



## Exploring the Impact of Concept Mapping and Non-Concept Mapping Instructional Strategies on Academic Achievement of Nigerian students in Basic Science

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### Abstract

This study explores the impact of concept mapping instructional strategy on students' academic achievement in basic science in Nigeria. Quasi-experimental research design was used in the study. Two research questions and two hypotheses guided the study. The hypotheses were tested at 0.05 level of significance. The population of the study was 2,437 junior secondary school two (JSS2), which comprised of 1,334 male and 1,103 female in public secondary schools in Nsukka, Enugu State, Nigeria. The sample size was 80 JSSII students were selected using simple random sampling techniques. The instrument used in the study was Basic Science Achievement Test (BSAT) with a reliability estimate of 0.89 derived using K-R 20. The research questions were analysed using descriptive statistics while the null hypotheses were tested using Analysis of Covariance (ANCOVA). The result show that concept mapping is an effective instructional strategy for improving students' academic achievement in basic science in Nigeria, with statistically significant improvement observed in students' test scores after the intervention regardless of gender. The study recommends that concept mapping be incorporated into basic science instruction in Nigeria to enhance students' understanding of scientific concepts.

**Keywords:** Academic achievement; Basic science; Concept mapping; Non-concept mapping; Instructional strategies

### Introduction

Basic Science is a core subject in junior secondary School Curriculum which has the potential role of laying the foundation for subjects like Physics, Chemistry and Biology at the later stage of education. It was introduced at the primary and Junior secondary school level as the foundation of other sciences. According to the National policy on Education (Federal Republic of Nigeria, 2014), the objectives of teaching Basic Science as a subject at the junior secondary school level are to enable the learners develop interest in science and technology; acquire basic knowledge and skills in science and technology; apply scientific and technological knowledge and skills to meet contemporary societal needs; take advantage of the numerous career opportunities provided by science and technology; become prepared for further studies in sciences. The

performance of students in core sciences may depend largely on their academic achievement in Basic Science.

Academic achievement is the success attained after accomplishing a task. Academic achievement is a major concern in Nigeria, particularly in the area of basic science. Basic science is a fundamental subject that forms the basis for advanced learning in science, technology,

engineering, and mathematics (STEM) fields. However, the academic achievement of Nigerian students in basic science has been consistently low, and this has become a cause for concern among educators, policymakers, and parents (Mbonu-Adigwe & Ude, 2023; Mbonu-Adigwe et al, 2021). Several factors have been identified as contributing to the poor academic achievement of Nigerian students in basic science. These include inadequate infrastructure, insufficient instructional materials, lack of qualified teachers, and inadequate funding for education (Mbonu-Adigwe et al, 2021; Mbonu, 2018). Additionally, many students in Nigeria come from economically disadvantaged backgrounds, which can limit their access to educational resources and opportunities. Efforts have been made to improve students' academic achievement in basic science in Nigeria. One approach is the implementation of curriculum reforms that emphasize the development of critical thinking and problem-solving skills (Ezeh & Amaechina, 2019). Another approach is the use of innovative teaching strategies, such as concept mapping and problem-based learning, which have been found to improve students' understanding and retention of scientific concepts (Adeneye & Adeleye, 2011)

Concept mapping is a teaching and learning strategy that helps students to organize, connect, and visualize ideas in a hierarchical manner, which promotes meaningful learning. It has been shown to be an effective instructional strategy in improving students' academic performance in various subjects, including basic science. In Nigeria, where the educational system has faced challenges, concept mapping has been identified as a promising approach to address students' poor academic achievement in basic science. This teaching approach involves the use of graphic organizers to visually represent relationships between concepts or ideas. This strategy has been found to be effective in improving students' understanding and retention of complex information. In Nigeria, where academic achievement in basic science has been a concern, the use of concept mapping instructional strategy could potentially enhance students' performance in this subject.

According to a study by Ukpai (2016), concept mapping instructional strategy was found to have a significant positive effect on the academic achievement of junior secondary school students in basic science. The researchers concluded that concept mapping promotes deeper understanding and retention of the subject matter, which is essential for academic success. Similarly, another study by Ahmed, Shittu, & Yahaya (2021) found that the use of concept mapping instructional strategy enhanced students' critical thinking skills, which are crucial for academic achievement. Concept mapping is an effective strategy for improving students' academic achievement in science, technology, engineering, and mathematics (STEM) subjects. This is because it encourages students to actively engage with the material and develop a deeper understanding of the relationships between different concepts.

Several studies examined the impact of concept mapping instructional strategy on academic achievement in basic science specifically in Nigeria. For instance, a study by Adeneye & Adeleye (2011) found that students who were taught using concept mapping had significantly higher test scores compared to those who were taught using traditional methods. Similarly, Ugwoke & Ude (2022) reported that concept mapping improved students' understanding and retention of science concepts. All these studies were carried out in different locations, subjects and level of students. However, this present study seeks to find out if concept mapping technique will be equally effective with junior secondary school basic science students in Nsukka LGA of Enugu State, Nigeria.

