Effect of Concept Mapping-Guided Discovery Integrated Instructional Approach on Basic Science Students' Attitude, Achievement and Retention

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Abstract
This study investigated the effect Concept Mapping-Guided Discovery integrated instructional approach attitude, achievement, and retention of Basic Science students. The simple random sampling procedure was employed to select 73 JSS I students from two public co-education schools in Kaduna South Senatorial District, Kaduna State, Nigeria. The quasi-experimental design was employed for the study. Three research questions guided the study, and three research hypotheses were tested at 0.05 level of significance. Two instruments were used for data collection namely; Basic Science Attitude Questionnaire (BSAQ) and Basic Science Achievement Test (BAT). The reliability of BSAQ was determined using Cronbach Alpha and the coefficient obtained was 0.79 while split half was used to determine the reliability of BAT and the reliability coefficient was found to be 0.85 implying that the instruments were reliable enough for the study. Mean Gain scores were used to answer the research questions while the hypotheses were tested using Analysis of Covariance (ANCOVA). Scheffe's post- hoc test was used to determine the magnitude of the differences. The findings of the study revealed that significant differences were found in the interest and retention of students taught using Concept Mapping-Guided Discovery integrated instructional approach and the Conventional Demonstration Method.
Keyword: *Achievement, Attitude, Basic Science, Cooperative, Concept Mapping-Guided Discovery, and Retention.*

INTRODUCTION

Basic Science is the foundational science subject taught at the Junior Secondary School level of the Nigerian educational system. It is a prerequisite subject for science subjects at the Senior Secondary and other applied courses at the tertiary institutions of learning (Samuel, 2017). The relevance of Basic Science in all fields of Science made it imperative to be included in the curriculum of Junior Secondary School as enshrined in the National Policy on Education (Federal Republic of Nigeria (FRN), 2014).

The purpose of Basic Science is to train students to acquire a proper understanding of basic principles as well as its application. It is also aimed at developing appropriate scientific skills and attitudes as a prerequisite for future scientific activities. To achieve these objectives, active participation and collaborative learning activities become imperative, and these need functioning instructional media to make Basic Science instruction effective (Osokoya, 2013; Samuel, 2017; Eriba & Samuel, 2018; Agu & Samuel, 2018).

Despite the relevance of Basic Science to national development, security, economy, manpower and government's efforts to improve science instruction in schools, students' achievement is below average. This has become a great concern for science educators. Researchers such as Bukunola and Idowu (2012), Osokoya (2013), Alabi (2014), Oni (2014) Kabutu, Oloyede and Bandele (2015) and Samuel (2017) observed that poor instructional strategies employed in the teaching of the subjects by teachers contribute to students' underachievement. In order to achieve the objectives of Basic Science education, the student-activity-based mode of teaching strategies has been recommended by the Federal Republic of Nigeria (FRN, 2014).

The concept mapping based instruction was developed by Novak at Cornell University in the 1970s. Concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line, referred to as linking words or linking phrases, specify the relationship between the two concepts (Novak, 1991). Concept maps are used as tools for meaningful learning, assessment, instructional

planning and finding out the alternative concepts or misconceptions held by the learners. Learning through concept mapping has a long-lasting effect on memory (Awodun, 2017; Fatokun & Eniayeju, 2014).

Guided discovery is an instructional strategy that employs exploration, manipulation, and experimentation to find out new ideas. It is regarded as convergent thinking. The instructor conceives a succession of declarations or questions that guide the learner, step by step, making a series of information that leads to a single predetermined goal. Summarily, the teachers initiate a stimulus, and the learners react by engaging in an active inquiry thereby discovering the appropriate response (Alabi & Lasisi, 2015; Omiko, 2017).

Nwachukwu (2013) viewed achievement basically as the competence a person has in an area of content. This competence is the result of many intellectual and nonintellectual variables. Researchers (Akanbi & Kolawale, 2014) have come out with constructive results on the causes of poor academic achievement in Secondary School Science; instructional strategies ranked very high amongst other causes identified. This indicates that the depreciation of instructional strategies, by not encouraging, promoting and improving learners' understanding of Basic Science and Technology concepts, this has made the desired achievement unattainable.

