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Impact of Mind-Mapping Instructional Strategy on Secondary School Students' Achievement and Retention in Biology in Delta State

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ABSTRACT

The study investigated the Impact of mind-mapping instructional strategy on Secondary School Students Achievement and Retention in Biology in Delta State. Two research questions were raised and two hypotheses were formulated to guide the study. The design for the study was pretest, posttest, and delayed test control group quasi-experimental design. The Sample for the study comprised 151 SSII Biology students sampled using simple random sampling technique. Instruments used for data collection were duly validated Biology Achievement Test (BAT). Reliability of BAT was established using Kuder-Richardson formula 21 (KR-21) which yielded a reliability coefficient of 0.81. Obtained data were analyzed using mean, standard deviation, t-test, percentage and ANOVA. The results show that there was a significant difference in the mean achievement and retention between students taught Biology using mind-mapping strategy and lecture method. It was concluded that mind-mapping strategy promotes students' achievement and retention in Biology more than the lecture method. It was thus, recommended that biology teachers in secondary schools should adopt and integrate the use of mind-mapping strategies in the teaching and learning of Biology in Delta State.

Keywords: Impact, Mind- mapping, lecture method, Students Achievement, Retention

INTRODUCTION

Effective teaching strategies are crucial for achieving successful learning outcomes in education. The complexity of biological concepts can present difficulties for students in terms of comprehension and retention. There is an increasing interest in investigating innovative instructional approaches that can improve Biology students' academic achievement and knowledge retention. Achievement pertains to the academic success level of students. Academic achievement comprises various measures such as grades, test scores, assignment completion, and overall performance. Achievement encompasses not only quantitative metrics, but also the development of critical thinking, problem-solving abilities, creativity, and social-emotional skills. The primary objective of science education is to cultivate students' problem-solving abilities and facilitate their transformation into self-sufficient, proficient, and lifelong learners (Kuo et al., 2013). To be able to achieve this objective, the right teaching strategy needs to be adopted by science teachers. Academic retention is often associated with academic achievement, as it can improve students' performance by enabling them to retain what they have learned in school. Active learning improves students' retention and application of course content in various contexts. (Pierre, 2011).

Retention refers to the capacity of students to recall Biology concepts learned over a specific period. Retention, as defined by Beer (2010), is a tool utilised by students to enhance their efficiency and effectiveness in various aspects of life, particularly in academic pursuits. This tool is essential for learners to retain and modify knowledge in their memory over short and long durations. The teacher's method of

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instruction can help students retain the knowledge they have learned and, as a result, increase their achievement. This is why it is important for biology teachers to utilize innovative strategies that promote critical thinking and problem solving abilities in the teaching and learning of biology. One such innovative method is mind-mapping instructional strategy.

Buzan (1993) defined a mind-map as a graphic technique that expresses Radiant Thinking and unlocks the potential of the human brain. Mind-mapping, a graphic and visual tool that helps students organize and connect information in a meaningful way, has emerged as a promising technique to support learning in science education. Mind-mapping is a visually engaging note-taking method that incorporates colors, images, and text, in contrast to traditional note-taking techniques that may appear dull. Mind-maps facilitate both the acquisition and retrieval of information .Mind-Mapping involves creating a diagram that connects related concepts with lines and images. By using Mind-Mapping, students can see the relationships between ideas and concepts, making it easier to understand and remember them.

Mind-mapping is a technique that involves the creation of a visual map that represents the relationships between different pieces of information. This tool helps students to organize and integrate knowledge, which can lead to improved learning outcomes .According to AmboSaidi et al. (2009), mind-mapping enhances long-term retention of information among students due to the brain's greater ease in processing, storing, and recalling images compared to written materials. Mind-maps also facilitates the organisation of relationships and connections between ideas and information. According to Al-Otaibi (2016) and Hariyadi et.al (2018), mind-mapping facilitates students' recall of information and concepts, leading to improved immediate achievement and retention.