The problem that this study aims to address is the potential inadequacy of current instructional

strategies in Nigerian basic science education, which may be contributing to lower academic achievement among students. Specifically, the study seeks to explore whether incorporating concept mapping as an instructional strategy can have a positive impact on academic achievement in this subject area.

### Research Questions

The following research questions were posed to guide the study.

1. What is the mean achievement score of students taught Basic Science using concept mapping instructional strategy (CMIS) and those taught using the conventional method?
2. What is the mean achievement score of male and female students taught Basic Science using concept mapping instructional strategy?

### Hypotheses

The following hypotheses tested at 0.05 level of significance were formulated to guide the study.

H<sub>01</sub>: There is no significant difference in the mean achievement scores of students taught Basic Science using concept mapping instructional strategy (CMIS) and those taught using non-concept mapping instructional strategy (NCMIS)

H<sub>02</sub>: There is no significant difference in the mean achievement scores of male and female basic science students taught using concept mapping instructional strategy (CMIS).

### Research Method

The research design adopted for the study is the quasi-experimental research design specifically the pre-test, post-test non-equivalent control group design. The population of the study was 2,437 junior secondary school two (2) Basic Science students (1,103 students are males and 1,334 students are females) in the public schools in Nsukka Local Government Area of Enugu State, Nigeria. This area was chosen because the examination reports available at the state's education board showed a persistent low achievement in Basic science in the area.

Three content areas, Environmental Pollution, Human Digestive System and Respiratory System were selected for the study. These topics were chosen because they are among content areas considered abstract by teachers and students in Basic Science. The extent of the treatment that was given to these content areas was based on the Basic Science curriculum for junior secondary schools.

Simple random sampling technique was used in selecting two schools for the study. One school became the experimental group while the other became the control group with 40 students in each intact class. Sample size of this study was 80 junior

secondary school two (JSS 2) Basic Science students, made up of 25 males and 55 females from two intact classes sampled from through schools. Basic Science Achievement Test (BSAT) with 30 items drawn from the three-content area was developed by the researcher, validated and used for data collection. The instrument was trial tested and a reliability coefficient of 0.89 was estimated using KR-20.

The researcher used concept mapping instructional strategy (CMS) in the first school, and

this served as the experimental group while non-concept mapping instructional strategy (NCMIS) was used in the second group (the control group). The instrument (BSAT) was administered on the first day and the scores used as pre-test. The treatment lasted for six (6) weeks. After the treatment, the researcher reshuffled the BSAT and re-administered it as post-test.

## Results

**Table 1: Pre/Post-test Mean Achievement Scores of Students taught Basic Science using concept mapping instructional strategy (CMIS) and those taught using the non-concept mapping instructional strategy (NCMIS)**

Group	N	Pre-test		Post-test		Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD	
CMIS	40	36.56	4.91	90.86	2.81	54.30
NCMIS	40	34.74	4.76	60.30	3.67	25.56

Table 1 shows that those taught using concept mapping instructional strategy had a pre-test mean achievement score of 36.56 with Standard Deviation of 4.91 and a post-test mean achievement score of 90.86 with Standard Deviation of 2.81. On the other hand, the pre-test mean achievement score of the non-concept mapping instructional strategy (NCMIS) group was 34.74 with Standard Deviation of 4.76, while their post-test mean achievement score was

60.30 with Standard Deviation of 3.67. The concept mapping group had a mean gain score of 54.30 as against the mean gain score of 25.56 recorded by the non-concept mapping instructional strategy (NCMIS) group. The result reveals that the students taught with the concept mapping achieved higher in Basic Science than those taught with the non-concept mapping instructional strategy (NCMIS).

**Table 2: Pre/Post-test Mean Achievement Scores of male and female Basic Science students taught using concept mapping instructional strategy (CMIS)**

Group	N	Pre-test		Post-test		Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD	
Male	25	44.53	5.00	69.24	3.42	24.71
Female	55	43.43	4.75	65.52	4.52	22.09

Table 2 shows that the male students had a pre-test mean achievement score of 44.53 with Standard Deviation of 5.00 and a post-test mean achievement score of 69.24 with Standard Deviation of 3.42. On the other hand, the pre-test mean achievement score of female students was 43.43 with Standard Deviation of 4.75, while their post-test mean

achievement score was 65.52 with Standard Deviation of 4.52. The male group had a mean gain score of 24.71 as against the mean gain score of 22.09 recorded by the female students. The result reveals that the male students achieved higher in Basic Science than the female students, even though they were exposed to the same treatment.