Retention is the ability to hold, keep or recall past experience and reproduce a learned concept when the need arises (Bukunola & Idowu, 2012). It is an important variable in learning because only a learned experience is recalled, learning cannot be said to have taken place if there is no proper retention. The ability of students to recall past learned Basic Science concepts as an objective of the Basic Science teaching and learning process may likely enhance achievement in the subject. For so long, researchers have been keen on knowing what could be done by teachers to enhance maximum retention of knowledge or skills long after they have been acquired whether in the classroom or outside the classroom (Azuka, 2012; Eriba & Samuel, 2018; Agu & Samuel, 2018).

Attitude as a concept is concerned with an individual's way of acting and behaving. It has very serious implications for the learner, the teacher, the immediate social group with which the individual learner relates and the school system. Attitudes are formed as a result of some kind of learner experiences. They may also be learned simply by following the examples, opinions of parents, teachers or friends. This is imitation which also has a part to play in the teaching and learning situation. In this respect, the learner draws on his teacher's deposition to form his own attitude which may likely affect his learning outcomes (Eriba, 2013). A negative attitude can lead to low expectations on students 'academics. Also, teaching strategies can influence the attitude of students positively or negatively. Reports have shown that improved instructional strategy affects the attitude of students. Gambari and Yusuf (2017) reported that students taught using cooperative learning strategy had a positive attitude to the educational benefits derived from group work.

The aim of the present study was to determine the extent to which classroom exposure to Concept Mapping-Guided Discovery integrated instructional approach could enhance Basic Science students' attitude, achievement, and retention. Specifically, the study sought to find out:

- The effect of Concept Mapping-Guided Discovery integrated instructional approach on students' attitude towards Basic Science.
- The effect of Concept Mapping-Guided Discovery integrated instructional approach on the achievement of Basic Science students.
- The effect of Concept Mapping-Guided Discovery integrated instructional approach on retention of Basic Science students.

Research Questions

- What are the mean attitude scores of students taught Basic Science using Concept Mapping-Guided Discovery integrated instructional approach and those taught using Conventional Demonstration Method?

- What are the mean achievement scores of students taught Basic Science using Concept Mapping-Guided Discovery integrated instructional approach and those taught using Conventional Demonstration Method?
- What are the mean retention scores of students taught Basic Science using Concept Mapping-Guided Discovery integrated instructional approach and those taught using Conventional Demonstration Method?

Research Hypotheses

H_{O1}: There is no significant difference in the mean attitude scores of students taught Basic Science using Concept Mapping-Guided Discovery integrated instructional approach and those taught using Conventional Demonstration Method.

H_{O2}: There is no significant difference in the mean achievement scores of students taught Basic Science using Concept Mapping-Guided Discovery integrated instructional approach and those taught using Conventional Demonstration Method.

H_{O3}: There is no significant difference in the mean retention scores of students taught Basic Science using Concept Mapping-Guided Discovery integrated instructional approach and those taught using Conventional Demonstration Method.

Methodology

The quasi experimental research design was employed for the study. The sample for the study comprised 73 JSS I from two intact classes randomly selected from two public co-education schools in Kaduna South Senatorial District, Kaduna State, Nigeria. The schools were randomly assigned to experimental groups (Concept Mapping-Guided Discovery integrated instructional approach (n = 33) and the control group (taught using the Conventional Demonstration Method (n = 40)).

Two instruments were used for data collection namely; Basic Science Attitude Questionnaire (BSAQ) and Basic Science Achievement Test (BAT). BSAQ contained 20 items designed to determine students' interest in Basic Science. BSAQ was rated using a four-point rating scale. The options were; Strongly agreed (SA) = 4 points, Agree (A) = 3 points, Disagree (D) = 2 points and Strongly Disagreed (SD) = 1 point. Basic Science Achievement Test (BAT) was a 25-item instrument with options A – D that tested the students' knowledge, comprehension, application of selected topics in Basic Science in Matter and Energy. The items were allotted 2 marks each, culminating in the total score of 50marks. The test was validated by experts in Science Education. The reliability of BSAQ was determined using Cronbach Alpha and the coefficient obtained was 0.79 while split half was used to determine the reliability of BAT and the reliability coefficient was found to be 0.85 implying that the instruments were reliable enough for the study. Mean Gain scores were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the research hypotheses at 0.05 alpha level of significance. Scheffe's post-hoc test was used to determine the direction of the differences among the strategies of instruction used.

