (X_1), while the control group (CG) with 51 students was taught same content using conventional lecture method (X_0) for six weeks period. Immediately after the treatment, the post-test (O_2) was administered to determine whether there is change in performance of the students.

The population of the study covers a total number of 4992 (2621 males and 2371 females) SSII Biology students from 22 public senior secondary schools in three local government areas (Kankia, Kusada and Ingawa) under Kankia ZEQA of Katsina State, Nigeria. The majority of

the schools are co-educational run similar curriculum manned by Katsina State Ministry of Education (KTS MOE). The sample for this study comprised of 107 (29 males and 27 females) SS II students from three out of 22 schools offering Biology in Kankia zonal education quality assurance of Katsina State. To ensure unbiased selection of the sample for the study, the researcher printed 25 copies of checklist containing the 33 equipment/apparatus available in the public schools' Biology laboratory. The researcher visited the schools to fill the checklist by the Lab Attendant. Each school ticked only readily available equipment they have on the checklist, in which only two 2) schools one from each of the three (3) local government areas in the educational zone to select three (3) have required lab equipment. Therefore, the researcher used simple random sampling technique of balloting and selected two schools and systematically assigned as School A (EG) with 56 students and School B (CG) 51 students was purposively selected as sampled schools for the study.

The instrument used for this study was adapted from WAEC and NECO past questions; Ecology Achievement Test (EAT). The instrument comprises of 30 multiple choice test items on the Ecology concept as a theme in SS II syllabus. Two (2) equal mark be awarded to each of the 30 test items 2 x 30 = 60 marks. The EAT, covers five topics that includes the association, tolerance, adaptation, pollution and conservation of natural resources. To verify the items conformity contained in the EAT in line with the purpose for which the instrument was meant for, it was validated by three experts in curriculum and instruction, measurement and evaluation and also Biology education departments in the Federal University Dutsin-ma (FUDMA). The research instrument was piloted tested using 35 students by the researcher himself through direct delivery and retrieval, at one secondary school not included in the main study. This school was purposively selected for it operates both male and female classes and also recently benefitted from the SBMC's intervention of needed instructional resources. The collected data from pilot testing was subjected to analysis using the Pearson Moment Correlation Coefficient (PPMC) and a reliability index stood at 0.85, which indicated that it is reliable for use in the main study. Research questions were answered using mean, standard deviations and mean difference while the null hypotheses were tested using the independent sample t-test at 0.05 level of significance.

Results

Research Question 1: What is the difference in the academic performance of students taught Biology using concept mapping instructional strategy and those taught using conventional lecture method in Kankia zonal education quality assurance?

Table 1: Mean and standard deviation of pre-test and post-test of experimental and control groups.

Group	**Pre-test**			**MD**	**Post-test**		**MD**
	N	**Mean**	**SD**		**Mean**	**SD**	
Experimental	56	30.64	5.01	0.07	46.86	5.11	13.25

Control	51	30.57	5.26		33.61	3.65

Table 1 shows that before the use of concept mapping instructional strategy in the teaching of Biology to students in the experimental groups had a pre-test mean score of 30.64 with standard deviation of 5.01 and mean difference of 0.07. The control group has a pre-test mean score of 30.57 with standard deviation of 5.26. However, after the treatment, the experimental group who were exposed to concept mapping instructional strategy recorded a mean of 46.86 and standard deviation of 5.11, while the control group exposed to lecture method recorded a mean of 33.91 and standard deviation of 3.65 with a mean difference of 13.25 calculated in favour of the experimental Table 1 shows that before the use of concept mapping instructional strategy in the teaching of Biology to students in the experimental groups had a pre-test mean score of 30.64 with standard deviation of 5.01 and mean difference of 0.07. The control group has a pre-test mean score of 30.57 with standard deviation of 5.26. However, after the treatment, the experimental group who were exposed to concept mapping instructional strategy recorded a mean of 46.86 and standard deviation of 5.11, while the control group exposed to lecture method recorded a mean of 33.91 and standard deviation of 3.65 with a mean difference of 13.25 calculated in favour of the experimental group. This finding implies that students taught Biology using concept mapping instructional strategy performed significantly better than those taught same concept using lecture method.

Research Question 2: What is the difference between the mean academic performance of male and female students when taught Biology using concept mapping instructional strategy in Kankia zonal education quality assurance?

Table 2: Mean and standard deviations of students at the experimental group based on gender.