**Table 3: Summary of Analysis of Covariance (ANCOVA) of Students' Post Achievement Scores in Basic Science by Teaching Method and Gender**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	740.170 <sup>a</sup>	4	185.042	18.516	.000	.414
Intercept	2747.759	1	2747.759	274.954	.000	.724
Pre-Achievement	50.161	1	50.161	5.019	.027	.046
Teaching-Method (CMIS)	631.703	1	631.703	63.211	.000	.376
Gender	20.500	1	20.500	2.051	.155	.019
Teaching-Method (NCMIS)	31.685	1	31.685	3.171	.078	.029
Error	1049.321	75	9.994			
Total	51738.000	80				
Corrected Total	1789.491	79				

a. R Squared = .414 (Adjusted R Squared = .391)

Results shown on Table 3 indicate that teaching method as a main factor has a significant effect on students' achievement in Basic Science. This is because the F value of 63.211 in respect of teaching method is shown to be significant at 0.001 level with associated effect size of .376. This means that at 0.05 level, the F value of 63.211 is significant. The result shows that the concept mapping instructional strategy significantly improved students' achievement in Basic Science more than the non-concept mapping instructional strategy (NCMIS). Thus, the null hypothesis which states that there is no significant difference between the mean achievement scores of students taught Basic Science using concept mapping and those taught using non-concept mapping instructional strategy (NCMIS) is not accepted.

Results shown on Table 3 also indicate that gender has no significant effect on students' achievement in Basic Science. This is because the F value of 2.051 with respect to gender is shown to be non-significant at 0.155 level with associated effect size of .019. This means that at 0.05 level, the F value of 2.051 is not significant. The result shows that the use of concept mapping does not significantly improve male students' achievement in Basic Science more than the female students' achievement in Basic Science. Thus, the null hypothesis that there is no significant difference between the mean achievement scores of male and female students of Basic Science students taught using concept mapping instructional strategy and those taught using non-concept mapping instructional strategy (NCMIS) is accepted.

### Discussion of Findings

The results of this study indicate that utilizing concept mapping instructional strategy can have a

significant positive impact on students' academic achievement in Basic Science. Specifically, the group of students who received instruction using this strategy exhibited notably higher achievement scores than the group taught using non-concept mapping instructional strategy (NCMIS)s. These findings align with prior research conducted by Jane and Adeola (2017), who discovered that technical drawing students taught using concept mapping had higher mean achievement and interest scores compared to those taught with traditional methods.

Furthermore, a recent study by Charity and Ebikebuna (2022) revealed that students exposed to concept mapping instructional strategy had a greater interest in Basic Technology when compared to those taught through lecture-style instruction. The improved academic achievement observed among students taught using concept mapping may be attributed to the active engagement and personalized learning experience facilitated by this instructional approach. These findings highlight the potential benefits of incorporating concept mapping instructional strategy into Basic Science instruction to enhance students' academic performance and interest in science education.

The present study also examined whether the use of concept mapping instructional strategy has differential effects on male and female students' academic achievement in Basic Science. The results indicate that there was no significant difference between the mean achievement scores of male and female students taught Basic Science using concept mapping instructional strategy and those taught using non-concept mapping instructional strategy (NCMIS)s. The null hypothesis, which proposes that there is no significant difference between the two groups, was not rejected. These findings are in line



with earlier studies conducted by Ogonnaya, Okafor, Abonyi, and Ugama (2016), which revealed that concept mapping instructional strategy was equally effective in improving the academic achievement of male and female students in Basic Science when compared to traditional methods. Similarly, Dania's (2014) study showed no significant difference in academic achievement based on gender for Social Studies.

In contrast, Cheema and Mirza's (2013) research found that concept mapping was more effective in improving the academic achievement of male students in science compared to female students. This difference in findings may be due to other variables, as the concept mapping instructional strategy itself is not gender-biased and is beneficial for meeting the learning needs of all students, regardless of gender.

## Conclusion

The present study demonstrates that the use of concept mapping instructional strategy has a significant positive effect on students' academic achievement in Basic Science. The findings are consistent with prior research that has also shown the benefits of this approach in improving academic performance and student engagement. Moreover, the results indicate that concept mapping instructional strategy is an effective teaching method for both male and female students. The personalized and interactive learning experience provided by this strategy enhances students' academic performance and increases their interest in science education. Therefore, integrating concept mapping instructional strategy into Basic Science instruction can be a valuable tool for educators seeking to improve their students' academic performance and interest in science. Further research may explore the specific factors contributing to the effectiveness of concept mapping instructional strategy and how it can be applied in other academic subjects.

## Recommendations

Based on the study's findings, the following recommendations were made:

1. Incorporate concept mapping instructional strategy into Basic Science instruction to enhance students' academic performance. Educators can use this approach to personalize learning experiences and engage students in interactive learning activities.
2. Encourage teachers to receive training and professional development opportunities to enhance their understanding of the concept mapping instructional strategy. This training

will ensure that teachers can effectively implement the strategy in their classrooms.

3. Foster a learning environment that is inclusive and supportive of both male and female students. This approach will help to eliminate any gender disparities in academic achievement and ensure that all students can benefit from the concept mapping instructional strategy.
4. Conduct further research on the factors contributing to the effectiveness of concept mapping instructional strategy and explore how it can be applied in other academic subjects. By doing so, educators can identify the most effective teaching methods and develop best practices for teaching various subjects using concept mapping instructional strategy.

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