Results

Research Question One

What are the mean attitude scores of students taught Basic Science using Concept Mapping-Guided Discovery integrated instructional approach and those taught using Conventional Demonstration Method?

The mean gain scores of students' attitude in Basic Science taught using Concept Mapping-Guided Discovery integrated instructional approach with those taught using Conventional Demonstration Method are presented in Table 1.

Table 1

Mean Gain Scores of Students' Scores Using Concept Mapping-Guided Discovery Integrated Instructional Approach with the Conventional Demonstration Method

Group	Type of test	No. of Students	Mean	Mean Gain
Concept Mapping-Guided Discovery integrated instructional approach	Pre-attitude	33	35.67	
	Post-attitude	33	65.61	29.94
Conventional Demonstration Method	Pre-attitude	40	29.71	
	Post-attitude	40	53.32	23.61

From Table 1, it is observed that there was a significant mean gain in the attitude between students taught Basic Science using Concept Mapping-Guided Discovery integrated instructional approach having the highest and the Conventional Demonstration Method with the lowest mean gain scores. This indicates that all the groups benefitted from the treatment, but the Concept Mapping-Guided Discovery integrated instructional approach benefitted more having a higher mean gain score.

Research Question Two

What is the mean achievement scores of students taught Basic Science using Concept Mapping-Guided Discovery integrated instructional approach with those taught using Conventional Demonstration Method?

The mean gain scores of students' achievement in Basic Science taught using Concept Mapping-Guided Discovery integrated instructional approach with those taught using Conventional Demonstration Method are presented in Table 2.

Table 2

Mean Gain Scores of Students' Scores Using Concept Mapping-Guided Discovery Integrated Instructional Approach with those Taught Using Conventional Demonstration Method

Group	Type of test	No. of Students	Mean	Mean Gain
Concept Mapping-Guided Discovery integrated instructional approach	Pre-test	33	21.87	
	Post-test	33	62.91	41.04
Conventional Demonstration Method	Pre-test	40	20.71	
	Post-test	40	58.65	37.94

From Table 2, it is observed that there was a significant mean gain in the achievement between students taught Basic Science using Concept Mapping-Guided Discovery integrated instructional approach with the higher mean gain than the Conventional Demonstration Method with the lower mean gain score. This indicates that all the groups benefitted from the treatment, but the Concept Mapping-Guided Discovery integrated instructional approach benefitted more having a higher mean gain score.

Research Question Three

What are the mean retention scores of students taught Basic Science using Concept Mapping-Guided Discovery integrated instructional approach and those taught using Conventional Demonstration Method?

The mean loss scores of students on retention in Basic Science taught using Concept Mapping-Guided Discovery integrated instructional approach and those taught using Conventional Demonstration Method are presented in Table 3.

Table 3

Mean Loss Scores Between Post-test and Post-posttest for Concept Mapping-Guided Discovery Integrated Instructional Approach and Conventional Demonstration Method Groups

Group	Type of test	No. of Students	Mean	Mean Loss
Concept Mapping-Guided Discovery integrated instructional approach	Post-test	33	62.91	
	Post-post-test	33	61.08	1.83
Conventional Demonstration Method	Post-test	40	58.65	
	Post-post-test	40	55.37	3.28

Table 3 shows a decrease in the post-posttest scores of the three groups as compared to the post-test scores. This indicates that all the groups benefitted from the treatment with the Concept Mapping-Guided Discovery instructional strategy having a lower mean loss score; this implies that the Concept Mapping-Guided Discovery instructional strategy group outperformed the other group on retention.

Research Hypotheses One

There is no significant difference in the mean attitude scores of students taught Basic Science using Cooperative instructional strategy, and Concept Mapping-Guided Discovery integrated instructional approach and those taught using Conventional Demonstration Method.