Research suggests that students retain information more effectively when it is presented to them both verbally and visually. The integration of mind-mapping facilitates the assimilation of knowledge through the use of visual aids and spatial organisation, thereby enhancing the comprehension of complex concepts. Mind-mapping has been found to be an effective tool for improving students' learning outcomes. Several studies have reported positive effects of mind-mapping on students' achievement. Okereke et.al (2017), Ogunleye et.al (2019), Al-Swalha (2021). While there is evidence that mind mapping can improve students' achievement, there is limited research on its effectiveness in improving students' retention of this knowledge. Therefore, the present study aims to investigate the impact of using mind-mapping instructional strategy in improving secondary school students' achievement and retention in Biology.

Statement of the Problem

Students frequently encounter difficulties in understanding, retaining and comprehending biology contents, due to the subject's immense and complex concepts. Sometimes, traditional methods that significantly rely on textbooks and lectures fall short of capturing students' attention, enhancing their performance, and facilitating long-term retention. To enable students to perform better in biology and retain learned concepts, it is necessary to implement teaching strategies such as mind-mapping that promote active participation, critical thinking, and the exploration of the relationships between various concepts, thereby nurturing a deeper understanding of biological concepts. The present study aims to examine the impact of mind-mapping instructional strategy on Biology students' achievement and retention.

The purpose of this study is to determine the impact of mind-mapping instructional strategy on the Achievement and Retention of Secondary School Students in Biology in Delta State.

Research Questions

1. What is the difference between the mean achievement scores of students taught Biology using mind-mapping instructional strategy and lecture method?

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume X Issue IX September 2023

2. What is the difference in the retention rate of students taught biology using mind-mapping instructional strategy and lecture method?

Hypotheses

1. There is no significant difference between the mean achievement scores of students taught Biology using mind-mapping instructional strategy and lecture method.
2. There is no significant difference in the retention rate of students taught biology using mind-mapping instructional strategy and lecture method.

METHODOLOGY

The study employed a quasi-experimental design, specifically utilizing pretest, posttest, and delayed posttest measures. The study included 151 SSS II students from three public secondary schools in Delta State's three senatorial districts. The study's schools were selected through a simple random sampling technique. The researcher employed the simple random sampling technique of balloting to select one school from each of the three Senatorial Districts, as the schools were already stratified. Lesson plans were written for mind mapping and lecture methods. The lesson plans were used to train the research assistants who were the subject teachers of the students. The duration of each weekly instruction was 80 minutes. The teacher instructed students in the technique of mind-mapping by providing examples at the start of the lesson and then requiring them to construct their own mind maps. The students identified key concepts in the content within their respective groups. The concepts were hierarchically arranged in a descending order of inclusivity and generality. The teacher facilitated active participation and provided guidance in concept identification and organization for all learners. Students utilized linking words to connect the various concepts. During the exercise, students were prompted to utilize colors to highlight highly pertinent concepts. The lecture method was employed to teach students in the lecture group. The teacher in this group provided required information on the selected Biology concepts to students during instruction. The data collection instrument was the Biology Achievement Test (BAT). The BAT consisted of 50 objective questions sourced from previous WAEC question papers on Respiration I and II, as well as Food Test I and II. Each question was accompanied by answer options labeled A-D. Two points were awarded for each correct answer. BAT was utilized to assess students' academic achievement in Biology.

BAT was also utilized to assess students' Biology knowledge retention. The BAT was modified by rearranging the item numbers and answer options to measure students' retention. The test was administered four weeks after the posttest was conducted. The BAT was face validated by three experts in the fields of measurement and evaluation, as well as biology education. The internal consistency of the BAT was assessed using Kuder-Richardson Formula 21 (KR-21) and resulted in a coefficient of 0.81. Prior to treatment, students in the mind-mapping and lecture groups underwent pretests in the form of BAT. This was done to determine the equivalence of the groups before treatment and be sure that any noticed change after treatment was due to the treatment administered. Both groups received treatment for six weeks, followed by a posttest of BAT administered to all students at the end of the treatment period. After a four-week interval, the students in both groups were given a delayed test, which involved the re-administration of BAT. Subsequently, the scores were compiled and analyzed.

Research Question 1

What is the difference between the mean achievement scores of students taught Biology using mind-mapping instructional strategy and lecture method?