Gender	**Post-test**			**MD**
	N	**Mean**	**SD**	
Male	29	46.90	5.31	.08
Female	27	46.81	5.00	

Table 2 presents the mean and standard deviations of academic performance score of male and female Biology students taught the concept of ecology in SS II using concept mapping instructional strategy. From the result, male students taught the concept of ecology using concept mapping recorded a mean of 46.90 and standard deviation of 5.31 while female students in the experimental group one recorded a mean of 46.81 and standard deviation of 5.00 with a mean difference of 0.08. This implies that both male and female students in experimental group one taught using concept mapping instructional strategy performed nearly same. It was concluded that concept mapping instructional strategy is gender friendly as no significant difference found.

Hypothesis one: There is no significant difference in the academic performance of students taught Biology using concept mapping instructional strategy and those taught using conventional lecture method in Kankia zonal education quality assurance.

Table 3: t-test on academic performance between experimental and control groups.

Groups	N	Mean	SD	Df	t_{cal}	Alpha	t_{crit}	Decision
Concept Mapping	56	46.86	5.11	1105	16.637	0.05	.000	Significant
Conventional Method	51	33.61	3.65					

*significant at P-value = .000 < 0.05

Table 3 revealed that the t_{cal} is 16.637 and the t_{crit} value = 0.000 at degree of freedom = 105. Since the P-value = .000 < 0.05, the hypothesis which states that there is no significant difference in the mean academic performance of SS II Biology students taught using concept mapping instructional strategy and those taught using conventional method was rejected. This implies that there is a significant difference between the academic performance of students taught using concept mapping and those taught using lecture method. The difference is in favor of students taught using concept mapping instructional strategy.

Hypothesis Two: There is no significant difference between the academic performance of male and female students when taught Biology using concept mapping instructional strategy in Kankia zonal education quality assurance.

Table 4: Comparison of biology performance of male and female students in experimental group

	N	Mean	SD	t-cal	df	Alpha	p-value	Decision
Male	29	46.90	5.31	.059	54	0.05	0.953	Significant
Female	27	46.81	5.00					

*Significant at p > 0.05

Table 4 shows the t-test result for male taught Biology concepts using concept mapping instructional strategy yielded a mean score of 46.90 with standard deviation of 5.31 and the female mean score was 46.81 with a standard deviation of 5.00. The result further reveals that t = 0.59, p > 0.05. Since the p value of 0.953 is greater than the 0.05 level of significance, the null hypothesis that stated there is no significant difference between the mean academic performance of male and female students when taught Biology using concept mapping instructional strategy is retained, indicating that there was no significant difference between male and female students.

Discussion of Findings

The discussion of findings of this study is based on the research questions answered and hypotheses tested. The finding from research question and hypothesis indicated that the mean academic performance of SS II students taught ecology using concept mapping and conventional method. The significant difference exist in favour of the experimental group exposed to concept mapping instructional strategy as shown by the mean scores and the standard deviation. Therefore, this finding corroborates the findings of Emmanuel et al. (2021) which revealed that concept mapping instructional strategy enhances students' academic performance in Biology. Similarly, the findings agrees with the findings of Wokocha (2020) which revealed that students in the experimental group taught Basic Science concepts using concept-mapping teaching strategy achieved significantly and retained significantly higher than their counterparts taught using lecture method. Also, there was no significant difference in academic achievement between the male and female students exposed to concept-mapping and lecture instructional strategies.

The finding from research question two and hypothesis two indicated that there is no significant difference in the mean academic performance of SS II students taught ecology using concept mapping instructional strategy. This finding coincide with the finding of Olaoye (2021) who found no significant difference between male and female students taught biology using concept mapping instructional strategy. Similarly, Kanji, Lawrence, and Salihu (2021) conducted a study that examined the effects of concept mapping instructional strategy on students' achievement in number and numeration in Kogi State, Nigeria. Findings revealed that there was no significant effect of gender on students' achievement, it is found to be gender friendly as both male and female students scored higher marks

Conclusion

The study examines the effects of concept mapping instructional strategy on academic performance in Biology among secondary school students in Katsina State. The study implied that concept mapping creates pathways that can be used to design and deliver the instructional concepts in Biology organized from familiar to unfamiliar and simple to complex.

Finally, the study concludes that teaching Biology using concept mapping instructional strategies motivate students to easily achieve higher academic performance especially in difficult areas of Biology such as association, tolerance, adaptation, pollution and conservation of natural resources better than lecture method. For example, the ecology as a concept in Biology is better taught to the understanding of students using concept mapping instructional strategy (Singh & Moono, 2015).

Recommendations

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

1. Biology teachers should employ the use of concept mapping instructional strategy as it has proved to be effective in enhancing students' academic performance.

2. Biology teachers should wisely consider students aptitude levels while forming small groups irrespective of gender stereotype to encourage male and female students learn through concept mapping instructional strategy as one of the 21st century innovative teaching strategies.

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