The test of this hypothesis provided the data in Table 4.

Table 4

The result of Analysis of Covariance on Students' Attitude in Basic Science Using SBAQ

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Result
Corrected model	5708.321	1	3014.610	63.012	0.000	S
Intercept	4321.034	1	3310.125	214.628	0.001	S
Pre-attitude	211.102	1	308.432	32.104	0.000	S
Group	2345.312	1	2345.312	45.503	0.000	S
Error	2812.115	69	76.032			
Total	12585.572	73				

Significant at P<0.05

Table 4 shows a significant difference among the learning strategies on attitude, F= ratio of 45.503, P<0.05. The result implies that the instructional strategies produced significant effects on the attitude scores of students when the covariate effect (pre-attitude) was controlled. The null hypothesis of no significant difference was therefore rejected indicating that there is a significant difference. The result indicates that the treatment using Concept Mapping-Guided Discovery integrated instructional approach accounted for the difference in the attitude scores of the students.

Based on the established difference in the attitude scores of the groups, Scheffe's test was used for post-hoc analysis to determine the direction of the difference. The results of this post-hoc analysis are as shown in Table 5.

Table 5

Scheffe's post-hoc Results of Students' Attitude Mean Scores of Concept Mapping-Guided Discovery Integrated Instructional Approach and Conventional Demonstration Method Groups

Groups	Mean Scores	Concept Mapping-Guided Discovery	Conventional Demonstration Method
Concept Mapping-Guided Discovery integrated instructional approach	65.61		0.003
Conventional Demonstration Method	53.32	0.003	1.05

The mean difference is significant at 0.05 level.

The results shown in Table 5 indicate that there was no significant difference in the mean attitude scores of students exposed to Concept Mapping-Guided Discovery integrated instructional approach (X= 65.61) and Conventional Demonstration Method (X = 53.32). This implies that the Concept Mapping-Guided Discovery integrated instructional approach had a significant effect on the students more than the Conventional Demonstration Method.

Research Hypothesis Two

There is no significant difference in the mean achievement scores of students' taught Basic Science using Cooperative instructional strategy and Concept Mapping-Guided Discovery integrated instructional approach with those taught using Conventional Demonstration Method.

The test of this hypothesis provided the data in Table 5.

Table 5

The result of Analysis of Covariance on Students' Achievement in Basic Science Using BAT

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Result
Corrected model	3624.102	1	5124.016	78.102	0.000	S
Intercept	4101.203	1	4132.311	432.010	0.001	S
Pretest	261.322	1	311.342	98.012	0.000	S
Group	5323.072	1	2253.312	74.670	0.000	S
Error	2541.705	69	98.452			
Total	15851.404	73				

Significant at P<0.05

Table 5 shows a significant difference among the learning strategies on interest, F= ratio of 74.670, P<0.05. The result implies that the instructional strategies produced significant effects on the attitude scores of students when the covariate effect (pretest) was controlled. The null hypothesis of no significant difference was therefore rejected indicating that there is a significant difference. The result indicates that the treatment using Concept Mapping-Guided Discovery integrated instructional approach accounted for the difference in the attitude scores of the students.

Based on the established difference in the achievement scores of the groups, Scheffe's test was used for post-hoc analysis to determine the direction of the difference. The results of this post-hoc analysis are as shown in Table 6.

Table 6

Scheffe's post-hoc Results of Students' Achievement Mean Scores of Cooperative Instructional Strategy Concept Mapping-Guided Discovery Integrated Instructional Approach and Conventional Demonstration Method Groups

Groups	Mean Scores	Concept Mapping-Guided Discovery	Conventional Demonstration Method
Concept Mapping-Guided Discovery integrated instructional approach	62.91		0.005
Conventional Demonstration Method	58.65	0.005	1.10

The mean difference is significant at 0.05 level.

The results shown in Table 6 indicate that there was a significant difference in the mean achievement scores of students exposed to Concept Mapping-Guided Discovery integrated instructional approach (X= 62.91) and the Conventional Demonstration Method (X = 62.39) in favor of the Concept Mapping-Guided Discovery integrated instructional approach.