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume X Issue IX September 2023

Table 1. Mean and Standard Deviation (SD) of Pretest and Posttest Achievement Scores Among Students Taught Biology Using Mind-Mapping Strategy and Lecture Method

Group	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Mind-mapping	74	21.45	9.46	58.05	10.23	36.60
Lecture	77	21.90	8.26	49.38	10.52	27.48

Table 1 shows a pretest mean achievement score of, 21.45 and 21.90, with corresponding standard deviation score of 9.46 and 8.26, for students taught Biology using mind-mapping strategy and lecture method respectively. Regarding the posttest, students in mind-mapping group obtained a mean achievement score of 58.05, with a standard deviation of 10.23. Students in the lecture group obtained a mean achievement score of 49.38, with a standard deviation of 10.52. Table 1 indicates that students taught using mind-mapping strategy had a higher mean achievement score compared to students taught using lecture method.

Research Question 2

What is the difference in the retention of students taught Biology with Mind-mapping instructional strategy and lecture method?

Table 2. Mean, Standard Deviation (SD) and percentage retained of posttest and delayed test Scores between Students Taught Biology Using Mind-Mapping and Lecture Methods

Group	N	Posttest		Delayed posttest		MD	% Lost $(\frac{MD}{mpt} x\ 100)$	%Retained(100-%lost)
		Mean	SD	Mean	SD			
Mind-mapping (Mm)	74	58.05	10.23	55.65	8.82	2.40	4.13	95.87
Lecture (L)	77	49.38	10.52	43.06	10.16	6.32	12.80	87.20

MD = Mean Difference, mpt = mean posttest

Table 2 shows a posttest mean score of 58.05, with a standard deviation of 10.23, for students taught Biology using mind-mapping strategy and students taught Biology using the lecture method had a posttest mean score of 49.38, with a standard deviation of 10.16. Table 1 further shows a delayed test score of 55.65, with a standard deviation of 8.82, for students taught Biology using mind-mapping strategy and students taught Biology using the lecture method had a delayed test mean score of 43.06, with a standard deviation of 10.16.Table 1 indicates that students taught Biology using mind-mapping and lecture method retained 95.87% and 87.20% of Biology knowledge respectively. The variation in the percentage retention showed that there is a difference in the mean retention scores between students taught Biology using mind-mapping and lecture method, with students in the mind-mapping group retaining higher than lecture group respectively.

Hypothesis 1

There is no significant difference among the mean achievement scores of students taught Biology with mind-mapping instructional strategy and lecture method.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume X Issue IX September 2023

Table 3. ANOVA Comparison of Pretest Scores of Students Taught Biology Using Mind-Mapping Strategy and Lecture Method

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	7.647	1	7.647	.097	.756
Within Groups	11713.453	149	78.614		
Total	11721.099	150			

p>0.05

Table 3 shows that there is no significant difference in the pretest mean achievement scores among students taught Biology using Vee heuristics strategy, mind-mapping strategy and lecture method, F(1, 149) = 0.097 P(0.756) > 0.05. Hence, Ho_1 was tested using ANOVA.

Table 4. ANOVA Comparison of Posttest Scores of Students Taught Biology Using Mind-Mapping Strategy and Lecture Method

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2841.370	1	2841.370	26.378	.000
Within Groups	16049.862	149	107.717		
Total	18891.232	150			

P<0.05

Table 4 shows that there is a significant difference in the posttest mean achievement scores among students taught Biology using mind-mapping strategy and lecture method, F (1, 149) = 26.378, P (0.000) < 0.05. Therefore, the null hypothesis is rejected. Thus, there is a significant difference in the mean achievement scores between students taught Biology using mind-mapping strategy and lecture method.

Hypothesis 2

There is no significant difference in the retention of students taught Biology with mind-mapping instructional strategy and lecture method.

Table 5. ANOVA Comparison of Delayed test Scores of Students Taught Biology Using Mind-Mapping Strategy and Lecture Method

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	5975.347	1	5975.347	65.855	.000
Within Groups	13519.540	149	90.735		
Total	19494.887	150			

P<0.05

Table 3 shows that there is a significant difference in the delayed test mean scores among students taught Biology using mind-mapping strategy and lecture method, F(1, 149) = 65.855, P(0.000) < 0.05. Therefore, the null hypothesis is rejected. Thus, there is a significant difference in the mean retention scores between

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume X Issue IX September 2023

students taught Biology using mind-mapping strategy and lecture method.

DISCUSSION OF FINDINGS

This study focused on the Impact of mind-mapping instructional strategy on Secondary School Students Achievement and Retention in Biology in Delta State. The Finding of this study revealed that the difference in the mean achievement scores between students taught biology using minding-mapping and lecture method was statistically significant. A possible reason for the observed superior academic performance of students instructed in Biology through the use of mind-mapping instructional strategy, in comparison to those taught using the traditional lecture method, could be attributed to the active cognitive involvement of students. When engaging in the development of mind-maps, students are required to engage in cognitive processes such as information processing, identification of significant concepts, and establishment of interconnections among these concepts. Active engagement in the learning process facilitates enhanced comprehension and long-term memory retention. However, the students who were instructed using the conventional lecture approach received the requisite knowledge from the teacher. The students passively received the teacher's explanation. The observed decrease in student performance within the lecture method group may be attributed to the passive engagement of students. This finding aligns with the research conducted by Waqad (2009), which identified significant differences in the academic achievement of Biology students across various levels of Bloom's taxonomy (understanding, application, analysis, and synthesis). The study found that mind-mapping was more effective than the conventional lecture method in enhancing student performance. The present finding aligns with the research conducted by Okereke and Okigbo (2019), which examined the effectiveness of the mind-mapping teaching strategy in enhancing academic achievement and fostering interest in computer studies among senior secondary school students in the Owerri municipal council of Imo State. The study additionally showed the significant effect of mind-mapping in comparison to the traditional lecture method. The study's findings also demonstrate a statistically significant disparity in the retention rates of students who were taught Biology using the mind-mapping strategy compared to those who were taught using the lecture method. The potential of the mind-mapping strategy to enhance students' discovery-oriented learning abilities may explain the observed improvement in retention scores between students instructed in Biology using this strategy, compared to those instructed through traditional lecture methods. The utilization of the mind-mapping technique enables individuals to engage in self-directed learning and acquire knowledge. As a result, the students who received instruction using mind-mapping techniques demonstrated the ability to autonomously learn knowledge. The utilization of the lecture method was employed as a means to disseminate knowledge to the students. The notion that information that is actively discovered is more likely to be preserved in memory for a longer period of time compared to information that is passively provided is commonly recognized in academic discourse. The utilization of mind-mapping as an instructional strategy in Biology teaching perhaps played a role in the attainment of higher retention scores among students, in contrast to those who received instruction through traditional lecture-based method. This discovery offers corroborating evidence for the research conducted by Mohammed et al. (2021), who identified a significant difference between Biology students who were taught Genetics using mind-mapping techniques and those who were taught using the conventional lecture method. The findings demonstrated a preference for the mind-mapping instructional approach. This finding is consistent with the research conducted by Abamba et.al (2021), who demonstrated that the use of mind-mapping results in significantly greater academic achievement and retention among students compared to the traditional lecture method.

CONCLUSION

The study's results indicate that both mind-mapping and lecture methods had significant impact on students' achievement and retention, as determined by post-test and delayed test scores measuring achievement and retention. The study found significant differences in the performance between students taught using mind-

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume X Issue IX September 2023

mapping strategy and those taught with lecture methods, with students taught using mind-mapping strategy outperforming those taught using lecture method. The study also found that the retention rate was higher among students who were taught using the mind-mapping strategy compared to those who received instruction through lecture method.

RECOMMENDATIONS

1. Teachers should consider incorporating mind-mapping as a regular instructional method in the field of biology, as it has been shown to enhance academic performance and improve long-term knowledge retention.
2. Government agencies and professional associations responsible for the development and modification of the biology curriculum in secondary schools should consider integrating mind-mapping techniques into the official curriculum. Additionally, it is recommended that workshops and training sessions be provided to assist teachers in effectively implementing this instructional strategy.
3. It is recommended that governmental bodies dedicate resources and funding towards conducting additional studies on the efficacy of mind-mapping across many academic disciplines.

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