Research Hypothesis Three

There is no significant difference in the mean retention scores of students taught Basic Science using Concept Mapping-Guided Discovery integrated instructional approach with those taught using Conventional Demonstration Method.

The test of this hypothesis provided the data in Table 7.

Table 7

The result of Analysis of Covariance on Students' Retention in Basic Science Using BAT

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Result
Corrected model	5014.121	1	4112.872	103.032	0.000	S
Intercept	4021.231	1	3451.021	215.230	0.001	S
Posttest	415.321	1	164.211	25.022	0.000	S
Group	2116.231	1	2511.231	78.052	0.000	S
Error	2071.101	69	87.525			
Total	13638.005	73				

Significant at P<0.05

Table 7 shows a significant difference among the learning strategies for retention, F= ratio of 78.052, P<0.05. The result implies that the instructional strategies produced significant effects on the retention scores of students when the covariate effect (posttest) was controlled. The null hypothesis of no significant difference was therefore rejected indicating that there is a significant difference. The result indicates that the treatment using Concept Mapping-Guided Discovery integrated instructional approach accounted for the difference in the retention scores of the students.

Based on the established difference in the retention scores of the groups, Scheffe's test was used for post-hoc analysis to determine the direction of the difference. The results of this post-hoc analysis are as shown in Table 8.

Table 6

Scheffe's post-hoc Results of Students' Retention Mean Scores of Concept Mapping-Guided Discovery Integrated Instructional Approach and Conventional Demonstration Method Groups

Groups	Mean Scores	Concept Mapping-Guided Discovery	Conventional Demonstration Method
Concept Mapping-Guided Discovery integrated instructional approach	61.08		0.022
Conventional Demonstration Method	55.37	0.032	0.014

The mean difference is significant at 0.05 level.

The results shown in Table 6 indicate that there was a significant difference in the mean retention scores of students exposed to Concept Mapping-Guided Discovery integrated instructional (X= 61.08) and Conventional Demonstration Method (X = 55.37) in favor of the Concept Mapping-Guided Discovery integrated instructional.

Discussion

The findings of this study revealed that the use of Concept Mapping-Guided Discovery integrated instructional approach had significant effects on students' attitude, achievement, and retention in Basic Science. The students taught using Concept Mapping-Guided Discovery integrated instructional approach had a significant attitude than those taught using the Conventional Demonstration Method. This result is in agreement with the findings of Gambari & Yusuf (2017) they found that minds-on-hands-on instructional strategies have a positive effect on students' attitude in Science.

In relation to achievement and retention, the study revealed that the use of Concept Mapping-Guided Discovery integrated instructional approach had a significant effect on Basic Science students than the Conventional Demonstration Method. This finding is consistent with findings of Kabutu, Oloyede & Bandele, 2013; Fatokun & Eniayeju, 2014; Furo, 2015; Gull & Shehzad, 2015; Nwafor & Okoi, 2016; Awodun, 2017; Omiko, 2017; Gambari & Yusuf, 2017; Eriba & Samuel, 2018; Agu & Samuel, 2018; they found out that cooperative, concept mapping and guided discovery instructional strategies enhance students' achievement and retention in Science.

These findings have strong implications for the teaching and learning of Basic Science and in Secondary Schools in Nigeria using Concept Mapping-Guided Discovery integrated instructional approach. Furthermore, the findings of this study suggest that exposing Basic Science students to a Concept Mapping-Guided Discovery integrated instructional approach could improve attitude, achievement, and retention of the subject. These should be given strong emphasis in the teaching of Basic Science in Junior Secondary Schools of Nigeria.

Conclusion

The findings of the study, among others have shown that; using Concept Mapping-Guided Discovery integrated instructional approach has a way of improving attitude, achievement, and retention in Basic Science at the Junior Secondary School level in Nigeria. The present demonstration method should be minimized, and innovative student-centered approaches should be incorporated.

Recommendations

Basic Science teachers should be encouraged to adopt Concept Mapping-Guided Discovery integrated instructional approach so as to improve and promote social interaction, active learning, discovery learning, motivation, learning by doing and learning by experience among students.

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